Harry Kim
Mayor

Wilfred M. Okabe
Managing Director

William A. Kucharski
Director

Diane A. Noda
Deputy Director

County of Hawai'i

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

345 Kekūanāo'a Street, Suite 41 · Hilo, Hawai'i 96720
Ph: (808) 961-8083 · Fax: (808) 961-8086
Email: cohdem@hawaiicounty.gov

February 5, 2019

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

Subject: Draft Environmental Impact Statement for the Kealakehe Wastewater Treatment Plant R-1 Upgrade Project Tax Map Keys: (3) 7-4-008:058, 7-4-008:073, and 7-4-020:007 Kailua-Kona, Hawai'i

Dear Mr. Glenn:

With this letter, the County of Hawai'i Department of Environmental Management (DEM) hereby transmits the Draft Environmental Impact Statement (DEIS) for the Kealakehe Wastewater Treatment Plant R-1 Upgrade Project. A completed Agency Publication Form and a summary of the proposed action are enclosed (with a copy of the same sent via electronic mail to oeqc@doh.hawaii.gov).

Pursuant to the requirements of Hawai'i Administrative Rules Sections 11-200-3 and 11-200-15, we request that you publish notice of the DEIS in the next available edition of *The Environmental Notice*. The public is to submit comments to Wilson Okamoto Corporation, with copies to DEM during the 45-day public comment period. We have enclosed one (1) each of the following items:

- Hardcopy of the DEIS and OEQC publication form
- CD containing three (3) copies of the DEIS and OEQC publication form in PDF format

If you have any questions, please contact Earl Matsukawa of Wilson Okamoto Corporation at (808) 946-2277.

Sincerely,

William A. Kucharski
Director

WK:mef
Enclosures

19-255

AGENCY
PUBLICATION FORM

Project Name:	*Kealakehe Wastewater Treatment Plant R-1 Upgrade*
Project Short Name:	*Kealakehe WWTP R-1 Upgrade*
HRS §343-5 Trigger(s):	1) Use of State and County Lands / Funds, 2) Proposed use within land classified as a conservation district
Island(s):	Hawai'i
Judicial District(s):	North Kona
TMK(s):	7-4-008:058, 7-4-008:073, 7-4-020:007 (por.)
Permit(s)/Approval(s):	Special Management Area, Conservation District Use Application
Proposing/Determining Agency:	County of Hawai'i Department of Environmental Management
Contact Name, Email, Telephone, Address	Curtis Bailey, 345 Kekūanāo'a St., Suite 41, Hilo, HI 96720; 808.961.8279 Curtis.Bailey@hawaiicounty.gov
Accepting Authority:	Mayor of the County of Hawai'i, Harry Kim
Contact Name, Email, Telephone, Address	Office of the Mayor, West Hawai'i: 74-5044 Ane Keohokalole Highway, Bldg C, Kailua-Kona, HI 96740 (808) 323-4444 http://www.hawaiicounty.gov/office-of-the-mayor
Consultant:	Wilson Okamoto Corporation
Contact Name, Email, Telephone, Address	Earl Matsukawa, ematsukawa@wilsonokamoto.com 1907 South Beretania Street, Suite 400 Honolulu, Hawai'i 96826 T (808) 946-2277 F (808) 946-2253

Status (select one)	**Submittal Requirements**
____ DEA-AFNSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEA, and 4) a searchable PDF of the DEA; a 30-day comment period follows from the date of publication in the Notice.
____ FEA-FONSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; no comment period follows from publication in the Notice.
____ FEA-EISPN	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; a 30-day comment period follows from the date of publication in the Notice.
____ Act 172-12 EISPN ("Direct to EIS")	Submit 1) the proposing agency notice of determination letter on agency letterhead and 2) this completed OEQC publication form as a Word file; no EA is required and a 30-day comment period follows from the date of publication in the Notice.
__X__ DEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEIS, 4) a searchable PDF of the DEIS, and 5) a searchable PDF of the distribution list; a 45-day comment period follows from the date of publication in the Notice.
____ FEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEIS, 4) a searchable PDF of the FEIS, and 5) a searchable PDF of the distribution list; no comment period follows from publication in the Notice.
____ FEIS Acceptance Determination	The accepting authority simultaneously transmits to both the OEQC and the proposing agency a letter of its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS; no comment period ensues upon publication in the Notice.
FEIS Statutory Acceptance	Timely statutory acceptance of the FEIS under Section 343-5(c), HRS, is not applicable to agency actions.
____ Supplemental EIS Determination	The accepting authority simultaneously transmits its notice to both the proposing agency and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and

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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

Provide a description of the proposed action and purpose and need in 200 words or less.

The County of Hawai'i Department of Environmental Management (DEM) is proposing improvements to the Kealakele Wastewater Treatment Plant (WWTP) that will provide additional treatment to produce R-1 standard water suitable for reuse in accordance with the State of Hawaii, Department of Health Reuse Guidelines. In addition, treated wastewater in excess of demand for reuse will be further treated through a proposed onsite subsurface flow constructed wetlands and then conveyed to a proposed offsite soil aquifer treatment (SAT) facility for even further treatment and disposal.

The recycled water will be used to irrigate a proposed landscaped buffer parcel surrounding the WWTP and the DEM also proposes to construct an underground recycled water transmission pipeline to the Old Kona Airport Park for irrigation within the park. The transmission pipeline will be avialble to other users in the area. A recycled water transmission pipeline is also proposed from the WWTP to Queen Ka'ahumanu Highway where it will turn north within the highway right-of-way and connect to a recycled water transmission pipeline that was constructed in the highway by the State Department of Transportation for the DEM as part of its Queen Ka'ahumanu Highway Widening Project. That pipe will extend from the connection at the Kealakehe Parkway intersection to the driveway entrance of the Kohanaiki Golf and Ocean Club, which plans to use the recycled water for irrigation. At the intersection of Hina Lani Drive, a new transmission pipe will branch off mauka along Hina Lani Drive to an abandoned Department of Water Supply reservoir, which has been conveyed to DEM and will be converted to store recycled water.

In future phases, underground transmission pipelines and another new storage tank will be constructed in road rights-of-way and easements for distribution of recycled water to other users.

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Kealakehe Wastewater Treatment Plant R-1 Upgrade

Draft Environmental Impact Statement

Prepared For

County of Hawaii

Department of Environmental Management

Prepared By

Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

February 2019

Harry Kim
Mayor

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Pursuant to the requirements of Hawai'i Administrative Rules Sections 11-200-3 and 11-200-15, we request that you publish notice of the DEIS in the next available edition of *The Environmental Notice*. The public is to submit comments to Wilson Okamoto Corporation, with copies to DEM during the 45-day public comment period. We have enclosed one (1) each of the following items:

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If you have any questions, please contact Earl Matsukawa of Wilson Okamoto Corporation at (808) 946-2277.

Sincerely,

William A. Kucharski
Director

WK:mef
Enclosures

PREFACE

This Draft Environmental Impact Statement (EIS) was prepared pursuant to Chapter 343, Hawaii Revised Statutes, and Title 11, Chapter 200, Administrative Rules, Department of Health, State of Hawaii. The County of Hawai'i Department of Environmental Management (DEM) is proposing improvements to the Kealakele Wastewater Treatment Plant (WWTP) to provide additional treatment to the effluent to produce R-1 recycled water suitable for reuse in accordance with the State of Hawai'i, Department of Health (DOH) Reuse Guidelines. Treated effluent in excess of demand for reuse will be further treated through a proposed onsite subsurface flow constructed wetlands and then conveyed to a proposed offsite soil aquifer treatment (SAT) facility for further treatment and disposal. The facilities related to the R-1 treatment process will be constructed adjacent to the area of the existing treatment facilities so that the improvements will be located within WWTP parcel.

The recycled water will be used to irrigate a proposed landscaped buffer parcel surrounding the WWTP and the DEM also proposes to construct an underground recycled water transmission pipeline to the Old Kona Airport Park where the recycled water will be used to irrigate areas within the Park. The transmission pipeline will be designed to allow other nearby properties to also use the recycled water. A recycled water transmission pipeline is also proposed from the WWTP to Queen Ka'ahumanu Highway where it will turn north within the highway right-of-way to the Kealakehe Parkway intersection where it connect to a recycled water transmission pipeline that was constructed in the highway by the State Department of Transportation (DOT) for the DEM as part of its Queen Ka'ahumanu Highway Widening Project. The DOT constructed line extends from the connection at the Kealakehe Parkway intersection to the driveway entrance of the Kohanaiki Golf and Ocean Club, which plans to use the recycled water for irrigation. At the intersection of Hina Lani Street, the DOT has constructed a recycled transmission pipeline to the mauka side of the highway where DEM will extend the pipeline along the north side of Hina Lani Street to an abandoned Department of Water Supply reservoir, which has been conveyed to DEM and will be converted to store recycled water.

In future phases, an underground transmission pipeline and another new storage tank will be constructed in road rights-of ways and easements for distribution of recycled water to other users.

The DEM, through its previous EIS Preparation Notice published on March 23, 2017, determined the collective scale of the recommended improvements warrants the preparation and processing of an environmental impact statement (EIS) to comply with Chapter 343. This Draft EIS was prepared in accordance with that determination. The R-1 Upgrade improvements will also use funds provided by the State of Hawaii DOH Clean Water State Revolving Fund which also requires the project comply with certain federal requirements.

SUMMARY

Project Name:	Kealakehe Wastewater Treatment Plant (WWTP) R-1 Upgrade
Proposing Agency:	County of Hawai'i Department of Environmental Management 345 Kekuanoa Street, Suite 41 Hilo, Hawaii 96720 William A. Kucharski, Director Telephone: (808) 961-8083; Fax: (808) 961-8086
Accepting Authority:	Harry Kim, Mayor County of Hawaii
Planning Consultant:	Wilson Okamoto Corporation 1907 South Beretania Street, Suite 400 Honolulu, Hawai'i 96826 Mr. Earl Matsukawa, AICP Telephone: (808) 946-2277; Fax: (808) 946-2253
Location:	Kealakehe, Keahuloa, North Kona, Hawai'i
Tax Map Keys:	Kealakehe WWTP/Buffer: 7-4-008:058/7-4-008:073 Soil Aquifer Treatment (SAT) facility site: Portion of 7-4-020:007 Various road rights-of-way and easements for transmission pipes
Land Area:	105.4 Acres (approximate) and approximately 3.77 miles of underground recycled water transmission pipelines
Recorded Fee Owner:	7-4-008:058 (State of Hawai'i) 7-4-008:073 (State of Hawai'i) 7-4-020:007 (State of Hawai'i)
Existing Use:	Kealakehe Wastewater Treatment Plant (WWTP), wastewater disposal basin site, various roads, driveways and jeep trails, one (1) abandoned water tank and vacant land
State Land Use District:	Kealakehe WWTP, buffer and SAT site: Urban Portions of proposed recycled water transmission pipelines cross land designated Conservation and Agricultural
Special Management Area:	The Kealakehe WWTP, buffer and recycled water transmission pipelines makai of Queen Ka'ahumanu Highway are located in the County of Hawai'i Special Management Area (SMA)
County of Hawai'i Zoning:	Open. Portions of the recycled water transmission pipelines cross Agricultural-minimum 5 acre building site (A-5a).
Proposed Action:	The County of Hawai'i Department of Environmental Management (DEM) is proposing improvements to the Kealakele Wastewater Treatment Plant (WWTP) to provide additional treatment to the effluent to produce R-1 recycled water suitable for reuse in accordance with the State of Hawai'i, Department of Health (DOH) Reuse Guidelines. Treated wastewater in excess of demand for

reuse will be further treated through a proposed onsite subsurface flow wetlands and then conveyed to a proposed offsite soil aquifer treatment (SAT) facility for further treatment and disposal. The facilities related to the R-1 treatment process will be constructed adjacent to the area of the existing treatment facilities so that the improvements will be located within WWTP parcel.

The recycled water will be used to irrigate a proposed landscaped buffer parcel surrounding the WWTP and the DEM also proposes to construct underground recycled water transmission pipes to properties that plan to utilize the recycled water. These properties include the Old Kona Airport. A recycled water transmission line is also proposed from the WWTP to Queen Kaʻahumanu Highway where it will turn north within the highway right-of-way and connect to a recycled water transmission pipe that was constructed in the highway by the State Department of Transportation (DOT) for the DEM as part of its Queen Kaʻahumanu Highway Widening Project. The DOT constructed pipeline extends from the connection at the Kealakehe Parkway intersection to the driveway entrance of the Kohanaiki Golf and Ocean Club, which plans to use the recycled water for irrigation. At the intersection of Hina Lani Street, the DOT has constructed a recycled pipeline to the mauka side of the highway where DEM will extend the pipeline along the north side of Hina Lani Street to an abandoned Department of Water Supply reservoir, which has been conveyed to DEM and will be converted to store recycled water.

In future phases, underground transmission pipelines and another new storage tank will be constructed in road rights-of ways and easements for distribution of recycled water to other users.

Significant Beneficial and Adverse Impacts and Proposed Mitigation Measures

Ground Water: The proposed project improvements will have beneficial water quality impacts to ground water resources and to coastal waters.

Construction and operation of the proposed improvements is expected to significantly reduce the mass of nutrients, primarily nitrogen and phosphorus, which percolates to the ground water when compared to the current amount discharged to the existing percolation basin. The nutrient mass reductions will be achieved via the combination of water recycling, the subsurface flow constructed wetlands, and the SAT system. The existing percolation basin will be closed as part of the project.

The R-1 Upgrade improvements project is expected to reduce the mass of nitrogen and phosphorus that currently percolates to ground water via disposal by greater than 90 percent when compared to the current percolation basin disposal method. Other treatment benefits will be realized through implementation of the R-1 Upgrade project, include reduction of metals, trace organic compounds, endocrine disrupting compounds, and other pollutants that currently percolate to ground water from the WWTP's existing disposal system. Use of the treated effluent as R-1 recycled water for irrigation purposes will reduce the volume or amount effluent for disposal. Thus, reduction in the volume of disposal and some reduction of the concentration of the various pollutants is expected to be achieved.

Construction and operation of the project is projected to significantly reduce the mass of nitrogen and phosphorus that percolates to the basal ground water lens via effluent disposal, in the area generally flows towards the ocean. As a result, the project will reduce the mass of nitrogen and phosphorus originating from the Kealakehe WWTP effluent that ultimately enters the ocean via ground water.

Air Quality: In the long-term, the primary air quality concern will be the odor generated from the Kealakehe WWTP.
The existing WWTP is equipped with an odor control system at the headworks, and the recently-upgraded lagoon aeration system ensures that the existing WWTP processes are not a source of nuisance odors.

The R-1 treatment system and subsurface flow constructed wetlands improvements will be fed water that has already been oxidized in the aerated lagoons, therefore they will not be a source of nuisance odors. The use of highly-treated R-1 water is not associated with nuisance odor conditions. The SAT site will receive WWTP effluent that has been treated in the aerated lagoon system and subsurface flow constructed wetland and will not be a source of nuisance odors.

Short Term Construction Impacts: There will be short term temporary impacts related to noise and traffic during the construction period.
Noise
In the short-term, noise levels will increase from construction activities at the Kealakehe WWTP, the buffer area, the SAT site and along the areas adjacent to the transmission pipelines. It is expected the noise will be intermittent and unavoidable, since construction vehicles, heavy equipment generate noise as part of normal operations. The mitigation of noisy activities to inaudible levels will not be practical in all cases due to the intensity and exterior nature of the work. Ambient noise levels in the vicinity of construction sites can be expected during construction periods. Construction activities will need to comply with the provisions of HAR Title 11, Chapter 46, Community Noise Control.

Traffic
Short-term impacts on traffic would occur during construction of the various improvements. Construction of the R-1 treatment facilities will require bringing construction equipment, supplies, and material to the Kealakehe WWTP and to the SAT project site. Various types of construction equipment will be required to excavate the sites for construction of the treatment facilities, including the constructed wetlands and the SAT. Trucks will be needed to transport the excavated material from both sites to a disposal site. Also, various types of materials and supplies will be needed to construct the above ground structures and the administration building and to install the pumps. The materials and supplies include rebar, concrete, piping, motors, pumps, conduits, process equipment, controls, and various fabricated items.

Alternatives Considered
Project alternatives were considered related to treatment method and effluent disposal.

The treatment alternatives included:
- Activated Sludge Treatment Plant
- Advanced Nutrient Removal

Effluent disposal alternatives included.
- Surface Water Discharge
- Ocean Discharge
- Injection wells
- Evaporation

- Slow Rate Land Treatment
- Seasonal Storage Reservoir
- Desalination

List of Agencies; Other Parties Consulted in EIS Preparation Notice:

Federal Agencies	U.S. Army Corps of Engineers U.S. Department of Agriculture, Natural Resources U.S. Environmental Protection Agency U.S. Fish and Wildlife Service U.S. National Parks Service, Kaloko Honokohau National Historic Park U.S. National Marine Fisheries Service U.S. Department of the Navy Federal Aviation Administration Federal Highways Administration U.S. Department of Homeland Security National Oceanic and Atmospheric Administration
State Agencies	Department of Agriculture Department of Accounting and General Services Department of Business, Economic Development and Tourism (DBEDT) DBEDT, Strategic Industries Division DBEDT, Hawai'i State Energy Office DBEDT, Land Use Commission DBEDT, Office of Planning Department of Defense Department of Education Department of Hawaiian Homelands Department of Health Department of Health, Environmental Management Branch Department of Health, Environmental Planning Office Department of Health, Clean Water Branch Department of Health, Wastewater Branch Department of Health, Office of Environmental Quality Control Department of Land and Natural Resources (DLNR) DLNR, Historic Preservation Division DLNR, Division of Forestry and Wildlife DLNR, Engineering Division DLNR, Commission on Water Resource Management Department of Transportation Department of Transportation, Airports Division Department of Transportation, Highways Division Office of Hawaiian Affairs University of Hawai'i Environmental Center University of Hawai'i Sea Grant
County Agencies	Fire Department Department of Parks and Recreation Department of Planning

	Department of Public Works Department of Water Supply Office of the Mayor
Utilities/Others	Hawai'i Electric Light Company (HELCO) Verizon Hawai'i Hawai'i Gas Hawaiian Telcom Oceanic Time Warner Cable Queen Liliuokalani Trust Kohanaiki Golf & Ocean Club Aronson, Sue Aronson, Ron Bennett, Richard Clement, Jane Gaffney, Rick Holmes, Steve Kaapu, David Kahui, Bo Kanuha, Dru Kim, Susan Leicher, Terri Moore, Bill Murata, Justin Nazara, Cynthia Palacat-Nelson, Shane Purdy, Mānā Root, Joe Sung, Shihwu Shibata, Michael Taylor, Bill Wilson, Ross Zimpfer, Jeff

Comments and responses to the EIS Preparation Notice are shown in Appendix A

1. INTRODUCTION

1.1 Introduction

In 1993, the County of Hawai'i Department of Public Works constructed the Kealakehe Wastewater Treatment Plant (WWTP) within the area which was then identified as a 52.959-acre parcel north of Kailua-Kona. It lies about 1.5 miles north of Kailua-Kona and about 4.7 miles south of Runway 35 at Ellison Onizuka Kona International Airport at Keāhole on the western coast of Hawai'I Island. It is also located about 3,700 feet (0.70 miles) south of Honokohau Small Boat Harbor and about 4,500 feet (0.85 miles) south of the southern boundary of Kaloko Honokohau National Historical Park. The WWTP lies at an elevation of about 56 feet mean sea level (msl). The access road to the Kealakehe WWTP is on the west (makai) side of Queen Ka'ahumanu Highway (Route 190) at mile maker 98.06 and is an extension of Hale Māka'i Place which extends mauka on the east side of the highway. The Kealakehe WWTP is at the end of the access road, approximately 2,000-feet (0.38 miles) from the highway (See Figure 1-1, Project Location Map). The Kealakehe WWTP is secured with a 6-foot security fence topped with a 3-strand barbed wire outrigger. A locked traffic gate located about 250 feet west of Queen Ka'ahumanu Highway controls access into the WWTP. (See Figure 1-2., Project Site Map)

The Kealakehe WWTP treats and disposed of sewage collected from the North Kona Sewerage system, which extends across the greater Kailua-Kona region from just south of Kealakehe Parkway at its northern edge to Ali'i Heights at the southern edge. When constructed, it was intended that secondary treated effluent from the Kealakehe WWTP would be reused to irrigate the proposed Kealakehe municipal golf course that was planned to be located mauka of Queen Ka'ahumanu Highway in the area opposite the WWTP. The golf course, which was to be privately developed, for a variety of factors, was never constructed. As a result, since 1993, the secondary treated effluent, produced through the aerated lagoon process, has been disposed of into an approximately 10,000 square-foot disposal percolation basin located in the lava field located mauka of Queen Ka'ahumanu Highway and about 1,600 feet north of Hale Māka'i Place. The site of the formerly planned golf course is now planned as a County regional park and lies within TMK: 7-4-020:007. Access to the disposal percolation basin is via Hale Māka'i Place which also provides access to a Hawai'i Electric Light Co. (HELCO) substation, the Kona Police Substation and the County's Kealakehe solid waste transfer station.

The Kealakehe WWTP currently treats about 1.7 million gallons per day (mgd) of incoming flows to secondary treatment classification through the use of five aerated lagoons. The existing facilities at the Kealakehe WWTP consist of a headworks; five below-grade lined lagoons and related facilities used to operate the partial mix aerated lagoons; facilities to further treat the effluent, including adding sodium hypochlorite; and, a pumping system to transmit the effluent to the disposal percolation basin.

1.2 Land and Other Site Information

The Kealakehe WWTP occupies an area currently shown as a 52.959-acre parcel (TMK 7-4-008:058) owned by the State of Hawai'i (See Figure 1-3, Tax Map Keys). In July 1992, the parcel was set aside by Executive Order (EO) 3560 for the purposes of the Kealakehe WWTP and under the control and management of the County of Hawai'i. The EO also includes a 60-foot wide access easement to Queen Ka'ahumanu Highway. In February 2001, an approximately 40.458-acre buffer parcel (TMK 7-4-008:073), owned by the State of Hawai'i was set aside by EO 3856 for use as an addition to the Kealakehe WWTP. The buffer parcel surrounds all four sides of the WWTP parcel and includes an additional 30-foot wide access

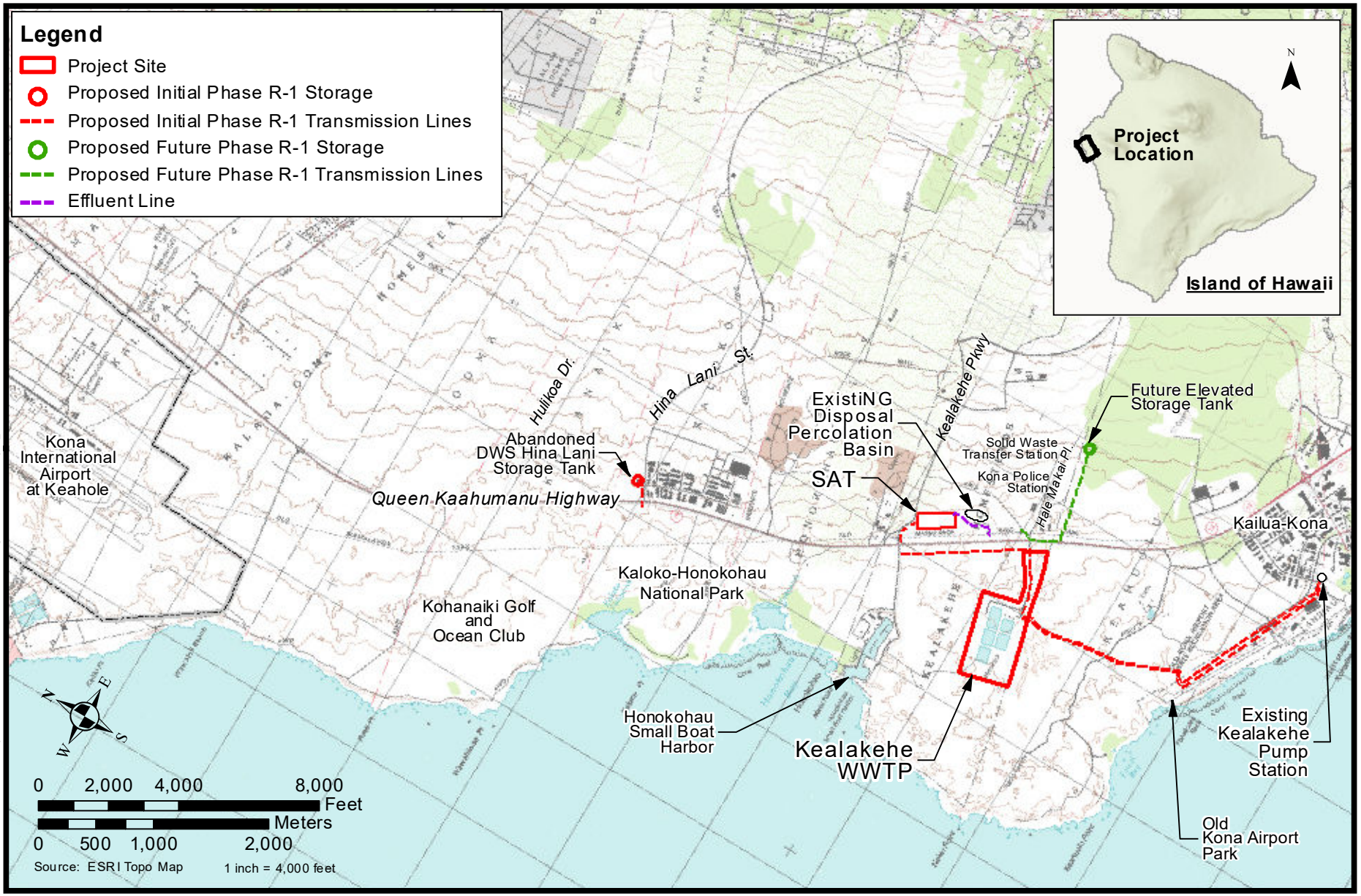
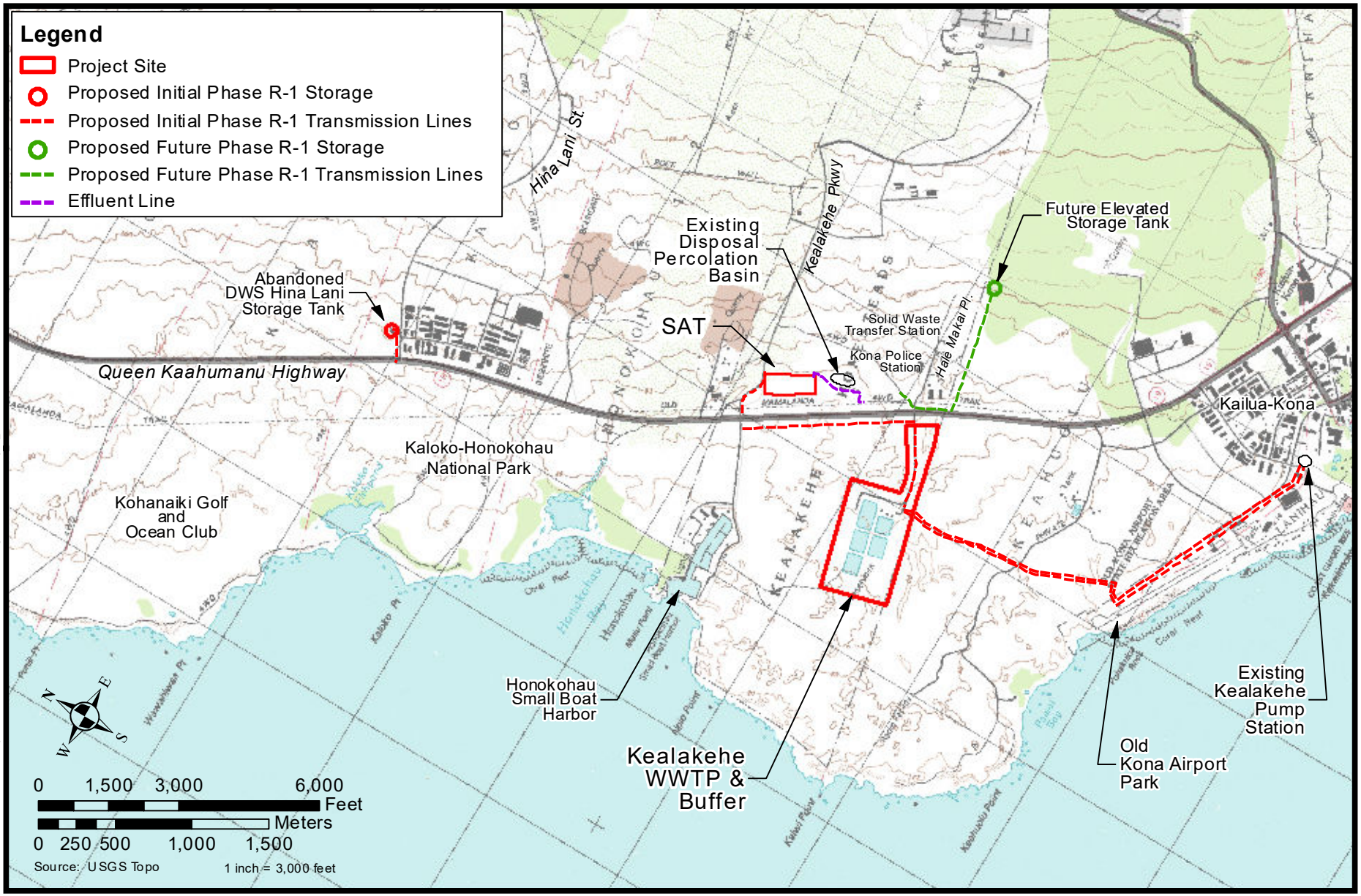


FIGURE 1-1

PROJECT LOCATION MAP

Kealakehe WWTP R-1 Upgrade

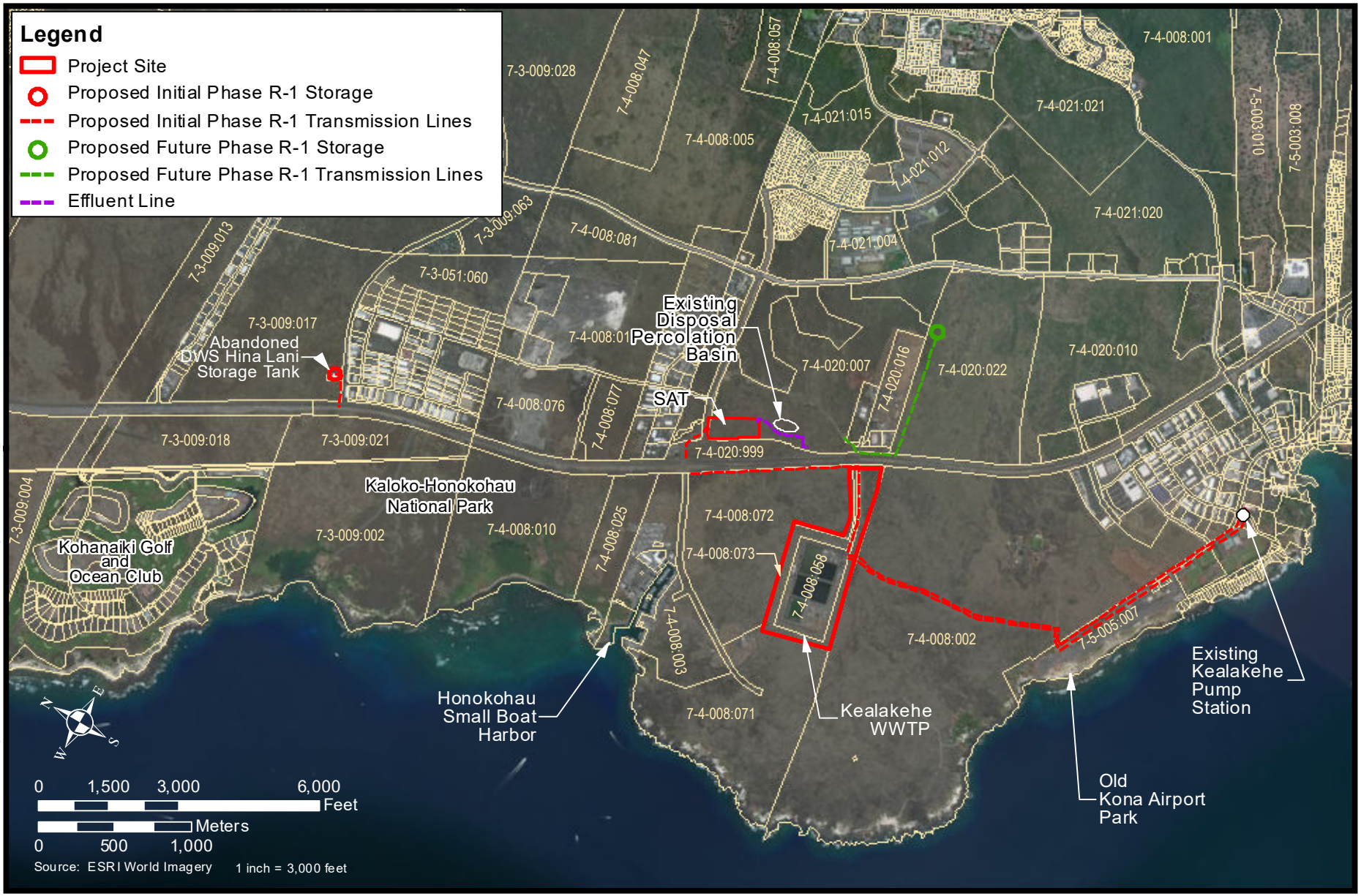


WILSON OKAMOTO CORPORATION

FIGURE 1-2

PROJECT SITE MAP

Kealakehe WWTP R-1 Upgrade



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WILSON OKAMOTO CORPORATION

FIGURE 1-3

TAX MAP KEYS

Kealakehe WWTP R-1 Upgrade

easement that extends eastward to the western edge of the Queen Ka'ahumanu Highway. Executive Order 3856 also established a 3,573.56-foot long by about 60-foot wide (4.918 acres) perpetual non-exclusive irrigation easement along the west side of Queen Ka'ahumanu Highway.

The existing disposal percolation basin is located east of Queen Ka'ahumanu Highway within a 190.547 acre parcel identified as TMK: 7-4-020:007. That parcel was set aside in 1992 to the County of Hawai'i, Department of Public Works by EO 3665. The purpose of that EO was for a Kealakehe Wastewater Reclamation Field and North Kona Golf Course. In 2009, the County requested the State of Hawai'i Department of Land and Natural Resources (DLNR) to amend EO 3665 to allow development of an active public park. Subsequently, on November 22, 2010, the Land Board approved the DLNR recommendation to cancel EO 3665 and the same land be reset aside to the County under a new EO to include the broader purposes requested by the County. The DLNR stated that one of the reasons a cancellation is recommended instead of an amendment was that EO 3665 had been issued specifically to "the Department of Public Works, County of Hawai'i." However, since DLNR understood the County Department of Parks and Recreation would manage the public park, the DLNR reasoned that a reset-aside of the parcel to the "County of Hawaii" would give the County the flexibility to designate the portions to be managed by the appropriate department. Finally, on March 11, 2011, EO 4355 was issued for the for the Kealakehe Wastewater Reclamation Field, North Kona, Golf Course and/or Public Park purposes, to be under the control and management of the County of Hawai'i.

1.3 Previous Environmental Documents

In July 1981, the County of Hawai'i Department of Public Works (DPW) issued the *Revised Environmental Impact Statement (EIS) for the Kailua-Kona Sewerage System Phase IV (Northern Zone)*. As described in the Revised EIS, the project included an expanded collection system, a new treatment plant at Kealakehe near Honokohua Harbor and disposal via a deep ocean outfall. The project also included abandoning the treatment plant located in the industrial area of Kailua-Kona.

As described in the Revised EIS, the most cost effective treatment process is aerated lagoons because of its low operation and maintenance costs. The lagoons will achieve secondary treatment using the complete mix aerobic systems. Solids will settle in the bottom of the lagoons and will not require disposal. The document stated the State had committed 25 acres of land at Kealakehe for the treatment facility. The County had requested the site be expanded to 30 acres.

The drawing for the plant showed: 4 lagoons; influent line; headworks; blower building; control and maintenance building; lagoon road; and perimeter fence. A 30-inch deep ocean outfall was to be used for disposal of the treated effluent. That facility was to have a design capacity of 2.8 mgd.

In March 1982, the DPW issued the *Revised Final Environmental Impact Statement for the Kailua-Kona (Southern Zone) Facility Plan North Kona District* project. As described in the Revised Final EIS, the project included construction of a sewage collection and transmission system, including pump stations, force mains, and gravity interceptors for the area designated as the Kailua-Kona southern zone. The southern zone collection system will be an integral part of the overall regional concept and will collect and transport the sewage generated within the southern zone to a treatment facility located within the area designated as the Kailua-Kona

northern zone. The environmental assessment was limited to proposed actions within the Kailua-Kona southern zone.

1.4 Previous Special Management Area Permits

1.4.1 Kealakehe WWTP

On January 31, 1989, the County of Hawai'i Planning Commission approved Special Management Area Use Permit No. 280 to allow the construction of the Kealakehe WWTP and related improvements at Kealakehe, North Kona, Hawai'i within TMK: 7-4-008: portion of 3. The application was for the 53+ acre area to be used for the wastewater treatment plant and related improvements. The applicant was to submit a metes and bounds description of the 53+ acre area. (See Figure 1-4, Special Management Area Map)

The approval stated that the requested Special Management Area Use Permit Application will not have any significant adverse environmental or ecological effects. The project site is located on pahoehoe lava with little soil and vegetation. Endangered species have not been associated with this site. Additionally, no historic or archaeological sites have been associated with the project site.

Further, the development of the Kealakehe WWTP was determined to be consistent with the objectives and policies provided by Chapter 205A, HRS, and the Special Management Area Guidelines. The project did not involve dredging or filling; did not reduce the size of a beach or recreational area; did not reduce access to the shoreline; did not interfere with the line of sight from the Queen Ka'ahumanu Highway to the shoreline; and did not adversely affect the coastal water quality, fisheries, wildlife habitats or agricultural use of land.

Moreover, the development was found to be consistent with the County General Plan and zoning. The project is sited in the Urban District, in an area designated as Alternate Urban Expansion and is a use permitted in the Zoning Code. The proposed improvements to the Kealakehe WWTP is part of a coordinated development effort involving the County and State of Hawai'i.

Further, no adverse impacts on air and water quality are expected to be generated by this proposal. The nature of these additional improvements is such that no unusual air emissions will be produced by the aerated lagoon treatment. The municipal golf course is seen as the field which will consume the chemical nutrients found in the effluent used for irrigation.

The Planning Commission found, although the proposed use will alter the essential character of the land, it is determined that such a change may make the highest and best use of land involved for the public welfare at the present time.

1.4.2 Transmission Line and Pump Station

On July 2, 1991, the Planning Commission approved Special Management Area (SMA) Use Permit No. 315, to allow the construction of a sewage pump station, sewage force main and related improvements. The project site begins at the Kuakini Highway-old Kona Airport runway intersection in a northerly direction connecting to the new Kealakehe Wastewater Treatment Plant (WWTP), North Kona, Hawai'i. The permit covered improvements in Tax Map Key 7-4-8:2 & 3, and 7-5-5:7 & 83.

One of the criteria for approving a development within the SMA is that it is consistent with the General Plan and zoning designation. A Course of Action for the North Kona District is to construct a new wastewater treatment plant at Kealakehe near Honokohau, provide sewage

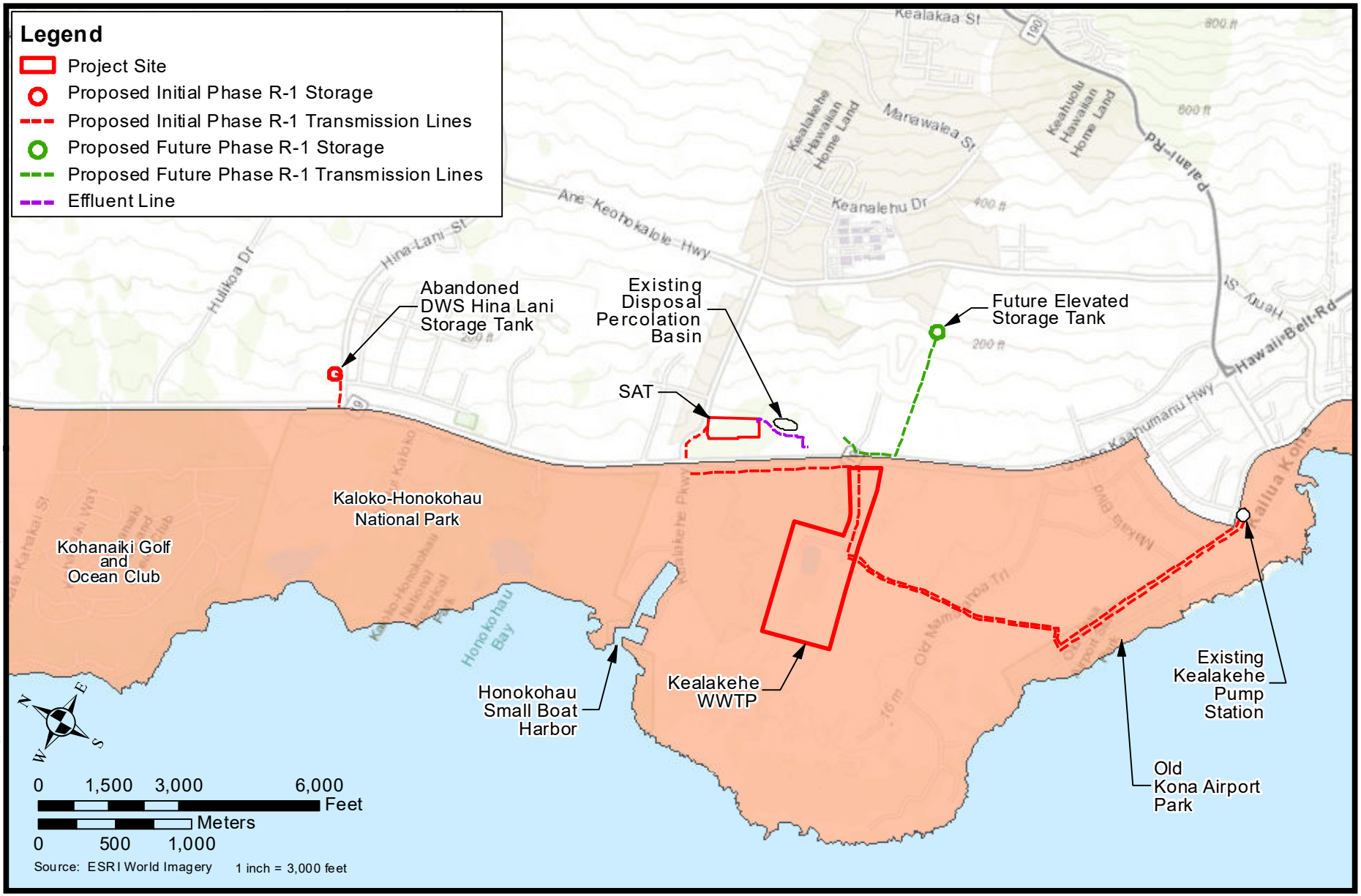

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FIGURE 1-4

SPECIAL MANAGEMENT AREA MAP

Kealakehe WWTP R-1 Upgrade

pumping station, force mains and interceptor sewers to handle existing and proposed wastewater flows. Approval of this request would support this course of action for North Kona.

Another criteria in reviewing an SMA Use Permit application is that, "The development will not have any significant adverse environmental or ecological effect, except as such adverse effect is minimized to the extent practicable and clearly outweighed by public health, safety, or compelling public interest."

The construction of a sewage pumping station and force main is not anticipated to have a substantial adverse environmental or ecological effects. The proposed sewage pump station and force main will be located within an area not known to contain any unique ecological systems nor provide habitat for any endangered plant or animal species. No adverse impacts on water quality are expected to be generated by the proposed improvements. Any potential runoff or discharge as a result of the project can be handled by on-site improvements as may be required by the Departments of Health and Public Works. The proposed improvements are part of an overall wastewater treatment system that has been designed to replace the existing Kailua-Kona Sewage Treatment Plant, which is rapidly approaching its design capacity, as well as to accommodate future development within the central Kona (Kealakehe) area.

1.5 Kealakehe WWTP Operation

Incoming sewage is received at the headworks, where it passes through mechanical screens and grit removal basins to remove inorganic debris before flowing into the aerated lagoons. The removed screenings and grit from the headworks are disposed at the West Hawai'i Landfill.

Next, the wastewater is treated as it flows by gravity through the lagoons in series. An aeration system consisting of blowers, piping, submerged diffusers, and appurtenances is used to maintain aerobic conditions within the water column and to provide mixing in each lagoon. Naturally-occurring aerobic microbes oxidize organic matter and convert ammonia into nitrate within the lagoons. Solids settle to the bottom of the lagoons where they anaerobically digest over time. Sludge removal is required infrequently, typically on a 20-year interval. At current flows, 3 of the 5 lagoons are in use at any time in this process to produce secondary effluent. As flows increase in the future, it will be necessary to use a fourth lagoon to achieve secondary effluent quality.

Following treatment through the aerated lagoons, sodium hypochlorite is added to the effluent before it is pumped to the off-site disposal percolation basin. While this method of effluent disposal has been used for a number of years, the County has sought to improve the WWTP treatment process so that the effluent could be beneficial reused in place of potable water, and allow the disposal percolation basin to be closed.

One of the considerations for effluent reuse is its salinity. The North Kona Sewerage service area from which wastewater is collected includes portions that are located near the shoreline where underground pipes may lie below sea level. Both publicly owned and private sewer lateral connections to the County collection system in these areas are subject to brackish ground water entering, or infiltrating, pipes through cracks, leaky joints and other breaches in the collection system. Over the years, the County has made improvements to reduce or eliminate brackish ground water infiltration to publicly-owned sewer lateral connections to the collection system. However, the County does not have the authority to make improvements or require private property owners to make improvements to sewer laterals infiltrating brackish groundwater on private property. As a result of infiltrating brackish ground water mixing with

incoming raw sewage, any recycled water produced by an R-1 treatment facility will have higher than desirable concentrations of chloride and total dissolved solids. This condition will limit irrigation use of R-1 recycled water to salt-tolerant vegetation.

1.6 Purpose and Need

The purpose of the Kealakehe WWTP R-1 Upgrade project is to construct the necessary improvements to produce treated effluent that meets the various objectives set forth in Hawai'i Administrative Rules (HAR) Title 11, Department of Health Chapter 62 Wastewater Systems (HAR Chapter 11-62), which was adopted on March 21, 2016.

Among various General Requirements, HAR Chapter 11-62 states that the DOH:

(1) Seeks to ensure that the use and disposal of wastewater does not contaminate or pollute any valuable water resource, does not give rise to public nuisance, and does not become a hazard or potential hazard to the public health, safety, and welfare.
(2) Seeks to work in close partnership with the counties to manage wastewater to prevent pollution and harm to public health, safety and welfare.
(3) Seeks to advance the use of recycled water consistent with public health and safety and environmental quality.
(4) Acknowledges that when properly treated and used, recycled water is a valuable resource with environmental and economic benefits and can be used to conserve the State's precious resources and that the most highly treated recycled water and exceptional quality wastewater sludge can be used for a wide variety of applications with the appropriate restrictions and when best management practices and other requirements of this chapter are met.

HAR Chapter 11-62 further seeks to ensure that the use and disposal of effluent from wastewater systems:

(1) Do not contaminate or pollute any drinking water or potential drinking water supply, or the waters of any beaches, shores, ponds, lakes, streams, groundwater, or shellfish growing waters;
(2) Do not encourage the harborage of insects, rodents, or other possible vectors;
(3) Do not give rise to nuisances;
(4) Do not become a hazard or a potential hazard to public health, safety and welfare;
(5) Contribute to the achievement of wastewater management goals contained in approved county water quality management plans;
(6) Reinforce state and county planning policies; and
(7) Are consistent with the State's administration of the National Pollutant Discharge Elimination System.

In addition, the proposed action is intended to realize several Policy and Action items outlined in the County of Hawai'i 2008 Kona Community Development Plan (KCDP):

- Policy PUB-4.5: Wastewater Treatment and Effluent Reuse
- Action PUB–4.5a: Master plan the expansion of the Kealakehe Wastewater Treatment Plant
- Action PUB–4.5c: Master plan a comprehensive wastewater reclamation system to maximize reuse.

The R-1 Upgrade improvements will also serve the purpose of allowing the County to achieve an increase toward the goals of the Hawai'i Fresh Water Initiative which is to increase the amount of R-1, R-2, and R-3 recycled water used for irrigation from about 18.3 mgd statewide to 30.0 mgd by 2030. In 2017, R-1 recycled water represented about 89 percent of the total recycled water usage. Facilities located within the County of Hawai'i accounted for 1.1 mgd, or about 6.0 percent, of the 18.3 mgd. The proposed action would allow the County to increase its statewide share from 6.0 percent to 9.6 percent of statewide goal of 30.0 mgd in 2030.

1.7 Objectives of the Proposed Action

The Kealakehe WWTP R-1 Upgrade Project will be undertaken to achieve the following objectives:

- Implement water recycling within the service area to decrease the amount of potable water currently being used for irrigation (and other non-potable uses);
- Reduce the quantity of WWTP effluent requiring disposal;
- Increase nutrient removal within the wastewater treatment process to reduce the nutrient load to the disposal system;
- Replace the existing disposal percolation basin with a land application system that will provide additional environmental protection and is recognized by the US Environmental Protection Agency (EPA);
- Provide for the wastewater management needs of the service area for the next 20 years;
- Minimize impacts to the ratepayers; and
- Provide a reliable wastewater management system that is relatively simple to operate and maintain.

1.8 Department of Health (DOH) Reuse Guidelines Background

The County of Hawai'i, Department of Environmental Management (DEM) proposes to upgrade the Kealakehe WWTP to produce recycled water meeting the State of Hawai'i Department of Health (DOH) R-1 classification, which is the highest classification with the broadest allowable reuse applications. "Recycled water" means treated wastewater that by design is intended to be used for beneficial purposes. The DOH advocates the use of recycled water provided that public health and water resources are not compromised. Use of recycled water has become more significant due to the state's growing population, limited potable water resources, and wastewater disposal issues.

In January 2016, the DOH issued their reuse guidelines as two volumes. *Recycled Water Facilities Volume 1* provides guidelines primarily for the design of the treatment facilities. *Recycled Water Projects Volume 2* provides guidelines for users of the recycled water. The design of the Kealakehe WWTP R-1 Upgrade project will meet the DOH Volume 1 requirements. To be classified as R-1 water, treated wastewater effluent must be oxidized, filtered and disinfected according to that classification.

Volume 2 covers the application process to use recycled water. R-1 water is suitable for various uses, including for crop and landscaped irrigation, construction, cleaning, cooling, firefighting, and other applications as outlined in the DOH Reuse Guidelines. Volume 2 also provides definitions applicable to the recycled water produced by the Kealakehe WWTP R-1 Upgrade project, including:

- "Purveyor" means one who sells or conveys recycled water to an end user, or to an intermediary other than a public or private entity providing water service.

- "Transmission Lines" fall under the jurisdiction of the recycled water purveyor and refer to the piping from the treatment facility to the approved use area, terminating after the service meter box for each approved use area. The meter is to be approved, purchased, and calibrated by the purveyor. The purveyor is also responsible for the quality of the recycled water. Design of new transmission systems shall conform to the "Water System Standards" (State of Hawai'i, 2002) and other applicable requirements.

Under these DOH definitions, for the Kealakehe WWTP R-1 Upgrade project, the County will be the purveyor and, as the purveyor, will be responsible for construction of the transmission lines as defined above. Volume 2 also defines the end user of the recycled water as:

- "Any person, firm, corporation, association, agency or customer receiving recycled water service."

The user will be responsible for meeting the DOH requirements for users set forth in Volume 2, including guidance and best management practices for applying recycled water for purposes such as irrigation, dust control, cleaning, and fire-fighting.

The following suitable uses for R-1 recycled water are found in Volume 2. The DOH may deem other uses suitable on a case-by-case basis. The listed R-1 Suitable Uses include:

- Irrigation: All landscape and agricultural irrigation via spray, surface drip or subsurface drip irrigation.
- Homes: Irrigation of a home on agricultural land or condominium property regimes provided there is a recycled water manager as described in Section K. Irrigation of single-family residential homes without a recycled water manager is prohibited.
- Farm Animals: Drinking water for livestock, and poultry with the exception of dairy animals that produce milk for human consumption.
- Supply to impoundments:
  - Restricted recreational impoundments such as golf course hazards, landscape water features, fountains, waterfalls;
  - Irrigation storage reservoirs and ponds; and
  - Fish hatchery basins.
- Dust control: Dampening, wet sweeping and/or wash-down of streets, roads, parking lots, walkways, etc.;
- Cleaning:
  - Flushing toilets, urinals, and sanitary sewers where permitted by the applicable county plumbing code;
  - High pressure water cleaning of surfaces; and
  - Agricultural cleaning to wash down animals such as cattle, livestock, animal pens and housing.
- Cooling of power equipment while cutting, coring or drilling pavements, walls and other hard surfaces; Water jetting to consolidate backfill material around piping for recycled water, non-potable water, sewage, storm drains, gas and electrical conduits;
- Washing aggregate and concrete manufacturing;
- Boiler feed water;

- Industrial processes and industrial cooling;
- Cooling in air conditioning systems;
- Fire-fighting; and
- Test water for gas pipeline testing.

Although not explicitly set forth in Volume 2, DOH Wastewater Branch confirmed the suitable uses for R-1 recycled water also include:

- Spray irrigation of parks;
- Spray irrigation of athletic fields as long as the irrigation does not occur when field users are present; and
- Spray irrigation of golf courses.

1.9 Clean Water State Revolving Fund

The Kealakehe WWTP R-1 Upgrade project may be funded by federal funds through the State of Hawai'i DOH Clean Water State Revolving Fund (CWSRF) Program, which would constitute a federal action and will require the project to meet all National Environmental Policy Act (NEPA) and Hawai'i SRF program requirements, including the Endangered Species Act (16 USC 1531-5411) and the National Historic Preservation Act (54 USC 300101 and 54 USC §302706). The State of Hawai'i DOH Clean Water State Revolving Fund (CWSRF) Program was created by the federal Water Quality Act of 1987 which authorized low interest loans for the construction of publicly owned wastewater treatment works, for implementation of a nonpoint source (NPS) pollution control management program, and for implementation of an estuary conservation and management program. In 1988, the Hawai'i State Legislature passed Act 365, now Chapter 342D, Hawai'i Revised Statues (HRS), to establish the State Water Pollution Control Revolving Fund to receive the federal capitalization grant. Chapter 342D [Part V.], Water Pollution Control Financing, and HRS 342D-81 set forth that the State's policy is to promote water pollution prevention and control, including the use of recycled water, by financing eligible projects consistent with applicable federal and state laws.

1.10 Environmental Assessment Documents

The DOH administers the Clean Water SRF Program to assist in financing construction of water pollution control projects necessary to prevent contamination of groundwater and coastal water resources and to protect and promote the health, safety and welfare of the citizens of the State of Hawai'i. The Clean Water SRF Program provides low interest loans to county and state agencies to construct point source and nonpoint source water pollution control projects. Environmental assessment documentation (EAD) required as part of the DOH CWSFR program include: 1) an environmental document prepared to meet the requirements of Chapter 343, HRS and Hawai'i Administrative Rules Title 11, State of Hawaii Department of Health, Chapter 200, Environmental Impact Statement Rules; 2) an Environmental Assessment (EA) checklist, and 3) a Certification form. In addition, to meet Environmental Protection Agency (EPA) requirements, the impacts of project must address the federal "cross-cutting" authorities.

1.11 Other Information

The lands west (makai) of Queen Kaʻahumanu Highway are within the Special Management Area (SMA). County of Hawai'i Rule 9 applies to lands within the SMA. Rule 9 defines development subject to an SMA permit as: "uses, activities, or operations on land or in or under water within the SMA. According to Rule 9, development includes placement or erection of any solid material or any gaseous, liquid, solid, or thermal waste." However, Rule 9 states that development does not include: "installation of underground utility lines and appurtenant

above ground fixtures less than four (4) feet in height along existing corridors." Hence, any such development could be exempted from an SMA permit.

The proposed Soil Aquifer Treatment (SAT) facility site will occupy an approximately 10-acre portion of TMK: 7-4-020:007, which lies east and across Queen Ka'ahumanu Highway from the WWTP. The SAT facility will be located near the area currently used as the disposal percolation basin for treated effluent from the existing Kealakehe WWTP.

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2. GENERAL DESCRIPTION OF THE PROPOSED ACTION'S TECHNICAL, ECONOMIC, SOCIAL, AND ENVIRONMENTAL CHARACTERISTICS

2.1 Proposed Action

The DEM proposes to implement improvements at the Kealakehe WWTP to upgrade the existing secondary treatment facilities to produce R-1 recycled water meeting the DOH Reuse Guidelines, which require the effluent to be treated, oxidized, filtered and disinfected to a median fecal coliform density of less than 2.2 organisms per 100 milliliters. The R-1 Upgrade facilities and systems will be designed to meet current and future anticipated regional demand for R-1 water in the vicinity of the Kealakehe WWTP. Effluent in excess of R-1 water demand will also be treated for disposal through an upgraded process.

The need to address effluent flow in excess of demand for recycled water results from several factors. Currently, the quantity of sewage inflow received and treated at the Kealakehe WWTP exceeds the anticipated initial demand for recycled water. Additionally, the demand for recycled water will vary seasonally with precipitation and evapotranspiration patterns. Furthermore, the DOH recycled water guidelines require an effluent disposal system for effluent that is not recycled or does not meet recycled water classifications. Secondary treated effluent that is not further treated for use as R-1 recycled water will be directed to a subsurface flow constructed wetlands for further treatment prior to final treatment and disposal at an offsite soil aquifer treatment (SAT) facility.

The subsurface flow constructed wetlands will be sited within the Kealakehe WWTP parcel outside of the existing security fence. The subsurface flow constructed wetlands will further "polish" the secondary effluent to remove additional nutrients and other constituents. After flowing through the subsurface flow wetlands, the treated effluent will be pumped via the existing effluent disposal pipe under Queen Ka'ahumanu Highway to the soil aquifer treatment (SAT) system - the final step to remove nutrients and other constituents prior to subsurface percolation to the soils below the site and finally to groundwater. The combination of treatment through the subsurface wetlands system at the WWTP and the SAT system will significantly improve upon the current percolation disposal basin method of effluent disposal.

Figure 2-1 shows the R-1 Upgrade Process Schematic. Figure 2-2 shows the R-1 Upgrade Treatment Facility Concept.

To ease discussion, the description of the R-1 upgrade improvements project has been divided into four components: R-1 Treatment Facilities, Polishing Wetlands, Soil Aquifer Treatment, and R-1 Recycled Water Storage and Transmission. Other related proposed improvements are also described thereafter.

2.1.1 R-1 Treatment Facilities

The R-1 treatment facility improvements are proposed to be constructed within the existing security fencing of the Kealakehe WWTP near the existing treatment facilities. Figure 2-3 shows the R-1 Upgrade Improvements Plan. These proposed improvements include:

1) Lagoons 5 and 6 Covers

Lagoons 5 and 6 are the last in a series of existing lagoons that progressively treats wastewater at the WWTP. The effluent in Lagoon 6 is at the end of the secondary treatment process. It typically contains algae due to the long hydraulic residence time in the treatment process, warm water temperatures, nutrients in the wastewater, and exposure to ample sunlight. The presence of algae can significantly increase filtration backwash requirements to further treat the secondary treated effluent, particularly if cloth media filtration is used. To reduce algae growth, a floating

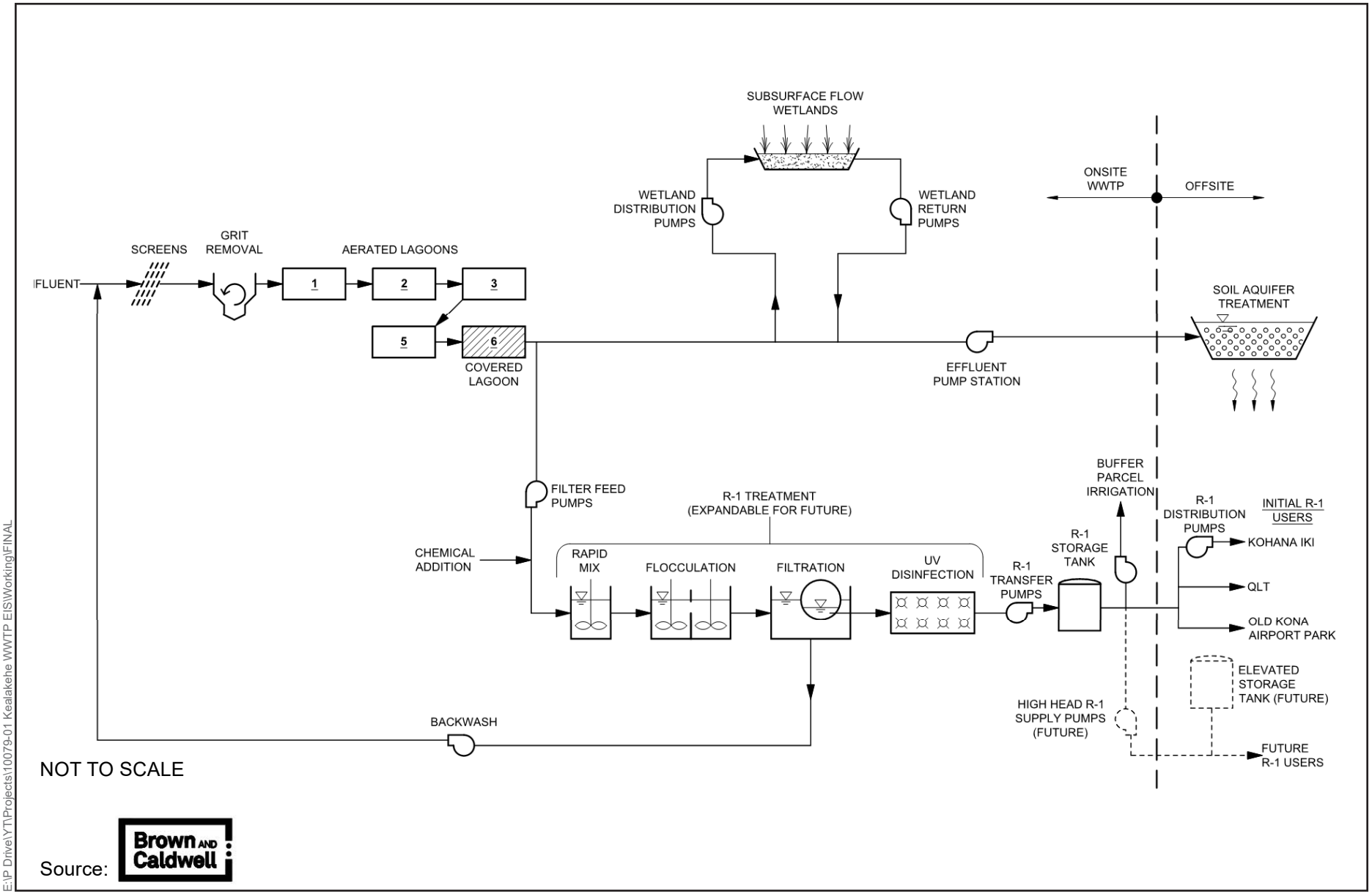

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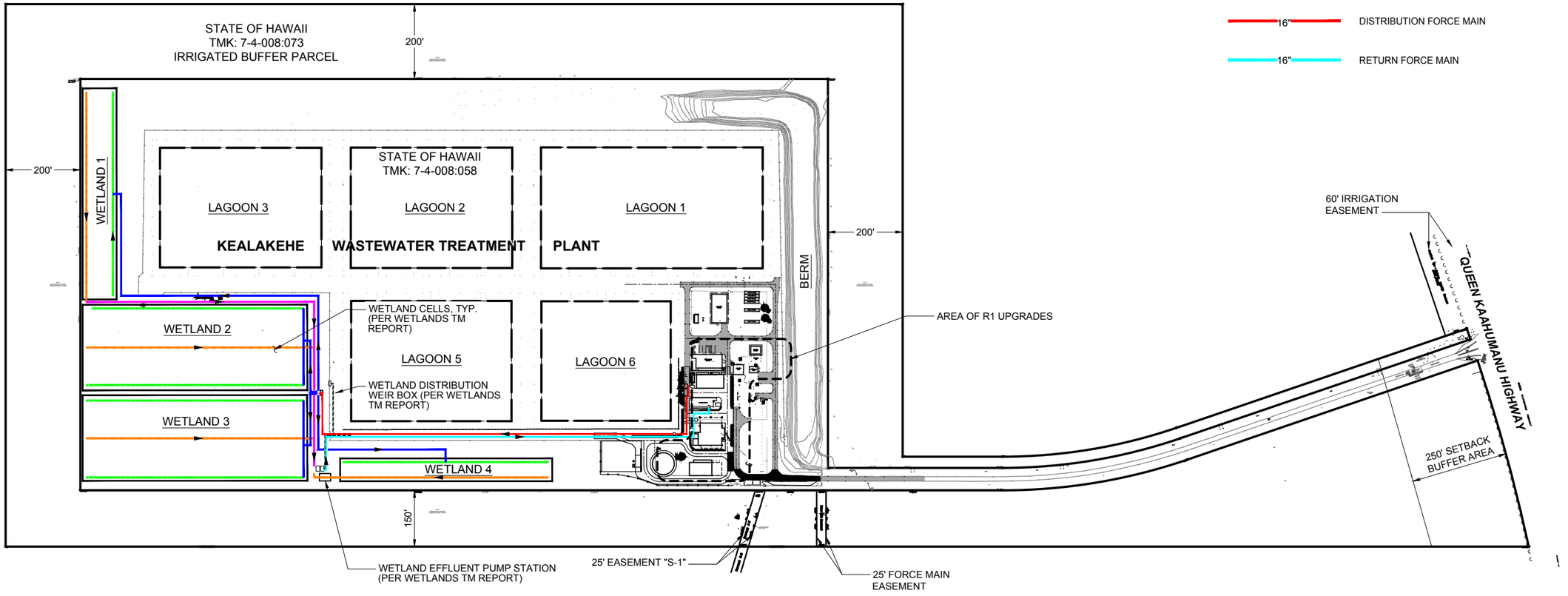
FIGURE 2-1

R-1 UPGRADE PROCESS SCHEMATIC

LEGEND

- CONSTRUCTED WETLAND (ACRES)
- 10" PERFORATED DISTRIBUTION PIPE
- 10" DISTRIBUTION MAIN
- 10" PERFORATED COLLECTION PIPE
- 12" TO 20" COLLECTION MAIN
- 16" DISTRIBUTION FORCE MAIN
- 16" RETURN FORCE MAIN



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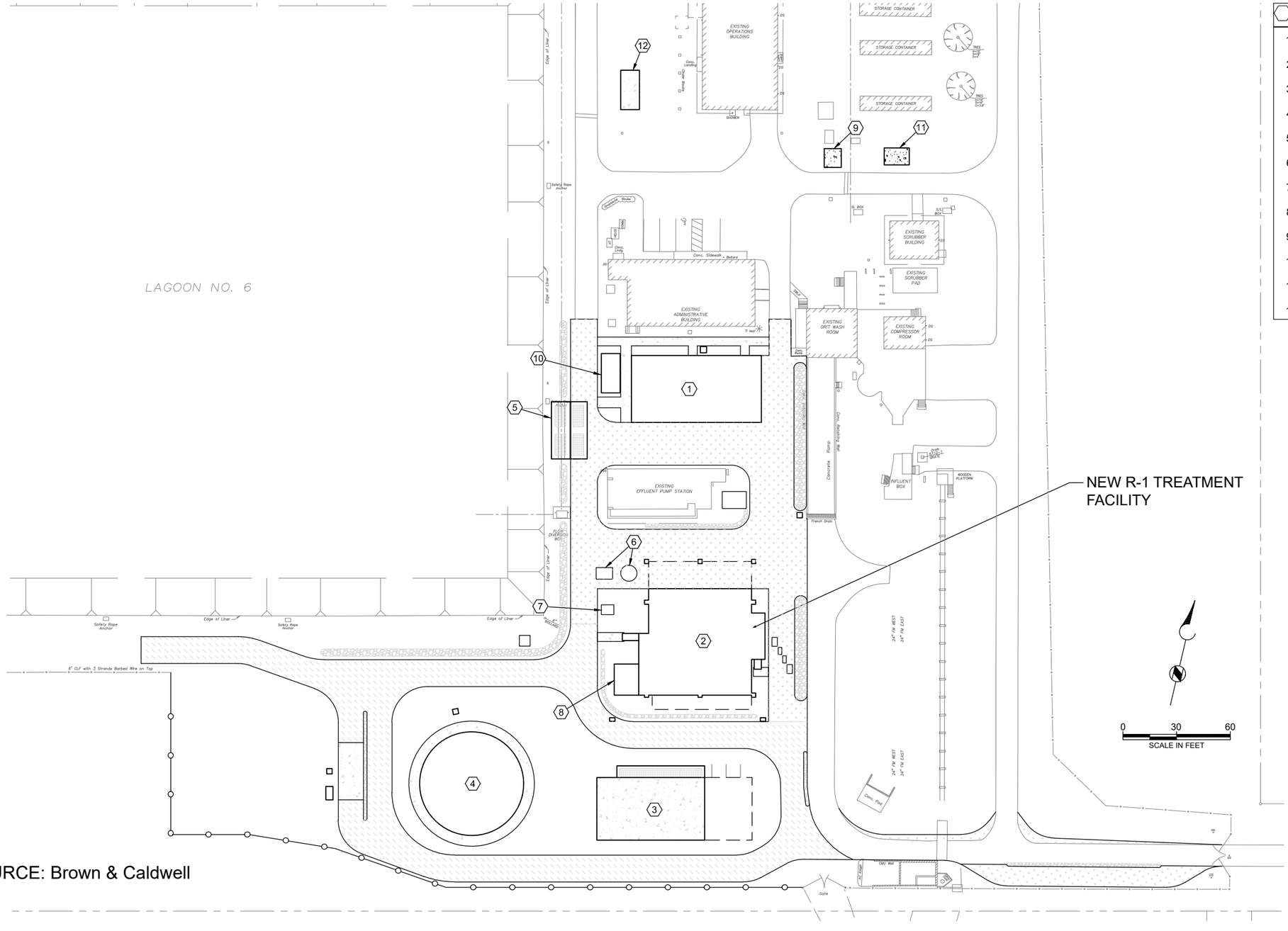
Brown AND Caldwell

SCALE: 1" = 300'

KEALAKEHE WASTEWATER TREATMENT PLANT

R-1 UPGRADE TREATMENT FACILITY CONCEPT

FIGURE 2-2



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KEY NOTES

1. NEW CHEMICAL/ELECTRICAL BUILDING
2. NEW R-1 TREATMENT FACILITY
3. NEW R-1 DISTRIBUTION PS
4. NEW R-1 STORAGE TANK
5. NEW PROCESS FEED PS
6. NEW BACKWASH RETURN PS
7. NEW FLOW METER VAULT
8. NEW R-1 TRANSFER PS
9. NEW TRANSFORMER
10. NEW FUEL TANK
11. NEW ELECTRICAL SWITCHGEAR
12. NEW BULK FUEL STORAGE TANK

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FIGURE 2-3

R-1 UPGRADE IMPROVEMENTS PLAN

cover will be installed over Lagoons 5 and 6 to block exposure to most of the sunlight currently received by these lagoons. The cover will consist of a layer of floating plastic balls that will deprive algae of sunlight, thereby reducing growth as well as killing algae, which will settle to the bottom of the lagoons. The cover will be resistant to degradation by ultra violet sunlight, is suitable for windy conditions and is permeable to rainfall.

2) Filter Feed Pumps

A filter feed pump station will be installed below grade to lift the effluent from the covered aerated Lagoon 6 to the R-1 treatment process improvements, described below, that will be constructed above-grade.

3) Rapid Mix and Flocculation Concrete Tank

Chemicals will be mixed into the secondary treated effluent in a short residence time, high-energy rapid mix tank. This will initiate the flocculation process, whereby small particles in the effluent will clump together so they can be filtered out. The process will involve low-energy mixing for 10 to 20 minutes to promote floc formation. The concrete flocculation tanks will all be above-ground or partially buried rectangular tanks with associated mixing equipment. A concrete roof structure about 31 feet above grade will provide weather and sun protection for the tanks. Figure 2-4 shows the R-1 Treatment Facility Plan. Figure 2-5 shows the R-1 Treatment Facility Section.

4) Concrete Filtration Tank

The filtration process will consist of cloth media filters. The filter hydraulic loading rates will comply with the DOH Reuse Guidelines. The filter backwash will be returned to the aerated lagoons. Continuous turbidity monitoring systems will be provided upstream and downstream of the filtration units to comply with DOH guidelines. If filter effluent turbidity exceeds 2 Nephelometric Turbidity Units (NTU) the recycled water production process will be automatically diverted to the Lagoon 6, and an alarm will notify the WWTP operators. Similar to the rapid mix and flocculation tank, the concrete filtration tank will all be above-ground or partially buried rectangular concrete tanks. There will be a concrete roof structure over the tanks to provide weather and sun protection.

5) Ultraviolet (UV) Disinfection Tanks

After flowing through the flocculation and filtration tanks, the filtered water will be disinfected by exposure to ultraviolet (UV) light. The UV system will be constructed as part of the flocculation tank structure and will consist of a channel with a system of UV light fixtures. The filtered water is disinfected as it flows through the channels between the UV lights. The UV system will be designed to comply with DOH guidelines. The UV dose will be continuously monitored. If the UV dose drops below the required level, the recycled water production process will automatically stop, and an alarm will notify the WWTP operators.

6) Chemical Addition Building and Emergency Generator Building

A new building will be constructed to house facilities to store and meter chemicals for the previously described R-1 treatment process. Facilities for coagulant and/or polymer addition will be provided so the chemicals can be added as needed to aid the filtration process. The building will also contain the electrical and control systems in a separate air conditioned space. These R-1 systems will be connected to the existing supervisory control and data acquisition (SCADA) control system. A separate room in the chemical addition building will contain a 1,250 KW emergency generator to provide power to the R-1 treatment processes in the event of a failure of the commercial power supply. An above-ground, double-wall diesel fuel tank and related above ground piping will provide fuel to the generator. Such a tank will not require a spill containment system around its base. The interstitial space between the walls of the tank will

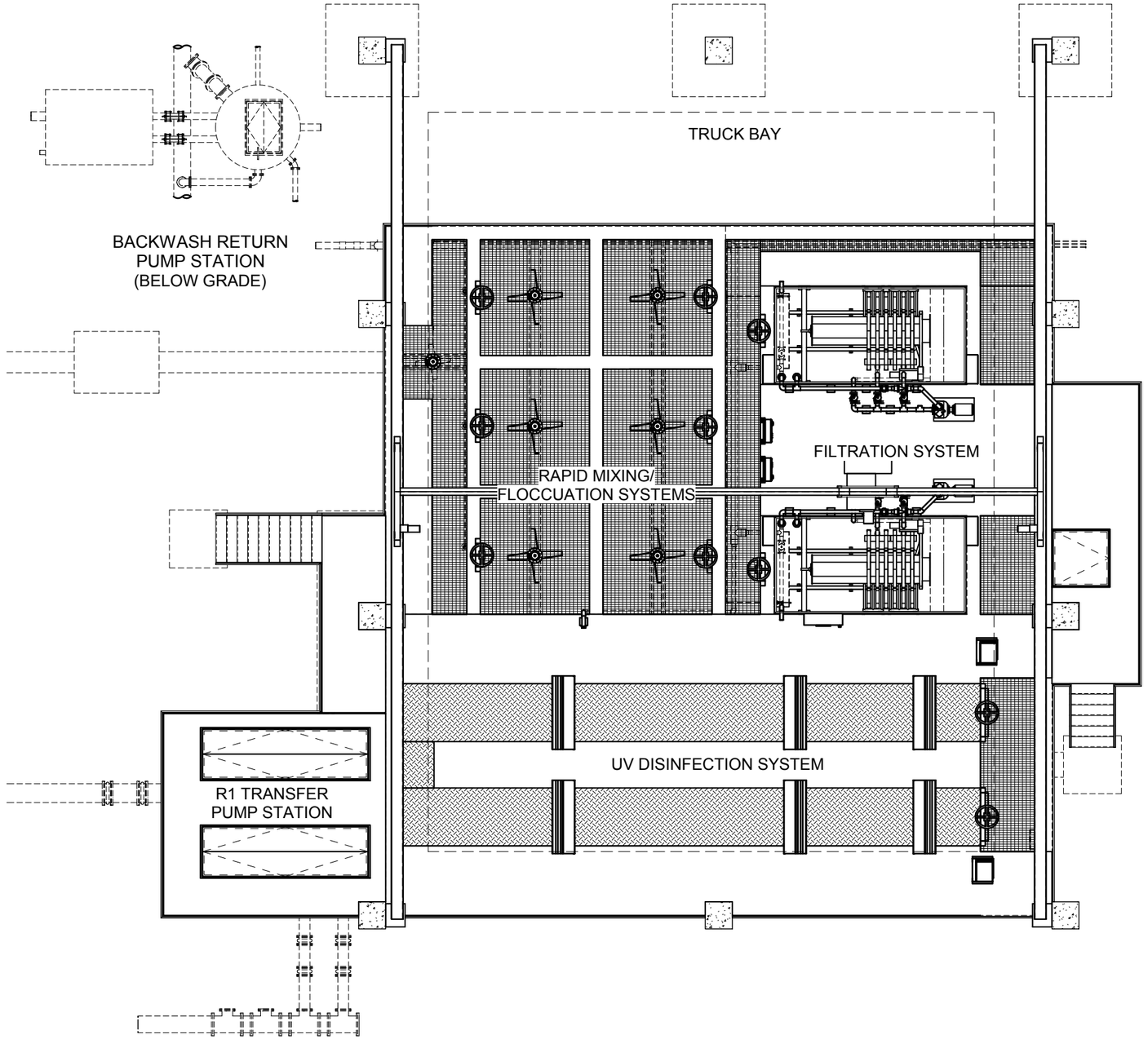

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FIGURE 2-4

R-1 TREATMENT FACILITY PLAN

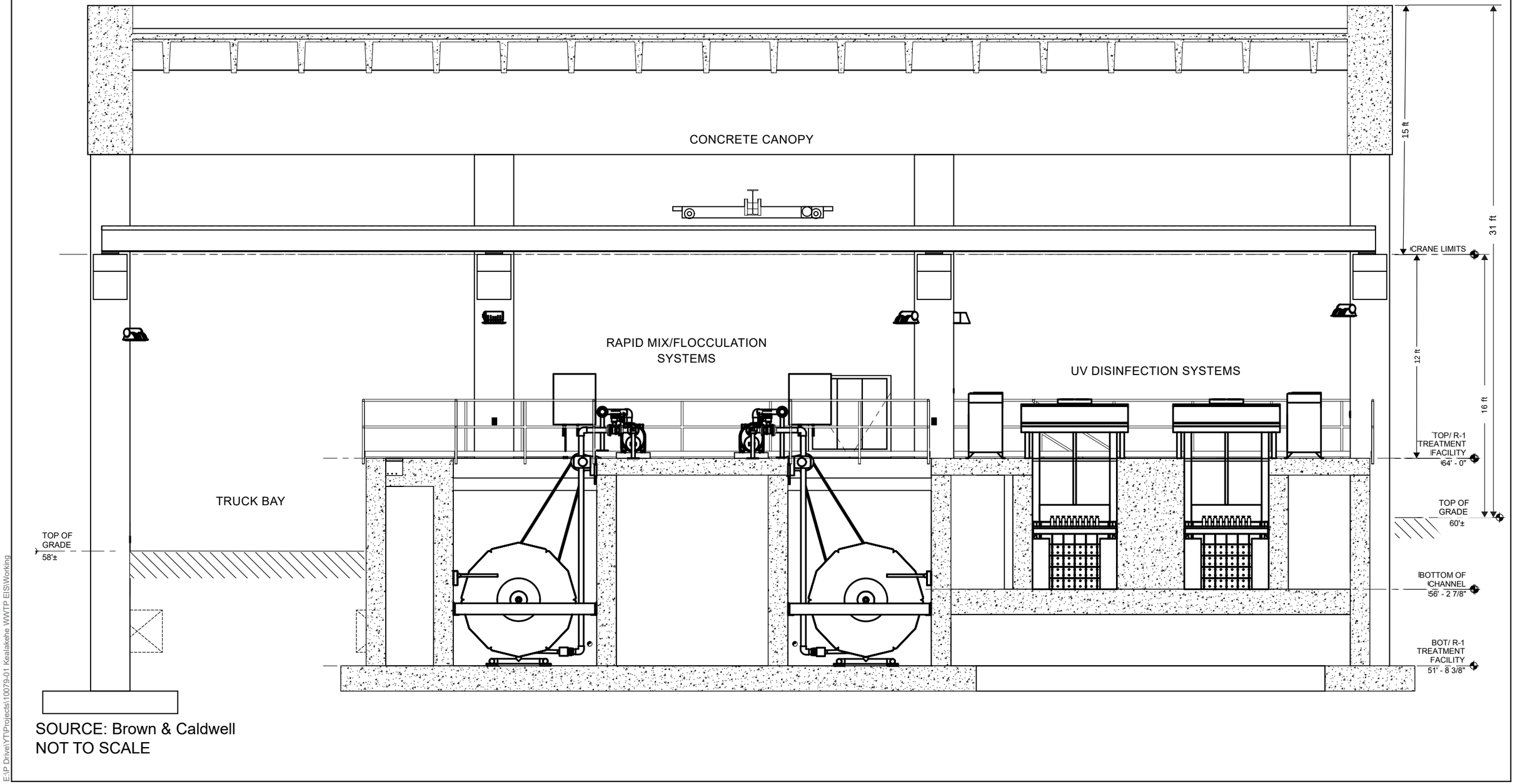

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FIGURE 2-5

R-1 TREATMENT FACILITY SECTION

Kealakehe WWTP R-1 Upgrade

contain a leak detection system. The tank fill openings contain an overfill protection system to contain any spills when the tank is being filled with fuel. Figure 2-6 shows the chemical addition building layout)

7) R-1 Transfer Pumps
The below grade R-1 transfer pumps will lift the R-1 water from the UV system to the adjacent R-1 storage tank.

8) R-1 Above-grade R-1 Storage Tank
An on-site 500,000 gallon above-grade storage tank will provide diurnal storage for the R-1 uses, and will also serve as a clear well for the R-1 transmission pumping systems. The R-1 storage tank will be about 60 feet in diameter and will stand approximately 30 feet above grade. R-1 water production will be controlled by a pressure sensor in the tank. When the tank is full, the R-1 water production process will automatically stop and the feed pumps to the subsurface constructed wetlands, described below, will be activated. The R-1 water production process will restart when R-1 water is drawn from the tank and the low tank level sensor is activated. This will also stop the feed pumps to the subsurface constructed wetlands.

2.1.2 Subsurface Constructed Wetlands

9) Feed Pumps
A wetland feed pump station and piping will continuously deliver secondary effluent from the existing Lagoon 6 to the subsurface flow wetlands when the R-1 storage tank is full, as discussed previously.

10) Subsurface Flows Constructed Wetlands
The existing Kealakehe WWTP aerated lagoon system currently converts ammonia present in the wastewater into nitrate via a process called nitrification. However, there is no existing mechanism to remove nitrate from the wastewater, so nitrogen is discharged to the environment with the treated effluent. The subsurface flow constructed wetland will provide additional treatment to remove nitrogen from the wastewater via a process called denitrification.

The on-site subsurface flow wetlands system will be located within the Kealakehe WWTP 52.959-acre parcel in the area currently outside of the security fence. The four (4) subsurface flow wetlands will each "polish" the secondary treated effluent by removing the nitrogen and other constituents, including: settleable biochemical oxygen demand; suspended solids; a limited amount of phosphorus via adsorption and plant uptake; metals (copper, zinc, and cadmium) from applied water via adsorption, sedimentation, precipitation, and plant uptake; trace organic compounds via volatilization or adsorption and biodegradation; greater than 90 percent of bacteria and virus via adsorption and filtration. The 4 subsurface flow wetlands will collectively occupy a total of about 6.3 acres, which is comparable in size to the area occupied by existing Lagoons 2 and 3.

The subsurface flow wetlands will be excavated about 5 feet below grade and will then be filled with a gravel media mix. A perforated distribution pipe on the surface of the gravel media will distribute the secondary treated effluent. In each wetland, the secondary treated effluent will flow through the gravel media in which emergent wetland vegetation would be grown. After flowing through the gravel media, the now polished effluent will be collected by a perforated pipe at the bottom of each wetland and then will be pumped by the wetlands pump station to the pipeline that

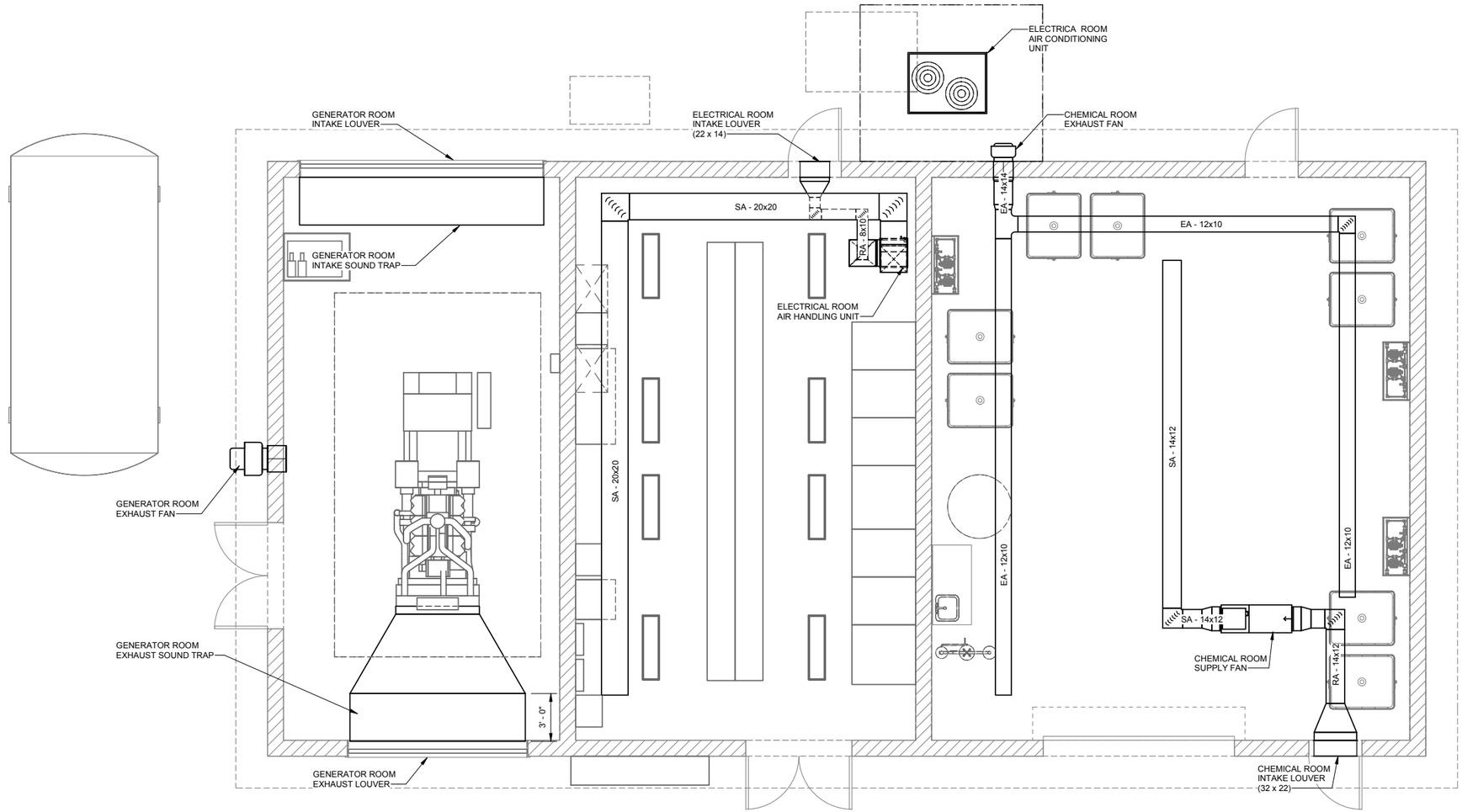

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FIGURE 2-6

CHEMICAL ADDITION BUILDING LAYOUT

will be used to transmit the polished effluent to the proposed new Soil Aquifer Treatment System discussed below.

Trenches will need to be excavated for the 16-inch wetlands distribution force main and the 16-inch return force main. The trenches for these wetland force mains will be constructed in the existing service road on the south side of Lagoons 5 and 6 and the west side of Lagoon 3.

The wetlands will be lined with the same material used for lining the existing lagoons and will be surrounded by above grade berms. The flows in the wetlands will not rise above the surface of the gravel media. Therefore, there will be no exposed water surface or standing water that could attract birds. Appropriate Hawaiian native plant species will be selected for planting in the wetland.

11) Effluent Pump Station

An existing effluent pump station and pipeline presently transmit secondary treated effluent across Queen Ka'ahumanu Highway to the existing percolation disposal basin. This pump station and pipeline will be used to transmit the polished effluent to the Soil Aquifer Treatment System.

2.1.3 Soil Aquifer Treatment

12) Underground Transmission Pipeline

A new underground line will be connected to the previously described existing effluent pipeline near Hale Makai Place. From that point, the new line will connect to a weir box which will be used to distribute the treated effluent into the SAT system basins. The rest of the existing line to the existing percolation disposal basin will be abandoned or removed with the closure of the basin.

13) Soil Aquifer Treatment

The proposed soil aquifer treatment (SAT) system will be the final step to remove nutrients and other impurities from the polished effluent prior to releasing it into the subsurface below the SAT basins. The SAT system is an EPA-recognized form of land treatment and disposal that will replace the current percolation disposal basin method. The polished effluent from the surface flow wetlands will be applied over one of eight basins, which will allow the effluent to percolate downward through a soil system engineered to provide additional treatment and flow control. The combination of polishing through the subsurface flow wetlands and the additional natural processes occurring through the SAT system will ensure that the highly treated effluent is safely returned to the environment.

The Kealakehe WWTP SAT system will be located within TMK: 7-4-020:007 east of Queen Ka'ahumanu Highway and north of Hale Makai Place. The site is adjacent to the area currently used for the percolation disposal basin. Occupying approximately 10 acres, the SAT will have a total of 8 basins (7 active basins and 1 reserve) each about 1-acre in area. The SAT's seven active basins will allow a weekly alternating wet/dry cycle where each basin will receive flows on one day of the week and then rotated out for the next six days to dry before receiving flows again the following week. The eighth basin will be an emergency or reserve basin to be used when a basin or the distribution system requires maintenance. Figure 2-7 shows the SAT Site Plan.

The SAT system concept is to intermittently apply the polished effluent over a large area and then allow it to trickle through permeable soils or sands, then into the native soils beneath the site. As the effluent percolates through the engineered sand and/or soil matrix, it is treated by physical filtration and by natural biological and chemical mechanisms. After an application period or wetting period, the SAT surface is allowed to dry so that oxygen can reenter the soil matrix, which

aids aerobic biological treatment. This alternating wetting and drying also maintains the infiltration rate through the soil surface and minimizes soil clogging.

The 1-acre SAT basins will less than ½ the size of the smaller existing lagoons at the Kealakehe WWTP. These existing lagoons range in size from approximately 2.6 to 4.4 acres.

The SAT system area will be cleared and graded and then excavated to create the SAT basins. The native ʻaʻā lava will be crushed and graded as needed to create structural fill to berm the basins. Portions of the basin bottoms will be over-excavated to highly-permeable clinker layers located below the surface and backfilled with the excavated rock and gravel to create hydraulic pathways to the permeable geology below. The over-excavated areas will be constructed so that they are wider than they are deep, so by definition would not be regulated as injection wells. Then, the basins will be filled with 4.25 feet of imported sand media. The basin surface will be about 2 feet below the top of the berm. Gravel access roads will surround each basin. A perimeter fence will be installed to prevent public access to the basins. Volunteer vegetation can be allowed to grow on the SAT surface.

The SAT distribution system will consist of pressure dosed piping near the surface. The piping will have slots or drilled orifices to allow the applied wastewater to be uniformly distributed over the basin surface. Typical spacing would be 5 feet between lines with openings every 4 feet. Once installed over the sand media, the piping system will be covered with gravel to protect the piping and to allow rainfall to percolate into the sand medium in the basin. Since the gravel covering will be highly permeable and the selected sand medium will also to be highly permeable, the effluent and rainfall will not accumulate on the surface of the SAT basins for any significant length of time. Hence, no prolonged ponding will occur, which could otherwise attract birds.

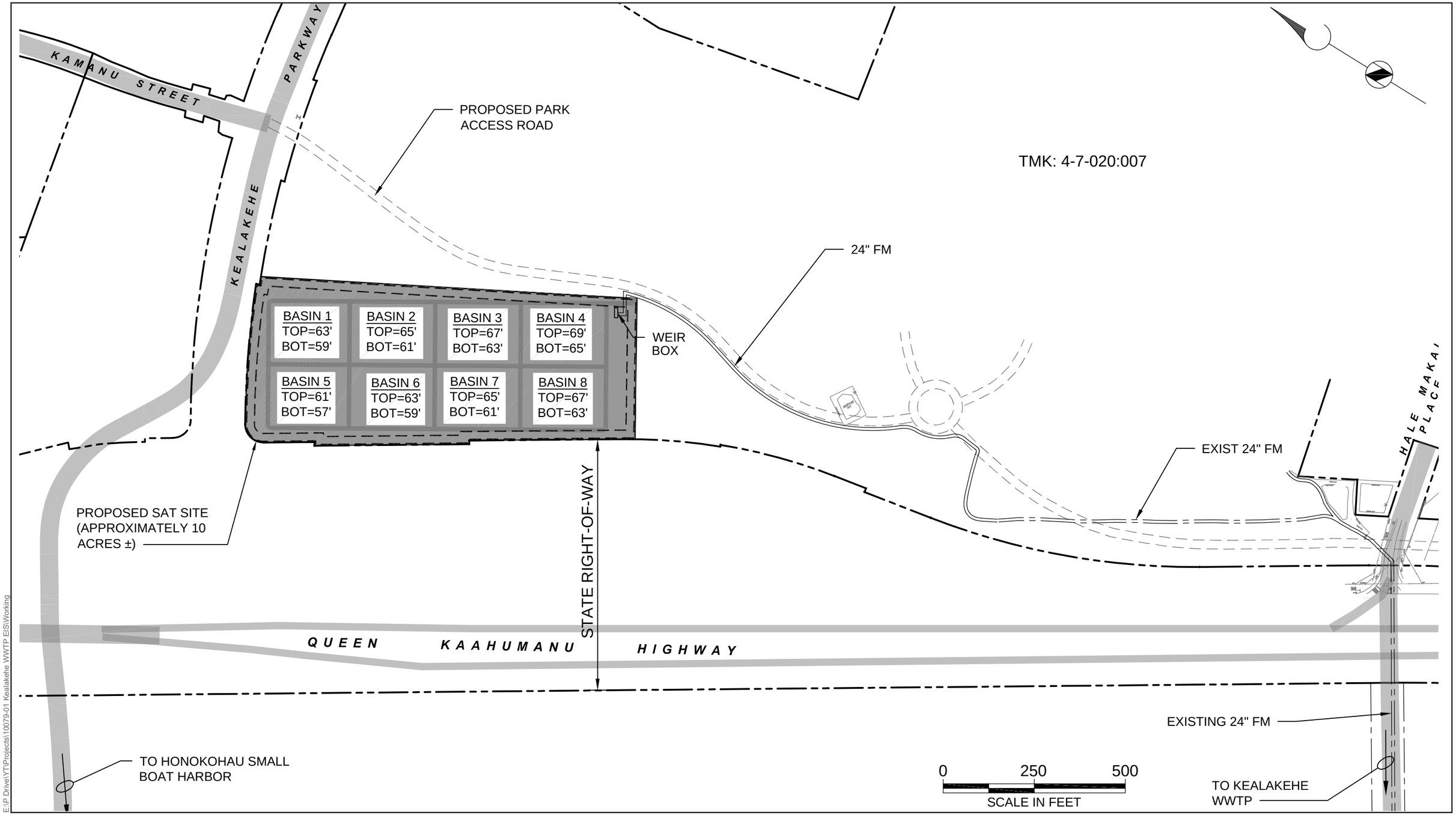
Once the SAT facility is complete and operational, the existing disposal basin will be closed according to DOH requirements and the area restored so it appears similar to the surrounding area.

2.1.4 R-1 Water Transmission and Storage (Initial Phase)

14) R-1 Water Transmission System

From the above-ground R-1 storage tank at the Kealakehe WWTP, as discussed in Section 2.1.2 R-1 Treatment Facilities, item 8, an approximately 2,500 foot long, 20-inch diameter R-1 water transmission pipeline will extend eastward (mauka) along Hale Māka'i Place to Queen Kaʻahumanu Highway. From there, an approximately 3,700-foot long transmission pipeline will be constructed beneath the makai shoulder area, and within the right-of-way of the recently widened Queen Kaʻahumanu Highway northward to the Kealakehe Parkway intersection. At that intersection, the 20-inch pipeline will connect to the existing R-1 recycled water transmission pipeline that was constructed by the State Department of Transportation (DOT) for DEM as part of the Queen Kaʻahumanu Highway Widening project. That DOT installed underground pipeline extends approximately 12,700 feet (2.4 miles) from the Kealakehe Parkway intersection north to Hulikoa Drive, the driveway for the Kohanaiki Golf and Ocean Club, which plans to use R-1 water recycled for irrigation.

At the Queen Kaʻahumanu Highway and Kealakehe Parkway intersection, the DOT also constructed a stub-out so that, in the future, the State can obtain R-1 water from it by connecting a transmission pipe leading to the Honokohau Small Boat Harbor and to a nearby proposed Department of Land and Natural Resources facility. Lastly, at the Queen Kaʻahumanu Highway and Kealakehe Parkway intersection, the DOT has constructed a stub out to the mauka side of



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SOURCE: Brown & Caldwell

FIGURE 2-7

SAT SITE PLAN

the highway, from the stub out, the DEM will extend the R-1 water recycled transmission pipeline to the upper end of SAT site so that the recycled water can be used to irrigate a planted buffer.

In addition, an approximately 9,300-foot (1.76-mile) long transmission pipeline will be constructed from the R-1 storage tank at the WWTP to the County of Hawai'i Old Airport Park, where the R-1 recycled water will be used to irrigate various areas in the Park. The R-1 transmission pipeline will be constructed within the existing easement that was established when DEM constructed the force main from the Old Airport Park pump station to the Kealakehe WWTP.

10) R-1 Recycled Water Storage at Abandoned Tank

In addition to the R-1 water storage tank at the Kealakehe WWTP site, an existing abandoned 1.0-million gallon Department of Water Supply (DWS) concrete reservoir will be used for R-1 water storage. This tank was constructed by the DWS and is about 14,200 feet (2.7 miles) southeast of Runway 35 at Ellison Onizuka Kona International Airport at Keahole. The tank has never been used by the DWS and will be disconnected from the potable water system. The tank has been conveyed to DEM. The tank is about 96 feet in diameter and approximately 20 feet high. The abandoned reservoir lies at about elevation 125 feet msl on the north side of Hina Lani Street. A pipeline will connect the R-1 storage tank to the existing R-1 transmission pipeline that was constructed to the mauka side of the highway by the DOT as part of the Queen Ka'ahumanu Highway Widening project. The pipeline will extend about 580 feet east (mauka) to the R-1 storage tank. A low-head pumping system will deliver R-1 water to the repurposed tank.

2.1.3 R-1 Recycled Water Transmission and Storage (Future Phase)

In future phase(s), R-1 recycled water transmission pipelines will branch off of the proposed 20-inch diameter pipe in Queen Ka'ahumanu Highway near Hale Māka'i Street. One branch will extend approximately 2,500 feet east (mauka) to a future regional park site where the municipal golf course was once planned and envisioned to use recycled water for irrigation. The other pipeline will extend approximately 4,000 feet (0.75 miles) east (mauka) to a 2.0 million gallon R-1 water storage tank at elevation 200± feet that will serve the future regional park as well as future developments on Queen Liliuokalani Trust lands to the south. A high-head pumping system will deliver R-1 recycled water to the future elevated storage tank. (See Figure 1-2).

2.2 Buffer Parcel

The 40-acre buffer parcel that surrounds the Kealakehe WWTP parcel will provide an area to apply R-1 recycled water to planted vegetation. The buffer parcel will be graded and planted with salt-tolerant vegetation to provide a green buffer around the WWTP. Top soil will be imported from an on-island source to provide a media for vegetation growth. A sprinkler irrigation system will be constructed to apply the R-1 recycled water. The buffer parcel irrigation pumps will deliver water from the R-1 recycled water above-grade storage tank to the sprinkler system. An irrigation control system will be provided to start and stop the flow of irrigation water. The buffer will not be fenced.

2.3 Redundant Force Main

As previously discussed, on July 2, 1991, the Planning Commission approved Special Management Area (SMA) Use Permit No. 315, to allow construction of a new sewage pump station, sewage force main and related improvements. The project site begins at the Kuakini Highway-Old Airport runway intersection and is aligned in a northerly direction, connecting to the then-new Kealakehe Wastewater Treatment Plant (WWTP), North Kona, Hawai'i. The permit covered improvements in Tax Map Key 7-4-8:2 & 3, and 7-5-5:7 & 83.

As part of the Kealakehe R-1 Upgrade, DEM will construct a redundant force main adjacent to the existing one. The redundant line would back-up the existing force main to ensure that wastewater collection and treatment services are not interrupted in the event that either line should fail. The redundant line would follow the same alignment as the existing one and would be placed in the same trench as the R-1 transmission pipeline to the Old Airport Park. Both lines will follow the existing easement between the Old Airport Park and the WWTP.

2.4 Other Project Improvements

The following improvements will also be undertaken as part of the R-1 Upgrade project. The improvements are considered exempt from assessment in this EIS pursuant to the DEM's Comprehensive Exemption List, Revised February 10, 2005. The specific exemption is *Exemption Class 1*: *Operations, repairs or maintenance of existing structures, facilities, equipment or topographical features involving negligible or no expansion or change in use beyond that previously existing. Item 4: Operate, repair and maintain all wastewater facilities including sewer lines, pump stations and treatment plan components*.

2.4.1 Lagoon 5 and Lagoon 6 Liner Replacement

In addition to the covers for Lagoons 5 and 6, the R-1 Upgrade project will include maintenance/ repair of the lining for Lagoon 5 and Lagoon 6. The maintenance/repair work will involve removal of the sludge in the lagoons and installation of a new lining over the existing lining. The work will involve the following: 1) removal of the bulk of the sludge from Lagoon 6 by dredging or pumping, mechanically dewatering the material, and then hauling it by truck for disposal at the West Hawai'i Landfill; 2) draining the remaining lagoon water into Lagoon 1 using temporary pumps and above ground lines; 3) once the lagoon has been drained, removing the remaining sludge and installing a new lining over the existing lining; 4) the same process will be repeated for Lagoon 5; and, 5) excavating an approximately 2 feet wide by 2 feet deep anchor trench for the liner around the perimeter of each lagoon and, after the new lining has been installed, backfilling the anchor trench to keep the lining in place. Other than the work on the perimeter of the lagoons, there will be no subsurface work on the service roads between the lagoons.

2.4.2 Underground Storage Tank Removal

In addition to the Lagoons 5 and 6 work, the R-1 Upgrade project will include removal of an existing underground storage tank (UST) used to store diesel fuel and related piping that supplies the existing emergency generator. Emptying, cleaning and removal of the underground storage tank and piping will be done according to DOH requirements. In addition, soil samples will be required to satisfy DOH requirements for tank closure. When laboratory analyses of soil samples confirm that soil meets the DOH specified levels, the excavated area will be backfilled.

The Lagoons 5 and 6 liner work and the underground storage tank removal are maintenance/ repair which is exempt from environmental documentation.

2.4.3 Kailua Park (Old Airport Park) Improvements

The Hawai'i Old Airport Park is owned and managed by the County of Hawai'i Department of Parks and Recreation (DPR). The DEM and DPR have agreed that DEM will remove and replace certain landscaped areas within the park, including the grassed playing fields, and replace the irrigation system with one meeting requirements for applying R-1 recycled water. To minimize ground disturbance, where appropriate, the existing potable water irrigation system will be abandoned in-place. As part of the agreement, DEM will also seek site approval from the DOH, Wastewater Branch for the use of recycled water at the park. Upon completion of construction, DPR will own, operate and maintain the improvements and will be responsible for meeting the DOH Reuse Guidelines. Although these activities would be "user" responsibilities as defined by

the DOH Volume 2 Reuse Guidelines, DEM will be providing funds to undertake these improvements.

The anticipated high salinity of the recycled water effluent from the Kealakehe WWTP means that the landscape irrigation areas will be restricted to salt-tolerant grass and plants. Salt-tolerant species of grass include seashore paspalum (*Paspalum vaginatum*) or Bermuda grass (*Cynodon dactylon*). Preliminary plans show a total of about 21.9 acres of planted areas within the park will be removed and replaced with the salt tolerant plant materials. The replacement R-1 recycled water irrigation system will service these areas.

In February 2011, the Department of Parks and Recreation issued the *Kailua Park Master Plan Final Environmental Assessment.* Kailua Park is often referred to as Old Kona Airport State Recreation Area, Old Kona Airport Park, Old Airport Park, or Maka'eo, as it rests on roughly 98 acres of the former Kona Airport. The Master Plan included a wide range of improvements such as additional restrooms and lockers, concessions, canoe hālau, youth and senior centers, 25-yard swimming pool, skate park, shared-use pedestrian and bicycle path, new access roads and parking and additional lawn and landscaped areas.

The Final EA stated that future improvements at the Kealakehe WWTP may provide the park with recycled (i.e., reclaimed) irrigation water, thereby reducing the existing domestic water demand within the park. Once improvements are completed at the Kealakehe WWTP, R-1 recycled water can be used for irrigation of the ballfields and landscaped areas. Without the demand on domestic water for irrigation, there should be adequate domestic water available for the proposed facilities. Irrigation mains will have to be installed from the treatment plant to the park and connected to the park's existing irrigation main.

Notwithstanding the information from the 2011 Final EA, the replacement irrigation system and replacement landscaping material can be exempted under the DPR Comprehensive Exemption List (August 2001), Exemption Class #2, "replacement or reconstruction of existing structures and facilities where the new structure will be located generally on the same site and will have the same purpose, capacity, density, height, and dimensions as the structure replaced, Item 6 essential utilities, including but not limited to, wastewater systems, drainage systems, water system, electrical systems, communication systems and irrigation systems", and Item 7, "landscaping".

Based on the above, the replacement irrigation system and replacement landscaping at Kailua Park (Old Airport Park) will not be further discussed in this EIS.

2.5 Alternatives

2.5.1 No Action

No Action would retain the existing aerated lagoon treatment system which provides secondary treatment of the effluent prior to disposal in the existing percolation basin. No R-1 Upgrade facilities would be constructed and no R-1 recycled water would be produced and potable water would have to be used for irrigation of playing fields and landscape areas within the existing Old Airport Park and the future Kealakehe Regional Park. No Action means the County DPR would need to continue the use of potable water for irrigation within the Old Airport Park and the future Regional Park. Also, No Action means there would be no opportunity for beneficial use of treated effluent for irrigation within the lands of the future Makalapua Project District planned in the area east (mauka) of the Old Airport Park.

No Action means, although users would not have to plant salt tolerant plant material, the users may need to use commercial fertilizer products to provide the nitrogen and phosphorus that would have been provided by the recycled water.

No Action would continue use of the existing percolation basin disposal. The volume of effluent discharged to the existing disposal system will increase as the service area develops and influent flows to the WWTP increase. The mass of nutrients discharged to the percolation basin disposal system will increase over time as population and commercial growth occurs in the service area. As a result, the mass of nutrients that the Kealakehe WWTP contributes to the area ground water will increase over time with this growth. The environmental impact to the ocean from the increased nutrient discharge cannot be estimated due to the contributions from other sources, including cesspools, individual wastewater systems, other WWTPs, etc. Nevertheless, the ocean ultimately receives the groundwater. The existing disposal system will need to be expanded before it reaches its hydraulic capacity, which is currently unknown.

No Action means the recycled water transmission pipelines constructed as part of the Queen Queen Ka'ahumanu Highway widening project would not be used. Thus, County and DOT investment in these pipelines would be lost.

No Action would not achieve the purpose and need for the proposed action as stated in Section 1.7, nor would it meet the objectives of the proposed action as stated in Section 1.8. Therefore, the No Action alternative is not considered a prudent alternative to pursue.

2.5.2 Treatment Alternatives

The R-1 Upgrade improvement project relies on the existing aerated lagoon treatment system to provide secondary treatment and then using the effluent produced from that process for further treatment to produce R-1 recycled water, with excess effluent receiving alternative treatment through the subsurface flow constructed wetland and finally through the soil aquifer treatment (SAT) process before disposal via percolation. Alternative treatment processes could be used in place of the lagoon treatment system and produce R-1 recycled water with excess effluent disposal via the SAT or an alternative method of disposal, as subsequently discussed.

Activated Sludge Treatment Plant

One of the treatment alternatives would convert the existing Kealakehe WWTP to a conventional activated sludge treatment plant. This alternative could be constructed by filling Lagoons 5 and 6 to accommodate various processing tanks needed for biological nutrient removal (BNR). The BNR process would remove nitrogen and phosphorus from the wastewater. Lagoons 1, 2, and 3 would be retained for emergency and effluent storage purposes. The improvements would include:

- Aeration tanks with anoxic and anaerobic zones for BNR
- Circular secondary clarifiers
- Return and waste activated sludge pumping
- Filtration
- Disinfection
- Sludge thickening
- Sludge digestion
- Sludge dewatering

An activated sludge process with BNR can reliably produce an effluent containing less than 10 mg/L total N (nitrogen) and less than 3 mg/L total P (phosphorus). This process would produce an effluent that could be distributed via the R-1 storage and transmission infrastructure and be

disposed of through the SAT. The process, however, has a high electrical power requirement when compared to the R-1 Upgrade improvements project. In addition to increasing long-term operational costs, the high electrical requirement would result in an increased use of fuel at the Keahole Power Plant, which would increase emissions of various air pollutants. Therefore, the activated sludge BNR treatment process is not the preferred alternative.

Advanced Nutrient Removal

Advanced nutrient removal is a process which would involve additional processes to the activated sludge with BNR process discussed above. The additional processes include:

- The use of denitrification filters to remove nitrate. This process requires addition of a supplemental chemical carbon source (typically methanol) prior to the denitrification filters to act as a carbon source for naturally-occurring denitrifying bacteria in the filters that convert nitrate into nitrogen gas.
- Addition of aluminum sulfate (alum) or ferric chloride to precipitate phosphorus.

Advanced nutrient removal would improve the quality of effluent for R-1 use and disposal but would be an added cost to the BNR process, which is already costlier and more energy consuming than the existing aerated lagoon treatment process. Thus, the advanced nutrient removal process is not the preferred alternative.

2.5.3 Effluent Disposal Alternatives

Effluent disposal is required for the proposed action as well as the two treatment alternatives. Various forms of effluent disposal are potentially available, as discussed below.

Surface Water Discharge

Discharging treated wastewater to surface waters, such as nearby creeks, streams, rivers, or lakes, is a common practice throughout the US. The receiving water dilutes the effluent and natural biological, physical and chemical actions within the water course further attenuate the remaining pollutants in the discharge. Surface water discharges are regulated via the National Pollutant Discharge Elimination System (NPDES).

Since there are no creeks, streams, rivers, or lakes near the Kealakehe WWTP, this surface water effluent discharge method is not considered a feasible alternative.

Ocean Discharge

Ocean discharge is also common practice for coastal WWTPs, including those at various locations in Hawaii. Under this method, treated effluent is disposed via an ocean outfall located at some distance and depth off shore. Outfall systems are designed to provide dilution and dispersion of effluent and are sited to ensure currents carry the treated wastewater away from the shoreline. Natural biological, physical and chemical processes within the ocean water column attenuate the remaining pollutants in the discharge. Ocean discharge is regulated via the National Pollutant Discharge Elimination System program.

Discharge to the ocean was explored as part of the original Environmental Assessment for the Kealakehe WWTP prepared by the County in the 1981. However, ocean discharge was rejected by the County in lieu of other strategies.

The State of Hawai'i has set forth the general policy of water quality, which is to protect and maintain existing uses and the level of water quality. Hawai'i Administrative Rules (HAR) Title 11, Chapter 54, Water Quality Standards (revised November 15, 2014), show that the entire Kona coast, including the area in the vicinity of the Kealakehe WWTP project site is classified as AA

Marine waters. Class AA Marine waters are recognized as high quality coastal waters with the objective that "these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions". Based on the need to comply with the AA Marine waters classification, the use of an ocean outfall for effluent disposal is not a preferred alternative for effluent disposal.

Injection wells

Injection wells are a common way of disposing of treated effluent in Hawai'i due to the often impermeable basalt layers in the subsurface geology that limit percolation of surface-applied water to the basal ground water lens. In addition, injection wells require very little land area to implement.

Injection wells are defined by the State of Hawaii as shafts or holes in the ground that are deeper than they are wide. Although the regulatory definition includes systems that don't extend all the way to the basal groundwater lens, for purposes of analysis it is assumed that injection wells for the Kealakehe WWTP would extend below sea level.

Treated wastewater that is discharged to an injection well is diluted by the groundwater flow. Additional degradation of wastewater constituents can occur as the groundwater and treated wastewater moves through the aquifer towards the ocean.

Injection wells are regulated in Hawaii as part of the Underground Injection Control (UIC) program which seeks to limit their use over potable water aquifers. The DOH has defined UIC lines for each island that defines the boundary of the potable water aquifer for the island. The Kealakehe WWTP is located makai of the UIC line, where injection wells are not prohibited. However, on July 5, 2018, Act 131 (18) was signed into law, which prohibits the DOH from issuing permits "for the construction of sewage wastewater injection wells unless alternative wastewater disposal options are not available, feasible, or practical." Since other effluent disposal methods are available, injection wells are not a feasible alternative at Kealakehe WWTP.

Evaporation

Evaporation is a zero-discharge approach, meaning that no treated effluent makes contact with surface water, ocean water or ground water. Under this method, treated effluent would be disposed by pumping it into shallow impermeable basins where the effluent is allowed to evaporate. Discharge to the basins would need to be rotated to allow the effluent to evaporate prior to re-flooding. The sediment left behind would need to be disposed of in a landfill.

Based on Kona climate data, approximately 185 acres of land would be required for disposal for each 1.0 mgd of effluent flow. Thus, to accommodate the full 5.3 mgd treatment capacity of the Kealakehe WWTP, a total of about 980 acres (net) of evaporation ponds would be required.

In addition, the Federal Aviation Administration (FAA) guidance strongly discourages the development of open-water features that could attract birds within 10,000 feet of a public use airport such as the Ellison Onizuka Kona International Airport at Keāhole and within 5 miles for the protection of approach, departure and circling space.

Based on the large land area requirements and the FAA guidance regarding wildlife attractants, the use of evaporation ponds is not considered a feasible alternative.

Slow Rate Land Treatment

Slow rate land treatment consists of irrigating planted vegetation with treated effluent. Significant treatment is provided as the effluent percolates through the specified soil medium. The planted

vegetation uses the nutrients in the effluent as fertilizer and transpires a portion of the applied water. The effluent is applied in excess of the crop requirement, resulting in a significant percolation component.

A slow rate land treatment system would require significantly more land area than the R-1 Upgrade SAT system and would require suitable soils to grow vegetation. Since the lava fields in the vicinity of the Kealakehe WWTP will not support suitable vegetation, significant quantities of soil would need to be imported to the site. Due to the large land area requirement and the lack of suitable soil in the area, use of the slow rate land application system is not considered a feasible alternative.

Seasonal Storage Reservoir

Implementation of a seasonal storage reservoir would make it possible to use 100 percent of the R-1 recycled water produced by the Kealakehe WWTP in a typical year. The seasonal storage reservoir would make it possible to store or save recycled water produced during the wet season for use during the dry season.

Based on the 5.3 mgd WWTP capacity, analysis of recycled water supply and use and an annual water balance shows the need for a peak storage capacity of approximately 254 acre-feet (83 million gallons) which would occur during June. By November, the storage reservoir would be dry and ready for another wet season. A lined, 20-foot-deep storage reservoir would have a water surface area of approximately 15 acres. The stored capacity of 83 million gallons would make it possible to irrigate approximately 643 acres of golf courses, parks, schools and other areas accessible to the public.

Storage of recycled water is not without its challenges. Recycled water contains nutrients that allow algae to grow. The algae can cause odors if stagnant water conditions are allowed to develop. Recycled water stored in open reservoirs must often be re-treated to improve the water quality characteristics before it be put to beneficial uses. Recycled water reservoirs can be equipped with mixers to prevent stagnant water conditions, and/or be equipped with floating covers to block the sunlight that fosters algal growth.

In addition, as previously discussed, the Federal Aviation Administration (FAA) guidance strongly discourages the development of open-water features that could attract birds within 10,000 feet of a public use airport and within 5 miles for the protection of approach, departure and circling space.

Based on the various drawbacks, use of a seasonal storage reservoir is not considered a feasible alternative.

Desalination

The R-1 Upgrade improvements will produce recycled water with elevated chloride concentrations. Some of this is due to the relatively high saline content of the service area's drinking water. Most of it is due to infiltration of brackish groundwater into the wastewater collection system. Desalination could reduce the chloride content of recycled water, allowing it to be used on vegetation that is not salt tolerant.

Desalination could be accomplished using reverse osmosis (RO) which is an energy-intensive process that typically requires microfiltration or ultrafiltration using membrane technology as a pretreatment. The Honouliuli Wastewater Treatment Plant on Oahu, for example, uses desalination to produce high quality recycled water for industrial use.

The RO process separates and concentrates the salts present in the effluent into a brine that requires disposal. The brine production rate is typically 15 to 20 percent of the flow and contains high concentrations of dissolved solids. Brine is most-commonly managed by marine discharge via ocean outfall or deep injection wells where an ocean outfall is not available. Evaporation in large, shallow, lined ponds with landfill disposal of the resulting solids is another option.

As previously discussed, an ocean outfall or injection wells are not considered to be feasible options for the Kealakehe WWTP, leaving evaporation ponds as the potential brine management solution. Desalination of the full 5.3 mgd design flow of the WWTP would create approximately 4.3 mgd of recycled water and 1.0 mgd of brine requiring disposal. An evaporation pond system encompassing approximately 200 net acres would be required to evaporate the brine, based on local climate data. Although the R-1 Upgrade improvements project produces recycled water that requires use of salt tolerant vegetation, the large land area required for brine management, coupled with high energy requirements for the RO process, use of desalination is not a feasible alternative for the Kealakehe WWTP.

3. DESCRIPTION OF EXISTING ENVIRONMENT, IMPACTS, AND MITIGATION MEASURES

3.1 Climate

The Kailua-Kona area of the island of Hawai'i is characterized by a tropical climate, consisting of a dry (April to October) and a wet (November to March) season. There are local climatic differences across the island due primarily to the mountainous terrain created by Mauna Kea, Mauna Loa, Hualālai, and the Kohala Mountains. The tradewinds that affect the east side of the island are blocked by the mountains, leaving the west side of the island drier and subject to ground heating and cooling.

In the absence of tradewinds, the difference in the ocean and land temperatures and related pressure differences create a local diurnal variation in the wind pattern along the Kona coast. Surface heating of the land causes upslope winds during the day. The wind direction reverses at night as cooled mountain air moves downslope. The higher surface heating in the summer intensifies this process. Due to these conditions, Kona is in the only place in the state that experiences peak rainfall levels in summer months.

Average temperatures in the Kailua-Kona region range from 72 degrees Fahrenheit in January, the coolest month, to 77 degrees in August, the warmest month. Kailua-Kona is located in the drier region of the island with an average precipitation of 25 inches per year. Rainfall in the region is highly seasonal, with most of the precipitation occurring in the winter months. However, storm events can result in heavy rain fall along the Kona coast, which can create localized flooding in the Kailua-Kona. Recently, on October 24-25, 2017, a storm event resulted in 1.66 inches of rain at the Ellison Onizuka Kona International Airport at Keāhole.

Impacts and Mitigation Measures

No significant impacts are anticipated on climate from the project to surrounding area. Construction and operation of the proposed project are not anticipated to affect temperatures, wind, or rainfall levels along this portion of the Kona coast.

3.2 Geology

The island of Hawai'i is composed of five major volcanic mountains. All of them are very young, and three have been active in historic time. The project site and surrounding area are located along the western coast of the island between Kailua-Kona and Keāhole, on the southwest slopes of Mauna Kea, Mauna Loa, and Hualālai Volcanoes. Mauna Kea, the highest mountain, reaches 13,784 feet mean sea level (MSL). The volcano has not erupted during historic time. It is built up of olivine basalt and covered with layers of volcanic ash. Hualālai, 8,251 feet high, is built up of basalt.

Hualālai is nearest volcano to the project site at approximately 9.5 miles to the east. It is the third youngest and third-most historically active volcano on the Island of Hawai'i. It is considered to be in the post-shield stage of activity. Six different vents erupted lava between the late 1700s and 1801, two of which generated lava flows that poured into the sea on the west coast of the island. The oldest dated rocks are from about 128,000 years ago and it probably reached an elevation above sea level before 300,000 years ago. The volume of Hualālai is 12,400 km^3 (2,975 mi^3). Its area is 751 km^2 (290 mi^2).

The last eruption of Hualālai, in 1800-1801, produced olivine basalt. Though Hualālai is not nearly as active as Mauna Loa or Kīlauea, geologic mapping of the volcano shows that 80 percent of Hualālai's surface has been covered by lava flows in the past 5,000 years. In the past few decades, when most of the resorts, homes, and commercial buildings were built on

the flanks of Hualālai, earthquake activity beneath the volcano has been low. However, in 1929, an intense swarm of more than 6,200 earthquakes rattled the area around Hualālai Volcano for more than a month. The earthquakes were most likely caused by an intrusion of magma beneath the volcano. Two large earthquakes (each about magnitude 6.5) destroyed houses, water tanks, stone fences, and roadways. For these reasons, Hualālai is considered a potentially dangerous volcano that is likely to erupt again.

Geotechnical borings were conducted during April and May 2017 within the Kealakehe WWTP in the area of the R-1 improvements, the subsurface constructed wetlands area, within the SAT system site, and within the existing easement along the R-1 transmission pipeline alignment between the Kealakehe WWTP and Kailua Park (Old Airport Park). The purpose of the borings was to provide subsurface information related to the design of foundations, including seismic considerations, probing for the presence of voids and the need for grouting, resistance to lateral pressures required for retaining walls, slabs on grade, and site grading.

Three borings were conducted at Kealakehe WWTP within the area of the R-1 Upgrade improvements. The borings encountered surface fill classified as gray basaltic gravel with sand. The fill was in a dense condition, and generally extended to depths ranging from about 5 to 6 feet, except for one which only encountered 1 foot of fill. Underlying the gravel fill was gray, moderately to slightly weathered basalt which was in a medium hard to hard condition, extending to the maximum depths drilled. A void was encountered in one boring at a depth of about 3.5 feet with a vertical dimension of about 0.5 feet. Neither ground water nor seepage water was encountered in the borings at the Kealakehe WWTP.

Borings in the buffer area also encountered surface fill classified as gray basaltic gravel with sand. The fill thickness was usually thin, ranging from only a few inches to about 1.5 feet. However, fill encountered in the three borings drilled along the south side of the existing lagoons, ranged from about 6 feet to the maximum depth drilled of 11 feet in one boring. Underlying the gravel fill was gray, moderately to slightly weathered basalt which was in a medium hard to hard condition and extended to the maximum depths drilled. A void was encountered in one boring at a depth of about 5 feet with a vertical dimension of about 0.5 feet. Neither groundwater nor seepage water was encountered in borings in the buffer area

The borings in the SAT system site encountered gravelly material at ground surface, usually only about 0.5 to 2.5 feet in thickness. One of the borings encountered about 5.5 feet of gravelly material, but a portion of the layer could be clinker. Underlying the gravelly fill was gray moderately to slightly weathered basalt which was in a medium hard to hard condition and extended to the maximum depths drilled. Voids were also encountered with vertical dimensions ranging from about 0.5 to 4 feet. Ground water was encountered in the borings at depths ranging from about 57.5 to 69.5 feet.

Three borings were conducted within the existing force main easement which will be used for the R-1 transmission pipeline between the Kealakehe WWTP and Old Kona Park. The three borings encountered surface fill classified as gray basaltic gravel with sand. The fill thickness was only a few inches thick. Gray, moderately to slightly weathered basalt was encountered below the relatively thin surface fill. The moderately to slightly weathered basalt was in a medium hard to hard condition, extending to the maximum depths drilled. A void was encountered in one boring at a depth of about 3 feet with a vertical dimension of about 0.5 feet. Neither groundwater nor seepage water was encountered in the borings along the R-1 transmission pipeline.

Impacts and Mitigation Measures

The Kealakehe WWTP facilities will require excavation for footings and foundations for the chemical addition building, above grade storage tank, the process feed pump station, the flocculation/UV structure, and the transfer pump station. The building footing and foundations would be relatively shallow with excavation of about less than 3 feet, including for base course material. The flocculation basins/UV structure would require excavation of about 10 feet below grade. Excavation of about 10 to 20 feet will also be required for the pumping facilities. Excavation will also be required for the subsurface constructed wetlands and the SAT basins.

Further, trenching will be required for placement of the recycled transmission pipelines along Queen Ka'ahumanu Highway which will to connect to the recently completed line constructed by the HDOT.

The trenches required to place the R-1 recycled transmission pipelines will be designed to County of Hawai'i standards applicable to water lines, as modified per DOH recycled water pipeline requirements. The typical trench would require 4 feet of cover from the top of the recycled water transmission pipeline to grade, 12 inches of cushion material on both sides of the pipeline, and 6 inches below the pipeline. The trench could be backfilled with suitable materials or controlled low strength material (CLSM), or flowable fill, a type of low strength concrete mix. Based on a 24-inch R-1 pipeline, the trench would be about 4 feet wide and 7'-6" deep. Similar trenches will be used for the future transmission pipelines.

Construction of the building footings, foundations and trenches would not create an adverse impact to the geological conditions of this area of the Kona coast.

On March 28, 2012, Ordinance No. 12 27 adopted the 2006 International Building Code (IBC) as the applicable code for the construction of buildings, structures, and facilities in the County of Hawai'i. The purpose of the seismic provisions in the IBC is primarily to safeguard against major structural failures and loss of life, not to limit damage or maintain functions. Structures are to be designed and constructed, at a minimum, to resist the effects of ground motions from seismic events. The site seismic hazard characteristics in the IBC are based on the seismic zone and proximity of the site to active seismic sources.

The findings of the geotechnical study will be incorporated into the design of the R-1 Upgrade improvements, including the SAT system, the structures and facilities within the Kealakehe WWTP and the buffer area, and along the R-1 transmission pipeline between the Kealakehe WWTP and the Old Airport Park. Designs based on the findings of the geotechnical study should assure that the geological conditions do not adversely affect the R-1 Upgrade project.

The Kealakehe WWTP facilities will be designed and constructed to meet the requirements of the 2006 IBC and Hawai'i County Code Chapter 5 and will comply with seismic loadings established for the County of Hawai'i. This will ensure that the Kealakehe WWTP R-1 facilities can meet the seismic loadings established in the IBC. This will also ensure that the geological conditions at the project site do not adversely affect the proposed building and facilities.

3.3 Soils

According to the U.S. Department of Agriculture Natural Resources Conservation Service, the Kealakehe WWTP project site and surrounding areas, including near the abandoned Hina Lani storage tank, are comprised mainly of Lava flows Honokohau complex. The SAT site is Lava Flows a'a. These soils are described as follows (see also Figure 3-1):

- 107 Lava Flows-Honokohau complex: The Honokohau series consists of very shallow, well drained soils formed in organic material mixed with minor amounts of basic volcanic ash over pahoehoe lava. Slopes range from 2 to 20 percent. From 0 to 6 inches below the surface, the soil is black highly decomposed plant material, very dark brown) dry; strong very fine granular structure; soft, very friable, nonsticky and nonplastic. Over 6 inches; the soil is hard, massive pahoehoe lava.

- 10 Lava Flows, .a'a. This lava has practically no soil covering and is bare of vegetation, except for mosses, lichens, ferns, and a few small 'ōhi'a trees. It is found at elevation ranges near sea level to 13,000 feet and receives from 10 to 250 inches of rainfall annually. It is associated with pahoehoe lava flows and many other soils. This lava is rough and broken. It is a mass of clinkery hard, glassly, sharp pieces piled in tumbles and heaps. In areas of high rainfall, it contributes substantially to the underground water supply and is used for watershed.

- 12 Lava Flows, Pahoehoe. This lava has a billowy, glassy surface is relatively smooth. In some areas the surface is rough and broken, and there are hummocks and pressure domes. Pahoehoe lava has no soil covering and is typically bare of vegetation, except for mosses and lichens.

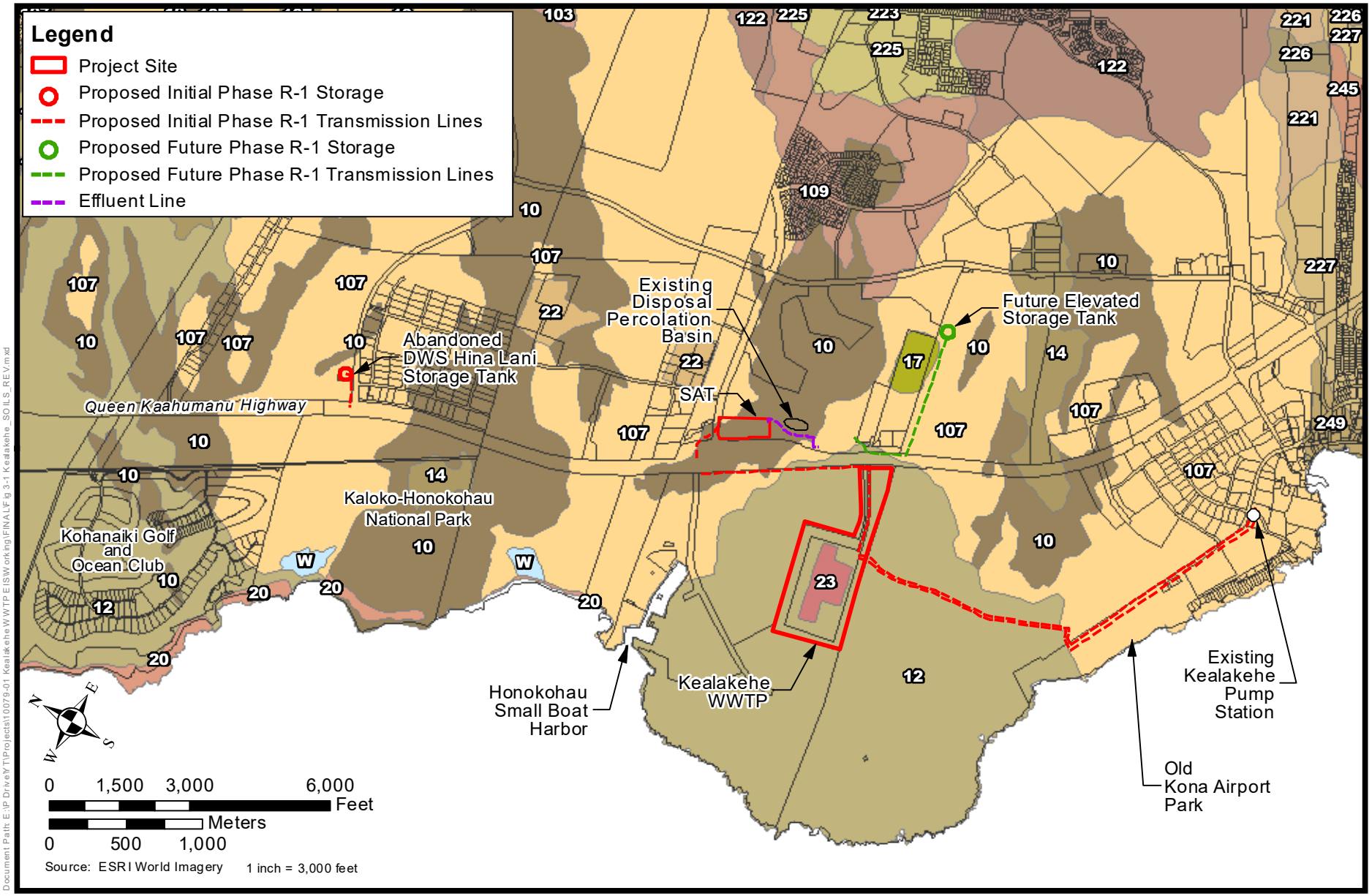
- 17 Landfill

- 23 Sewage Treatment Plant

Impacts and Mitigation Measures

The R-1 transmission pipeline along Queen Ka'ahumanu Highway and to the Old Airport Park, and the redundant force main are located in the Lava Flows-Honokohau complex. Trenching will be required for placement of the R-1 transmission pipelines. The trenches will be designed to County of Hawai'i standards applicable to water lines, modified per DOH recycled water pipeline requirements. The typical trench would require 4 feet of cover from the top of the R-1 transmission pipeline to grade and 12 inches of cushion material on both sides of the line and 6 inches below the line. The trench could be backfilled with suitable materials or with controlled low strength material or flowable fill, a type of low strength concrete mix. The type of cover will depend on the subsurface condition along the line and/or its location.

Excavation activities associated with construction of the trenches will be regulated by the County standards and the NPDES permit requirements administered by the State DOH. An NPDES Individual Permit for Storm Water Associated with Construction Activity will be required for the project, since the total areas of soil disturbance will exceed 1.0-acre. Mitigation measures will be instituted in accordance with site-specific assessments, including installing silt fences or filter socks around the disturbed areas to control surface flows into adjacent areas. Once the trench work has been completed,



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WILSON OKAMOTO CORPORATION

FIGURE 3-1

SOILS MAP

Kealakehe WWTP R-1 Upgrade

exposed soils at the project site and surrounding area will be stabilized and the excavated areas will be returned to the specified condition. Depending on the existing condition, this may involve repaving or re-vegetating to control erosion. Thus, the project is not anticipated to have any long-term impacts on area soils.

The Kealakehe 40-acre planted buffer area is also located in the Lava Flows-Honokohau complex. The planted buffer will be cleared and excavated and then top soil will be imported and placed on the site to create the 40-acre planted area. The contract documents will specify the type of soil to be imported to ensure that it is free of constituents or materials that could affect the soils of the surrounding area.

Almost all of the SAT system site is located within soil classified as Lava Flows, a'a, which has practically no soil covering and is bare of vegetation. The SAT system site will consist of 8 basins (7 active and 1 reserve). Using one basin per day will result in a wet dry cycle of 1 day wetting and 6 days of drying. The 8th basin will be used as an emergency or reserve basin, such as when maintenance is required to the basins' surface or to the distribution system. Each basin will be about 1-acre. A perimeter fence will be installed to prevent public access. Internal access roads will surround each basin.

The distribution system will consist of pressure dosed piping near the surface. The piping will have slots or drilled orifices to allow the applied wastewater to be uniformly distributed over the basin surface. Typical spacing would be 4 feet between lines with openings every 2 feet. The piping system will be covered with gravel.

The existing area will be excavated and the a'a lava will be crushed to form part of the media base in the SAT basins. The media depth in the basin will be about 4.25 feet of a base of crushed a'a and sand which will be imported from an on-island quarry. The contract documents will specify the type of soil to be imported to ensure that it is free of constituents or materials that could affect the soils of the surrounding area.

The SAT basins will be designed so that the surface will normally be dry with no standing water.

The State of Hawai'i DOH regulates wastewater discharges. Initial discussions with the DOH have indicated that the Kealakehe WWTP SAT system would be regulated as land disposal, as set forth in the requirements contained in HAR 11-62. HAR 11-62 regulations require secondary treatment (BOD_5 and TSS less than 30 mg/L) prior to land disposal and establishes minimum monitoring, record-keeping and reporting requirements. The treated effluent from the Kealakehe WWTP discharged to the SAT basins will be of better quality than the minimum requirements for land disposal.

3.4 Surface Water

There are no perennial streams, rivers, or major drainage features on the project site and surrounding area. Similarly, there is no designated wetland on the project site and surrounding area. Most rainfall percolates into the ground to the underlying groundwater body and moves slowly seaward to be discharged through the seafloor into offshore waters. Occasionally intense rain storm events occur and these can produce sheet flow, some of which could reach the adjacent shoreline as surface flows.

Kaloko Fishpond, located along the shoreline within the area of Kaloko-Honokōhau National Historical Park, is the surface water feature nearest the Kealakehe WWTP project site and the various transmission pipelines.

Based on documents shown in the *Atlas of Hawai'ian Watersheds & Their Aquatic Resources, Island of Hawai'i,* the Department of Land and Natural Resources (DLNR) Commission on Water Resources Management, the project area is located within the Honokōhau watershed.

Impacts and Mitigation Measures

No adverse impacts are anticipated on surface waters since the project is not expected to alter existing drainage patterns or have any long term water requirements. No alterations to drainage facilities will be required. Similarly, no dredging or filling of surface waters will be required.

Construction of the proposed improvements at the Kealakehe WWTP, planted buffer and the transmission pipelines sites will require the contractor to submit erosion control and stormwater control plans. Typically, the plans will require use of silt fences or filter socks to surround the construction sites, including material storage and staging areas, to control surface flows during construction. Any drainage inlets near the construction sites will be protected to prevent silt in surface runoff from entering into the stormwater system. Lastly, since the Kealakehe WWTP and the surrounding area show almost no slope, runoff to surrounding areas would be minimal.

The Kealakehe SAT basins will be located at elevations ranging from approximately 70 to 90 feet above sea level, and at least 3,000 feet mauka of the Honokohau Harbor, the closest surface water body. The SAT basins will be surrounded by berms designed to contain the applied effluent and rainfall on the basins from a 24-hour 100 year storm event. This will prevent discharges from the SAT basins.

Effluent applied to the SAT basins will percolate through an unsaturated vadose zone to the basal ground water lens, located a few feet above sea level. The water will then mix with and travel with the regional ground water flow generally makai to the ocean.

In addition to the SAT basins, recycled water will be used to irrigate the buffer parcel surrounding the Kealakehe WTTP. The DOH reuse guidelines require that recycled water irrigation systems be designed with controls to "prevent direct or indirect runoff from approved use areas to outside areas such as streets, right of ways, sidewalks, parking lots, storm drains, gutters, and water bodies such as streams, ponds and oceans". The buffer parcel irrigation system will be designed to conform with the DOH reuse guidelines to prevent discharge to surface waters.

3.5 Ground Water

Ground water occurs within portions of geologic formations where aquifers receive and store water. The island of Hawai'i is divided into nine ground water sectors, identified as Aquifer Sector Areas, which reflect broad hydrogeological (subsurface) similarities while maintaining hydrographic (surface), topographic, and historical boundaries. Within the Aquifer Sector Areas, smaller sub-regional hydrologic units, or Aquifer System Areas are delineated based on hydraulic continuity and related characteristics. The project site and surrounding area are within the Hualālai Aquifer Sector Area, and specifically within the Keauhou Aquifer System Area, which extends over the western and southwestern flank of Hualālai and the entire coastline from Mahai'ula to Keikiwaha point. The Keauhou Aquifer System is described as

being comprised of a basal water system in the coastal area with the possibility of having high-level, dike confined ground water near the rift zones of Hualālai.

The State DLNR Commission on Water Resource Management (CWRM) estimates that the Keauhou Aquifer System Area has a sustainable yield of 38 million gallons per day (mgd), based on a recharge estimate of 87 mgd and an unconfined, thin basal water development scenario. However, this estimate may be underestimated due to the discovery of high-level ground water occurrence in the southern and northern regions of North Kona. Based upon water level data from 14 wells (from Kalaoa to Ke'ei), the hydrologic discontinuity between the high-level ground water and basal-water aquifers roughly aligns with Māmalahoa Highway, and the high-level water appears to occur above 1400 feet mean sea level. This high-level ground water is considered to be of pristine quality, largely due to the absence of saltwater intrusion and little to no urban development overlying the aquifer recharge area.

The Underground Injection Control (UIC) program, administered by the State DOH's Safe Drinking Water Branch, was established to protect the quality of underground sources of drinking water from contamination by subsurface disposal of fluids. Chapter 340 E, HRS, and Title 11, Hawai'i Administrative Rules Department of Health Chapter 23, Underground Injection Control set forth the requirements related to protection of underground sources of drinking water. The DOH has also established maps that show the UIC line as the boundary between non-drinking water aquifers, generally located makai of, or below, the UIC line, and underground sources of drinking water, generally located mauka, or above, of the UIC Line.

The UIC line is generally located along the 500-foot MSL topographic contour line in the area of the Kealakehe WWTP. Further, the DOH maps indicate that the Kailua-Kona area, including Kealakehe WWTP, is located below the UIC line. The Kealakehe WWTP is located at about 50 to 56 feet MLS and the SAT basins at approximately 60 to 70 feet MSL. Thus, these areas will be about 410 to 450 feet vertically and approximately 6,000 to 8,200 feet horizontally below the UIC line.

Impacts and Mitigation Measures

No significant adverse impacts to ground water resources are anticipated from construction and operation of the proposed improvements. Construction and operation of the proposed improvements is expected to significantly reduce the mass of nutrients, primarily nitrogen and phosphorus, which percolates to the ground water when compared to the current amount discharged to the existing disposal percolation basin. The nutrient mass reductions will be achieved via the combination of water recycling, the subsurface flow constructed wetlands, and the SAT system. The existing disposal percolation basin will be closed as part of the project.

Construction activities are not likely to introduce to, nor release from the soil any materials which could adversely affect ground water. Construction material wastes will be appropriately disposed to prevent leaching into the ground water. Dewatering activities are not anticipated for this project.

The R-1 Upgrade project will allow a portion of the recycled water to be put to beneficial use. Nutrients present in the recycled water will be distributed over the areas that are irrigated. The applied nutrients will then taken up by the plant material as fertilizer or immobilized in the soil. Over-application of nitrogen via recycled water application represents a risk to the environment, therefore the amount of nitrogen applied via recycled water should not exceed the needs of the vegetation it is applied to. Applied

phosphorus is generally taken up by the crop or adsorbed to soil particles and represents less environmental risk so long as recycled water is applied at appropriate rates to prevent run off to surface water.

The proposed project will allow the County to control the nutrient content of the recycled water by blending a portion of the polished effluent from the subsurface flow constructed wetland with the lagoon effluent that is directed to the R-1 treatment processes. A 15 mg/L total nitrogen concentration has been established as a target for the recycled water, based on local climate and irrigation data. As previously discussed, areas that receive recycled water will need to be primarily planted with salt-tolerant turf grass, including the buffer parcel, areas within parks, and golf courses. The recycled water will provide most or all of the nitrogen requirements of the vegetation, and no supplemental fertilization will be required. Additional detail is provided in Appendix B.

Aerated lagoon effluent will be continuously circulated through the subsurface flow constructed wetland to remove nitrogen via denitrification and provide additional polishing treatment benefits. Denitrification is a biological process that requires anoxic conditions and a carbon source, both of which are present in a wetland environment. The naturally-occurring bacteria that accomplish the denitrification process attach to the gravel media within the wetland, but do not rely on chemical characteristics of the media. As a result, the subsurface flow constructed wetlands are expected to have a viable life of at least 40 years.

Water level control structures will be provided at each wetland cell to allow the County to set the operational water level within the wetland gravel matrix. The water level will be maintained below the surface of the gravel media to provide the desired treatment and to ensure no standing water. The return flow from the wetlands will be collected by a collection system in the wetland and then pumped so that it can be stored in Lagoon 6. This means the treated effluent directed to the SAT site will contain low concentrations of nitrogen. See Appendix B. A wetland monitoring schedule will be developed as part of the facility's operation and maintenance manual. Wetland operational performance monitoring will likely consist of periodic grab samples that will be tested for ammonia, nitrite, nitrate, biological oxygen demand (BOD), and total suspended solids (TSS).

The subsurface flow constructed wetlands will be lined with 60-mil high density polyethylene synthetic geomembrane liners to prevent percolation to subsurface ground water resources. The selected liner material is used to line sanitary landfills and has an expected lifetime of over 50 years when protected from sunlight.

The sand media used in the SAT basins will adsorb phosphorus from the applied treated effluent, so that water released to the environment from the bottom of the SAT will have low phosphorus concentrations. The SAT sand media is expected to last on the order of up to 40 years, based on results of phosphorus adsorption testing on potential media to be used in the basins. The actual life of the SAT media will depend on the amount of water that is disposed, the phosphorus concentration in the effluent, and the rate of chemical precipitation that occurs within the media. When the media is adsorption capacity is exhausted it will require replacement or supplementation to provide necessary adsorption capacity. See Appendix B.

The combination of water recycling, the subsurface flow constructed wetlands, and SAT system will significantly reduce the mass of nitrogen and phosphorus that percolates to ground water from the WWTP's disposal system. The R-1 Upgrade improvements project is expected to reduce the mass of nitrogen and phosphorus that currently percolates to ground water via disposal by greater than 90 percent when compared to the current percolation basin disposal method. See Appendix B.

Other treatment benefits will be realized through implementation of the R-1 Upgrade project, include reduction of metals, trace organic compounds, endocrine disrupting compounds, and other pollutants that currently percolate to ground water from the WWTP's existing disposal percolation system. Although removal of these pollutants is not a primary design goal of the R-1 Upgrade project, and quantification of the reductions that will be achieved by the proposed processes cannot be accurately predicted, use of the treated effluent as R-1 recycled water for irrigation purposes will reduce the amount of effluent for disposal. Thus, reduction in the volume of disposal and the reduction in the concentration of the various pollutants is expected to be achieved. Consequently, no additional adverse impacts are anticipated.

Three ground water monitoring wells will be installed at the SAT site as part of the project. One well will be located upgradient (mauka) of the SAT basins, and two wells will be installed downgradient (makai) of the SAT basins. To monitor the land treatment system performance, ground water monitoring program will be developed during development of the facility operations and maintenance manual in consultation with DOH. Semi-annual sampling for nutrients, salts, and other parameters developed in consultation with DOH is anticipated.

Each SAT basin will be equipped with a pan lysimeter that will allow collection of subsurface drainage samples. A lysimeter monitoring program will be developed in conjunction with DOH to monitor the SAT system's performance. Semi-annual sampling for nutrients, salts, and other parameters developed in consultation with DOH is anticipated.

The existing disposal percolation system will be closed as part of the project.

3.6 Coastal Waters

The State of Hawai'i has set forth the general policy of water quality, which is to protect and maintain existing uses and the level of water quality. Hawai'i Administrative Rules (HAR) Title 11, Chapter 54, Water Quality Standards (revised November 15, 2014), show that the entire Kona coast, including the area in the vicinity of the Kealakehe WWTP project site is classified as AA Marine waters. Class AA Marine waters are recognized as high quality coastal waters with the objective that "these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions".

HAR Title 11, Chapter 54, shows the waters inside Honokōhau Harbor are Class A. The DOH objective for Class A waters is to protect "their use for recreational purposes and aesthetic enjoyment".

Impacts and Mitigation Measures

No significant impacts on coastal waters in the greater project vicinity are anticipated as a result of the construction and operation of the proposed improvements.

Construction activities will involve land-disturbing activities that may result in some short-term surface runoff and soil erosion. The construction plans will include erosion control plans for the WWTP site, the buffer and soil aquifer treatment sites, and along transmission pipeline work areas.

A National Pollutant Discharge Elimination System (NPDES) Permit for storm water runoff is required for the disturbance of one acre or more of total land area for a single project. HAR Title 11, Chapter 55, "Water Pollution Control" effective December 6, 2013, is administered by the DOH Clean Water Branch and sets forth requirements for controlling storm water runoff during construction of the project. The construction contractor will be responsible for implementing a storm water management plan to control surface runoff from flowing into neighboring areas. Mitigation measures used may include site-specific structural and/or non-structural BMPs such as minimizing time of exposure between construction and landscaping, and implementing erosion control measures such as silt fences, filter socks, and sediment control basins. Following the associated construction activity, the excavated areas will be returned to the existing conditions, including use of pavement.

The location of offshore coastal waters for the Kealakehe WWTP and related facilities varies from about 500 feet (0.09 miles) to approximately 7,400 feet (1.4 miles). The R-1 facility improvements closest to the shoreline are located about 5,500 feet to the east and closest planted buffer about 3,400 feet east of the shoreline. The transmission line to Old Airport Park) is approximately 500 feet from the coast at its closest point. The distance from the shoreline for other portions of the transmission line vary from 3,400 feet to 4,200 feet. The NPDES permit will ensure that the storm water runoff during construction does not affect the nearby coastal waters. See Table 3-1.

Table 3-1
R-1 Upgrade Project
Distance to Shoreline

SITE/LOCATION	Approximate Distance to Shoreline (feet)
Kealakehe WWTP R-1 Facilities	5,500
Planted Buffer	3,400
Transmission Pipeline on Ka'ahumanu Hwy	4,500
Kealakehe WWTP Access Road	7,400
Kealakehe Parkway intersection	4,200
Hina Lani Street intersection	3,400 (*)
Old Airport Park	500
SAT System site	4,000

(*) Kaloko Fishpond

Construction and operation of the project is projected to significantly reduce the mass of nitrogen and phosphorus that percolates to the basal ground water lens via effluent disposal, as described in Section 3.5 Ground Water and in Appendix B. Ground water in the area generally flows towards the ocean. As a result, the project will reduce the mass of nitrogen and phosphorus originating from the Kealakehe WWTP effluent that

ultimately enters the ocean via ground water. Adverse impacts to ocean waters are not anticipated as a result of project implementation.

It should be noted that there are other sources of nutrients to the area ground water, including from septic tank systems, cesspools, and irrigation of landscape areas. These other sources of nutrients will not be affected by implementation of the proposed project.

3.7 Natural Hazards

According to the Flood Insurance Rate Map (FIRM) (Community Panel No. 1551660692C (effective date: September 16, 1988) prepared by the Federal Emergency Management Agency (FEMA)), the project site is located within Zone "X", defined as "Areas determined to be outside the 0.2% annual chance floodplain". The project site is located outside of the tsunami inundation zone. Figure 3-2 shows the FIRM map.

Tsunami Evacuation Zone maps for the State of Hawai'i identify low lying areas where excavation is recommended since extensive damage to life and property may occur from seismic sea waves. The maps state: "for any tsunami warning evacuate these areas".
Most of the project site is outside the tsunami evacuation zone.

Impacts and Mitigation Measures

Construction and operation of the proposed improvements are not anticipated to increase flood risks or cause any adverse flood-related impacts at the project site or lower elevation properties.

3.8 Seismic Hazard

In most areas of the world, earthquakes are caused by shifts in the tectonic plates. In contrast, earthquakes in Hawai'i are primarily linked to volcanic activity. Earthquake activity in Hawai'i generally occurs before or during volcanic eruptions or from underground movement of magma that comes close to the surface without an actual eruption to the surface.

On the island of Hawai'i, earthquakes directly associated with the movement of magma are concentrated beneath the active Kīlauea and Mauna Loa Volcanoes. Typically, the risk of seismic activity and degree of ground movement decreases with the distance from these active volcanoes. The several significant earthquakes, greater than Magnitude 6, have occurred on the west side of the island, including the recent Magnitude 6.0 earthquake on October 15, 2006 located near Kīholo Bay which lies about 16.6 miles north of the Kealakehe WWTP project site.

The International Building Code (IBC) includes a system that classifies seismic hazards on the basis of the expected strength of ground shaking and the probability of the shaking actually occurring within a specified time. The IBC seismic provisions contain six seismic zones, ranging from 0 (no chance of severe ground shaking) to 4 (10 percent chance of severe ground shaking in a 50-year interval). The entire island of Hawai'i is designated Seismic Zone 4, the highest rating among the major Hawaiian Islands.

Chapter 5, Building, Hawai'i County Code (SUUP.3 (1-2018) states the 2006 International Building Code (IBC) is adopted as the applicable code for the construction of buildings, structures, and facilities in the County of Hawai'i. The purpose of the seismic provisions in the IBC is primarily to safeguard against major structural failures and loss of life, not to limit

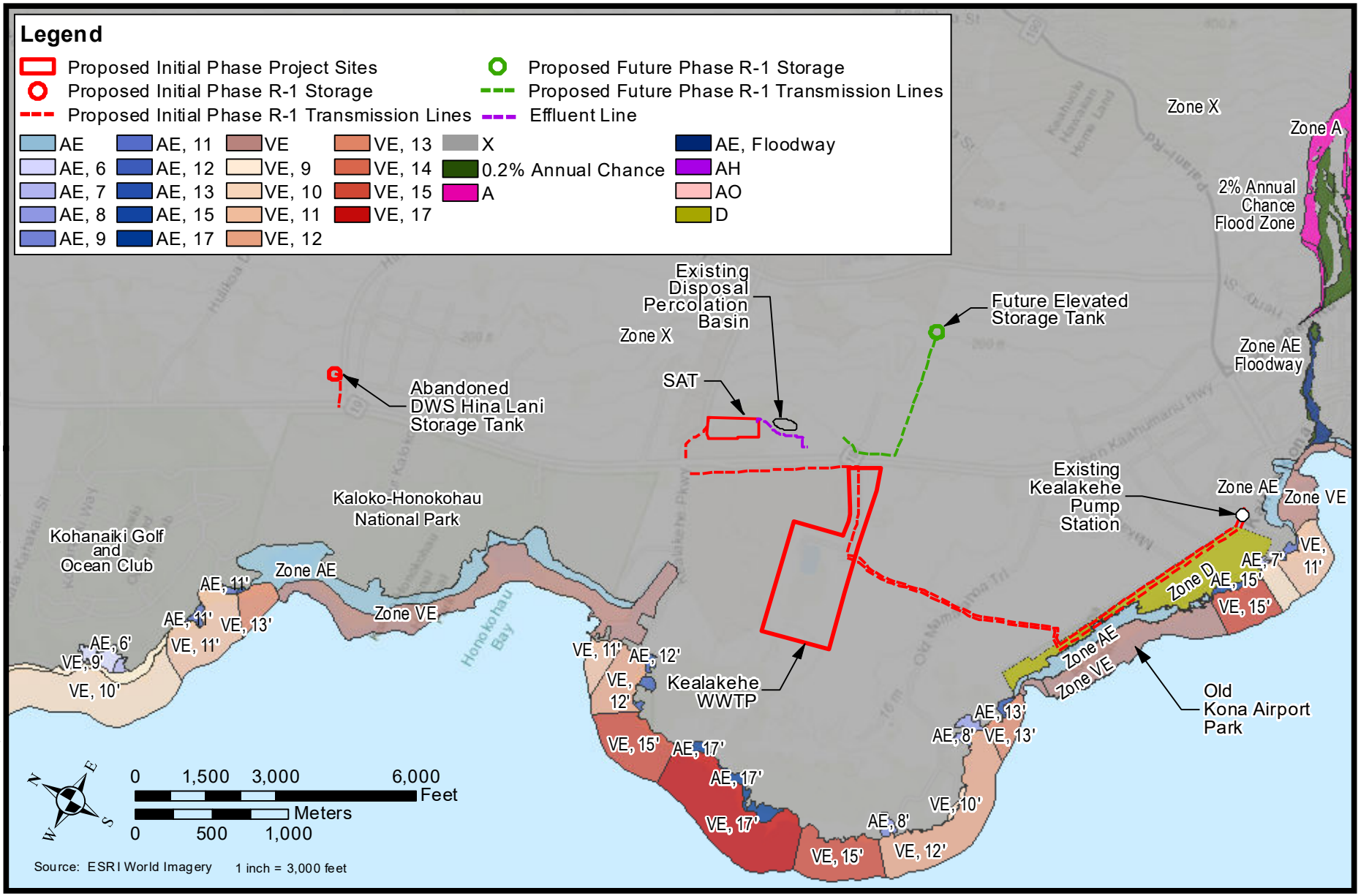

FIGURE 3-2

FLOOD INSURANCE RATE MAP

Kealakehe WWTP R-1 Upgrade

damage or maintain functions. Structures are to be designed and constructed at a minimum to resist the effects of ground motions from seismic events. The site seismic hazard characteristics in the IBC are based on the seismic zone and proximity of the site to active seismic sources. IBC serves primarily to safeguard against major structural failures and loss of life, not to limit damage or maintain functions. Structures are to be designed and constructed at a minimum to resist the effects of ground motions from seismic events. The site seismic hazard characteristics in the IBC are based on the seismic zone and proximity of the site to active seismic sources.

Impacts and Mitigation Measures

The Kealakehe R-1 improvements will be designed and constructed to meet the requirements of the 2006 IBC and Hawai'i County Code Chapter 5 and will comply with seismic loadings established for the County of Hawai'i. This will ensure that the R-1 improvements can meet the seismic loadings established for in the IBC. This will also ensure that the geological conditions at the project site do not adversely affect the buildings and facilities at the WWTP.

3.9 Agricultural Lands

The *Detailed Land Classification – Island of Hawai'i* published by the University of Hawai'i Land Study Bureau (LSB) evaluates the quality or productive capacity of certain lands on the island for selected crops and overall suitability in agricultural use. A five-class productivity rating system was established with "A" representing the class of highest productivity and "E" the lowest. The Kealakehe WWTP and buffer project sites are rated as "E". The SAT project site is rated as "Urban area".

In 1975, the US Department of Agriculture Soil Conservation Service (now Natural Resources Conservation Service) initiated a nationwide inventory of important farmlands. When completed, the inventory included three categories "prime", "unique", and "other farmlands of state-wide and local importance". This classification was later adopted by the State of Hawai'i Department of Agriculture under the title "Agricultural Lands of Importance to the State of Hawai'i (ALISH).

According to the ALISH system, the Kealakehe WWTP, buffer and SAT systems project sites are "Unclassified". As set forth in Act 183, Twenty-Third Legislature, 2005, HB 1640, defines agricultural lands as those: (1) Are capable of producing sustained high agricultural yields when treated and managed according to accepted farming methods and technology; (2) Contribute to the State's economic base and produce agricultural commodities for export, or local consumption; or, (3) Are needed to promote the expansion of agricultural activities and income for the future, even if not in current production. Thus, the project sites are not considered one of the three ALISH classifications or meet the definition of agricultural lands set forth in Act 183.

Impacts and Mitigation Measures

Based on the findings related to agricultural lands, the R-1 Upgrade improvements at the Kealakehe WWTP, buffer, and SAT systems project sites will not adversely affect agricultural lands in this area of the Kona coast.

3.10 Natural Environment

3.10.1 Flora

In September 2017, botanical surveys were conducted at following areas: (1) the buffer area which covered all the area outside the existing security fence surrounding the existing

Kealakehe WWTP to the buffer area property line; (2) the R-1 transmission pipeline routes from the Kealakehe WWTP to Kailua Park (Old Airport Park); (3) the R-1 transmission pipeline route to a future storage tank site southwest of the former County landfill; (4) along Queen Ka'ahumanu Highway from the Kealakehe WWTP access road to a connection point with the recently completed Queen Ka'ahumanu Highway widening project; (5) the SAT system site; and (6) the R-1 transmission pipeline route between the recently completed Queen Ka'ahumanu Highway widening project and the existing Hina Lani reservoir. Appendix C contains the botanical survey report.

The findings of the botanical survey show R-1 Upgrade the project sites are a mix of undisturbed, slightly disturbed, but mostly greatly disturbed lava flows and roadways. A total of 32 plant species were recorded during the botanical survey, with 26 of the species (81 percent) non-native species. Of the 6 native and early Polynesian species listed in one is a native endemic species (*maiapilo; Capparis sandwichiana*), four are native indigenous species, and one a Polynesian introduction. The most ubiquitous indigenous native in the project area is '*uhaloa (Waltheria indica*), a common plant that is abundant over most of the surveyed areas, and occurs in both disturbed and undisturbed areas.

Remnants of the native plant community exist throughout the area, but these are either common species (such as '*uhaloa* and *non*i, the latter a Polynesian introduction) or are rarely found across the sites. The only plant of concern found during the surveys was the *maiapilo,* which was sparsely distributed in the areas surveyed. Within the surveyed areas, the most *maiapilo* plants occur on the northern part of the buffer parcel and on the lava fields beside the R-1 transmission pipelines to the Old Airport Park.

Maiapilo is widely found in coastal areas of the Hawaiian Islands, but found nowhere else. Since this species population appears to be in slow decline, the International Union for Conservation of Nature (IUCN) regards the species as "vulnerable" due to development of the lowland environments. *Maiapilo* is not listed as threatened or endangered by US Fish and Wildlife Service (FWS) nor the State of Hawai'i Department of Land and Natural Resources (DLNR). Similarly, none of the other plant species found during the botanical surveys are listed as threatened or endangered by the FWS or DLNR. No federally delineated critical habitat overlays any portion of the surveyed areas. No equivalent designation exists under State law.

Impacts and Mitigation Measures

The Project areas for the Kealakehe WWTP R-1 Upgrade are a mix of undisturbed, slightly disturbed, but mostly greatly disturbed lava flows and roadways. Remnants of the native plant community exist throughout the area, but these are either common species (such as *'uhaloa* and *noni*, the latter a Polynesian introduction) or are rare across the sites.

The only plant of concern is *maiapilo*, a plant with a wide but essentially coastal distribution in the Hawai'ian Islands (and found nowhere else), but with a population that appears to be in slow decline. The species is regarded as "vulnerable" by the International Union for Conservation of Nature (IUCN) because lowland environments face threats from development on all of the islands. *Maiapilo* is not listed as threatened or endangered by FWS or the State of Hawai'i. It is misnamed on the FWS website as "*pus pilo*" (should be *pilo*, *pua pilo, or maiapilo*). Because of the sparse distribution of *maiapilo* in the Project area, it is likely that very few or no plants will be impacted. Within the survey areas, the most *maiapilo* plants occur on the northern part of the Kealakehe WWTP buffer parcel and on the lava fields over which the R-1 pipelines to the Old Kona

Airport Park are planned. In the former case, no plants are located in areas designated for polishing wetlands. In the latter case, *maiapilo* are not located close to the unimproved roads proposed as routes for installation of the R-1 pipelines.

As previously discussed, remnants of native plant communities exist throughout the area, but these are either common species or are rarely found across the surveyed areas. Moreover, the only species of concern, the *maiapilo;* is sparely distributed over the surveyed areas. The most *maiapilo* plants were found on the northern part of the buffer area. Since this area will be cleared, graded, and planted with a salt tolerant species, those existing *maiapilo* plants would be lost. The *maiapilo* plants found outside of the R-1 transmission pipeline easement between the Kealakehe WWTP and the Old Airport Park would not be affected by the R-1 Upgrade project. As previously discussed, *maiapilo* is not a listed species by the FWS or DLNR.

The R-1 Upgrade would not affect FWS or DLNR candidate or listed species as none were found during the botanical surveys. Similarly, no federally delineated Critical Habitat overlays would be affected as none exist within the R-1 Upgrade project sites or any portion of the surveyed areas.

The botanical survey recommended that any maiapilo plant noted to be close to construction associated with this Project (but that will not be removed) should be temporarily surrounded by construction fencing to prevent accidental damage.

3.10.2 Fauna

Avian Survey:

Between September 20 and 22, 2017, avian surveys were conducted in the areas outside of the Kealakehe WWTP. Later, on March 9, 2018, waterbird surveys were conducted within the Kealakehe WWTP in the area of Lagoons 5 and 6. At the time of the survey, all five lagoons were being used as part of the treatment process. The avian survey is included in Appendix C.

In the areas outside of the Kealakehe WWTP, a total of 20 avian count-stations were sited roughly equidistant from each other within the survey sites and along the various R-1 transmission pipeline routes. Count stations were sited approximately 300 m apart from each other. A single six-minute avian point count was made at each of the 20 count-stations. The avian counts were conducted in the early morning hours. Time not spent counting at point-count stations was used to search the area and pipeline alignments for species not detected during the point-counts.

Within the Kealakehe WWTP, the count methodology was to set-up at a location beside each lagoon where all of the waterbirds in the lagoon could be seen at one time. These birds were then counted by species three times and the highest number obtained taken as the result. All five lagoon counts were then combined to arrive at a total number of waterbirds counted within the facility during the count period.

A total of 926 individual birds of 32 species, representing 17 separate families, were recorded during station counts. Four of the species recorded are native resident species, two of which, Hawaiian Coot (*Fulica alai*) and the endemic sub-species of the Black-necked Stilt (*Himantopus mexicanus knudseni)* are listed as endangered species under both the federal and State of Hawai'i endangered species statutes. One species, Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*) is an indigenous resident water obligate species, and the Least

Tern (*Sterna antillarum*), is a recently established breeding seabird species. Additionally, six other species recorded are migratory indigenous shorebird or waterbird species. The remaining 21 species are established alien species.

Avian diversity and densities were very high in and adjacent to the Kealakehe WWTP, but low in all others areas surveyed away from the WWTP, in keeping with the highly disturbed native dominated grassland present across the bulk of the areas surveyed. Five species, African Silverbill (*Euodice cantans*), Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*), Hawaiian Coot (*Fulica alai*), Hawai'ian Stilt (*Himantopus mexicanus knudseni*), and Zebra Dove (*Geopelia striata*) accounted for 47% of all birds recorded during station counts. The most frequently recorded species was African Silverbill , which accounted for 14% of the total number of individual birds recorded during station point counts.

No seabirds were detected during the survey, but it is probable that both the endangered Hawai'ian Petrel (*Pterodroma sandwichensis*), and the threatened endemic subspecies of the Newell's Shearwater (*Puffinus auricularis newelli*), over-fly the project area in small numbers between April and the middle of December each year. Both species have been recorded flying to and from their nesting colonies over the greater Kona area. Both of these pelagic seabird species nest high in the mountains in burrows excavated under thick vegetation, especially uluhe (*Dicranopteris lineraris*) fern. There is no suitable nesting habitat for either of these seabird species on, or close to the project areas.

Waterbird Counts

A total of 15 waterbird and migratory shorebirds were recorded within the fenced area of the existing Kealakehe WWTP. Two of the species counted, Hawai'ian Coot (*Fulica Alai)*, and Hawaiian Stilt (*Himantopus mexicanus knudseni)*, are listed as endangered under both federal and state of Hawai'i endangered species statutes.

Mammalian Survey

Eight terrestrial mammalian species were detected on the surveyed areas. All of the mammalian species recorded are alien to the Hawai'ian Islands are deleterious to native species. No mammalian species currently proposed for listing or listed under either the federal or State of Hawai'i endangered species statutes was recorded on the surveyed areas.

With the exception of the endangered Hawai'ian hoary bat (*Lasiurus cinereus semotus*), or 'ōpe'ape'a as it is known locally, all terrestrial mammals currently found on the Island of Hawai'i are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all terrestrial mammalian species detected within the Project areas.

No Hawai'ian hoary bats were detected during the course of this survey. Given the location of the site and the lack of trees it is not expected that bats roost within the general project area. Hawaiian hoary bats have been seen flying over the existing wastewater treatment plant and the coastal areas to the north and south. It is not expected that the proposed actions will result in deleterious impacts to this listed endemic mammal.

There are no suitable roosting trees for the Hawai'ian hoary bat in the areas outside of the Kealakehe WWTP including along the R-1 transmission routes and the SAT system project site. This also applies to the area within the Kealakehe WWTP.

The findings of the mammalian survey are consistent with the location of the Project and the habitats currently present on the sites and along the pipeline routes. All of the introduced mammalian species recorded are deleterious to native ecosystems and the native faunal species dependent on them.

No terrestrial mammalian species were detected during the course of this survey. Thus, no listed or proposed threatened or endangered mammalian species under either the federal or State endangered species statutes were detected during the survey.

US Fish and Wildlife (FWS) Coordination

In May 2018, the DOH sent a letter to the US Fish and Wildlife Service (FWS) requesting technical assistance (TA) under the Endangered Species Act (ESA), as amended, (16 U.S.C. 1531 et seq.). That letter also noted the US Environmental Protection Agency (EPA) had designated the DOH as the consulting agency for Kealakehe WWTP project. This TA request referenced two previous TA requests (01EP1F00-2013-TA-0097MAR and 01EP1F00-2018-TA0143, both of which involved work related to the replacement of the liners and removal of sludge from the existing lagoons.

In response to TA request 01EP1F00-2013-TA-0097MAR, in June 2018, the FWS provided recommendations on appropriate conservations actions for the County to implement to avoid and minimize impacts to federally endangered species as well as protected under the Migratory Bird Treaty Act (U.S.C. 703-712).

The R-1 Upgrade project will reference the recommended conservation measures set forth in 01EP1F00-2018-TA0143, which also included Deterrent Measures for Endangered Species Act and Migratory Bird Treaty Act Species, a section of the Contract Specifications for the previous liner replacement and sludge removal project. The R-1 Upgrade project will include a similar section in the specifications.

The recommended conservation measures included:

- Adapt and implement measures detailed in attachments as appropriate: *2013-TA-0097 and Deterrent Measures for Endangered Species Act and Migratory Bird Treaty Act Species, Section 02002 of the KWWTP Aeration Upgrade and Sludge Removal Job No. WW-4061.*
- Unless construction resumes, do not deter nesting.
- Hire a qualified biological monitor to monitor bird activity (including bird counts, nesting, eggs, hatchlings and fledglings) three days per week and provide bi-annual reports to the FWS.
- Conduct cattle egret control during the Hawaiian stilt's non-breeding season (September through February).
    - Predation by cattle egrets of native Hawaiian birds has been well documented. A large cattle egret roost is located adjacent to the KWWTP at Kaloko-Honokohau National Historical Park and 30-100 egrets have been observed regularly at Kealakehe WWTP. The Service is concerned about the predation impacts this roost is ha vi ng on protected species at Kealakehe WWTP.
    - As of A u gust 24, 20 l 7 (82 FR 34419), authorized agencies (or their contractors) may conduct lethal control of cattle egrets without a depredation permit.
- Work with the FWS to develop and implement a permanent and robust predator control program for cats, rats and mongoose at the Kealakehe WWTP.

In addition to these measures, the County will follow the avoidance measures related to construction of the subsurface constructed wetlands piping along the southern access road within the WWTP.

It should be noted, the County has implemented on-going bird count and predator control work though a contract to a consultant, who has filed reports with the FWS.

Impacts and Mitigation Measures

Waterbirds

The principal potential impacts posed by the Project to endangered waterbirds are associated with construction activities creating disturbances of nesting birds during the year round nesting season within the small footprint of the proposed electrical and chemical buildings and a new underground waterline running parallel to the southern boundary fence, within the WWTP site. These activities, though of a short duration, could potentially disturb nearby nesting Hawaiian Stilts and Hawaiian Coots. Disturbance of this nature can result in birds abandoning their nest, eggs, and to a lesser degree, chicks.

As recommended in the biological report, to avoid impacts to the listed species, a sturdy silt fence or other suitable barrier system should be installed around the areas within the existing WWTP facility that will be excavated to install the subsurface constructed wetlands distribution and return lines along the southern and western fence lines to prevent ingress of listed waterbird species into the construction disturbances areas. Also, daily waterbird monitoring should continue until all work within the WWTP fenced facility is complete.

Seabirds

Potential impact to protected seabirds posed by the Project is an increased threat to transiting birds disoriented by lights associated with the Project during the seabird nesting season between September 15 through December 15 each year. If, during construction, it is deemed expedient to conduct night-time construction activities, or if streetlights are installed as part of the proposed action, these must be shielded. Shielding of lights would serve the dual purpose of minimizing disorientation and downing of petrels and shearwaters, and complying with Hawai'i County Code §14 – 50 et seq., which requires shielding of exterior lights to lower ambient glare reaching the astronomy observatories located on Mauna Kea.

Hawaiian hoary bat

As there are no suitable roosting trees anywhere close to any portion of the proposed action, and all fencing that will be installed will not have barbed wire strands topping them, it is not expected that the proposed action will result in deleterious impacts to this listed species.

The biological report recommended, to avoid impacts to the bat in locations where fencing is to be installed, that those fences not be topped with strands of barbed wire, as there have been records of Hawaiian hoary bats being impaled on barbed wire topped fences.

Wildlife hazard

The various avian species could present hazards to aircraft operations at Ellison Onizuka Kona International Airport at Keāhole which has its main entrance located

about 5.25 miles north of the Kealakehe WWTP. The airport serves as the main airport for the Kona coast and is considered a public use airport that conducts operations for scheduled air carrier, commuter and general aviation aircraft. The airport runway (Runway 17-35) is located adjacent to the coastline with Runway 35 located about 24,000 feet (4.5 miles) north of the Kealakehe WWTP facilities.

In August 2008, the Federal Aviation Administration (FAA) issued Advisory Circular 150/5200.33B to provide guidance on issues related to presence of wildlife near public use airport. The FAA guidance shows hazardous wildlife attractants must be sited at least 10,000 feet (1.9 miles) from the nearest airport operations area. According to the FAA guidance, wastewater treatment facilities and associated retention and settling ponds are considered as potential wildlife attractants.

Since the late 1980s-early 1990s, the 5 lagoons have been operational at the Kealakehe WWTP. As discussed above, the lagoons attract various species of waterbirds to the site. The presence of the lagoons and the relatively undisturbed access/service roads provide habitat for these waterbirds. The R-1 Upgrade improvements include the subsurface constructed wetlands, the basins within the SAT site and plant material to be planted in the buffer area. As previously discussed, both the subsurface constructed wetlands and the SAT basins have been designed such that there will be no standing water within the facilities. Based on these considerations, the R-1 Upgrade improvements will not result in a change to existing conditions at the Kealakehe WWTP and surrounding areas.

3.11 Historic and Archaeological Resources

In April 2018, an Archaeological literature review and field investigation study of the project site was conducted by Cultural Surveys Hawai'i, Inc. (CSH) to evaluate the presence of significant historic properties within the project site. The Literature Review and Field Investigation Study report is summarized below and included in full as Appendix D.

This investigation was designed through detailed historical, cultural, and archaeological background research and a field inspection of the project area, to determine the likelihood that historic properties may be affected by the project and, based on findings, consider cultural resource management recommendations.

The project area is located on the leeward side of Hawai'i Island just north of the town of Kailua-Kona. The project area straddles Queen Ka'ahumanu Highway (Route 19) within Kaloko, Honokōhau, Kealakehe, and Keahuolū Ahupua'a. The project area is depicted on a portion of the 1996 Keahole Point and Kailua U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle. Under this study for organizational purposes the project area has been broken into three geographical units (See Figure 3-3).

- The "Mauka Section" comprises portions of the Kealakehe Parkway and Queen Ka'ahumanu Highway rights-of-way (ROWs) and TMKs: [3] 7-4-020:007, 019, 021, 022 located mauka (upslope) of the Queen Ka'ahumanu Highway right-of-way;
- The "Makai Section" comprises TMKs: [3] 7-4-008:002, 058, 073 and 7-5-005:007 located makai (seaward) of the Queen Ka'ahumanu Highway right-of-way; and overlaps a Special Management Area (SMA);

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WILSON OKAMOTO CORPORATION

FIGURE 3-3

ARCHAEOLOGICAL STUDY AREAS

Kealakehe WWTP R-1 Upgrade

- The "Northern Section" comprises TMK: [3] 7-3-009:027 and portions of the Hina Lani Street and Queen Ka'ahumanu Highway right-of way.

The archaeologists accomplished fieldwork on 25–26 September 2017 and 6 October 2017; archaeologists required approximately 9 person-days to complete. The fieldwork focused on confirming sites located within or immediately adjacent to (within 5 meters of) the project area bounds, and determining the potential presence of previously unrecorded features.

The project area lies within the southernmost extent of the Kekaha region, in which the uplands were used for residences and farming, and the coastal lands for residence, fishing, and aquaculture. The lands located between the coast and uplands settlements, in which the majority of the project area is situated, contained networks of trails along which shelter and water collection caves, quarries, and scattered agricultural sites were located. In the historic era, the area was used widely for ranching.

Background research indicated the presence of 119 previously identified archaeological sites/historic properties overlapping or within 100 m (330 feet [ft]) of the bounds of the project area. Most of these are pre-Contact sites associated with agriculture, habitation, transportation, resource procurement, ceremony, burial, artistic expression, and/or recreation. Historic era sites included trails (including but not limited to State Inventory of Historic Places [SIHP] # 50-10-27-00002, Māmalahoa Trail), habitation areas, a cemetery, and ranching-related features like boundary walls. The field inspection identified variable levels of prior disturbance throughout the project area. The Mauka Section contains the largest areas of undisturbed land. The field inspection confirmed 30 of 119 previously identified archaeological sites and possibly relocated portions of eight previously identified sites; these 38 sites are within or immediately adjacent to the project area. In addition, archaeologists documented 16 newly identified archaeological features/feature complexes within or directly adjacent to the project area (See Figures 19, 20, 21, and 28 within Appendix D).

Impacts and Mitigation Measures

In general, efforts to minimize potential effects on historic properties will be made in the project design phase. Such efforts will include limiting ground disturbance within previously undisturbed areas as much as possible (e.g., propose installation of transmission pipelines within existing roadbeds or graded areas). Some portions of the project area are of potentially higher sensitivity given their known archaeological content:

- A section of the Māmalahoa Trail (SIHP # 50-10-27-00002) runs parallel to Queen Ka'ahumanu Highway within the Mauka Section in the vicinity of the proposed soil aquifer treatment (SAT) facility. A portion of this historic property within the project area has existing mitigations in place associated with the recently completed Queen Ka'ahumanu Highway Widening Phase 2 project. Impact to the Māmalahoa Trail will be avoided if possible by routing pipelines or other infrastructure through existing breaches along the trail.

- The portion of the Mauka Section relating to the future elevated storage tank has not been subjected to recent archaeological survey, and was found during the field inspection to contain several previously unrecorded archaeological features and lava tube openings. Lava tubes in this area commonly contain cultural modifications and/or deposits including but not limited to human burials.

- The section of the Initial Phase R-1 Transmission Line approaching the Old Kona Airport Park (Kailua Park) within the Makai Section is in direct proximity to several extensive previously identified site complexes. While many of these features are likely located a safe distance from the current project area, some are directly adjacent and could potentially by impacted. Difficulties in correlating present findings with the previously recorded sites—and the discovery of previously unrecorded features—highlight potential concerns with the existing body of archaeological coverage in this area.

  Should any significant pre-Contact or historic deposits (i.e. subsurface concentrations of indigenous or historic era artifacts and/or structural remnants) or human burials be encountered during the course of development of the project site, the subsurface excavation work and/or surface grading will be halted in the immediate area and the SHPD will be notified immediately.

3.12 Cultural Resources

In April 2018, a Cultural Impact Assessment (CIA) was conducted of the proposed project by Cultural Surveys Hawai'i, Inc. (CSH). The study area for the CIA includes the Kaloko, Kealakehe, and Keahuolū Ahupua'a. This report is summarized below. The entire report is included in Appendix E.

The CIA was prepared to comply with Chapter 343, Hawai'i Revised Statues, which requires consideration of the proposed project's potential effect on cultural beliefs, practices, and resources. Through document research and cultural consultation efforts, the CIA provides information pertinent to the assessment of the proposed project's potential impacts to cultural beliefs, practices, and resources (per the Office of Environmental Quality Control's Guidelines for Assessing Cultural Impacts) which may include Traditional Cultural Properties (TCPs) of ongoing cultural significance that may be eligible for inclusion on the State Register of Historic Places. The CIA is intended to support the project's environmental review and may also serve to support the project's historic preservation review under Chapter 6e,HRS, and Hawai'i Administrative Rules (HAR) §13-284.

The CIA may also be used to support the National Historic Preservation Act, Section 106 consultation/review as set forth in 54 U.S.C. §306108 and CFR 800.2(C)4. A letter will be sent out either by the State or County of Hawai'i to the State Historic Preservation Division to accomplish the Section 106 consultation.

As part of the community outreach and informal interviews, a total of 37 parties were contacted, including the Office of Hawaiian Affairs (OHA), the State Historic Preservation Division (SHPD), the County of Hawai'i, other agencies, Native Hawaiian Organizations (NHOs) and knowledgeable community members. The outreach effort was conducted through letters and emails over a 9 month period extending from June 2017 through March 2018. Some individuals were contacted but chose not to share information regarding the cultural practices and resources related to the Kealakehe WWTP. Of the 37 parties consulted, a total of 8 individuals/agencies responded to the consultation letter. Of those, 5 individuals participated in formal interviews. However, a total of 4 respondents agreed to interviews so that they could share their concerns about the project. Those who did share their response expressed concerns about the potential for the project to impact the Māmalahoa Trail and possible burial sites situated within the crevices of lava and several caves makai of Queen Ka'ahumanu Highway. Individuals were also concerned about future development and its impacts on significant archaeological and cultural sites.

Based on information contained in mo'olelo (stories), literature, oral histories, and previous archaeological/ethnographic studies conducted in the area, a distinguishing feature of the Kona landscape are the many trails that zig-zag through each ahupua'a, including the Māmalahoa Trail. These foot trails linked royal centers, coastal communities, and resources, and thus speak to the historic wealth of agricultural and aquatic resources in the area. Another prominent feature of the Kona landscape are the hōlua (sled) slides. Hōlua is an ancient sport that can be traced back to the time of Pele and was pursued by those of ali'i (chief) ranking.

The ahupua'a of Kaloko was awarded and kept by Lot Kamehameha (Kamehameha V) during the Māhele. A total of 21 additional land claims were made in Kaloko of which 12 were awarded in the uplands. Kealakehe Ahupua'a was awarded to Kekuapanio, a young noble who was a favorite amongst ali'i such as Kauikeaouli (Kamehameha III), who later returned the land to the government. The entire ahupua'a of Keahuolū was awarded to Ane Keohokālole who held two walled house lots "from very ancient times" along the shoreline.

There are many mo'olelo about the famous Kaloko fishpond along the seashore in the Kaloko Ahupua'a, including some versions suggesting the remains of Kamehameha I may have been buried nearby. During the Māhele (1848), Lot Kapuāiwa (Kamehameha V) was awarded the ahupua'a of Kaloko, allowing the Kamehamehas to reserve the loko i'a (fishpond) for themselves. Other mo'olelo included in the study are some of the oldest Hawaiian stories that have survived, and speak to the characteristics and environment of the area and its people.

Impacts and Mitigation Measures

In the short- and long-term, no significant impacts to cultural resources are anticipated as a result of the construction and operation of the proposed improvements. Community participants voiced concerns regarding the Māmalahoa Trail, and suggested the project be rerouted to avoid further disturbance and destruction. One of the community participants suggested archaeological and cultural monitoring for the Māmalahoa Trial. One participant strongly urged that CSH review a previously published monitoring report to gain further insight of the Māmalahoa Trail and known mauka-makai trails.

In the event that any potential historic properties are identified during construction activities, all activities will cease and the SHPD will be notified pursuant to HAR §13-280-3. In the event that iwi kūpuna (ancestral bones) are identified, all earth moving activities in the area will stop, the area will be cordoned off, and the SHPD and Police Department will be notified pursuant to HAR §13-300-40. In the event of an inadvertent discovery of human remains, the completion of a burial treatment plan, in compliance with HAR §13-300 and HRS §6E-43, is recommended. If iwi kūpuna and/or cultural finds are encountered during construction, project proponents should consult with cultural and lineal descendants of the area to develop a reinterment plan and cultural preservation plan for proper cultural protocol, curation, and long-term maintenance.

3.13 Air Quality

Ambient air quality standards (AAQS) have been established at both the national and state level for six criteria pollutants carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and particulate matter (PM10 and PM2.5). The State has also set a standard for hydrogen sulfide. Hawai'i ambient air quality standards are comparable to the national standards, although in some cases the Hawai'i standards are more stringent than the national standards, such as for carbon monoxide. For some other parameters, such as particulate matter and the

national standards are more restrictive. Criteria pollutant levels remain below federal and State ambient air quality standards within the State

Existing air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural resources. Also, volcanic pollution emissions affect the island of Hawai'i more than the other islands in the State. Since 1983, volcanic emissions from eruptions of Kīlauea Volcano have periodically affected the project area. Although emissions from Kīlauea are vented on the other side of a mountain barrier more than 50-miles east of the project area, the prevailing wind patterns eventually carry some of the emissions into the Kona area, especially during the winter months when southerly winds occur.

A recent analysis by the USGS details that the composition of vog depends on how much time the volcanic plume has had to react in the atmosphere. In areas such as the Kona District, far from Kīlauea Volcano's active vents, aerosols are the main component of vog which contains both aerosols and unreacted sulfur dioxide (SO_2) gas. Although SO_2 gas is colorless and invisible, the tiny particles in vog create a visible light-colored haze by scattering sunlight. Like smog, the presence of vog reduces visibility.

Vog concentrations on Hawai'i Island are primarily dependent on the amount of SO_2 emitted from Kīlauea, the distance from the source vents, and the wind direction and speed on a given day. From May through September, the main wind direction in the Hawai'ian Islands is from the northeast (trade winds) which occur about 80–95 percent of the time. Under trade wind conditions, vog travels around the southern part of the island, and along the Kona coast, where it becomes trapped by daytime onshore and nighttime offshore sea breezes. Most of the vog stays beneath an altitude of 6,000–8,000 feet above sea level, the usual height of the trade wind inversion. This layer of the atmosphere increases in temperature with altitude, inhibiting the rise of cooler, vog-laden air. When trade winds are absent, which occurs most often during winter months, east Hawai'i, the entire Island of Hawai'i, or even the entire State of Hawai'i can be affected by vog.

The DOH operates a network of air quality monitoring stations at various locations around the State. In December 2016, the DOH issued the Annual Summary 2015 Air Quality Data report which provides the results from the network of air quality monitoring stations. The DOH air quality monitoring site closest to the KWWTP site is located about 11.8 miles to the south in Kealakekua at the Konawaena High School. Both sulfur dioxide (SO2) and particulate matter (PM 2.5) are monitored at this site. Measurements of SO2 concentrations at this location during the 2011-2015 monitoring period were consistently low with annual average concentrations below 0.005 ppm, which is below the federal and State standard of 0.03 ppm. No exceedances of the federal/State 3-hour and 24-hour AAQS for SO2 were recorded at the Konawaena High School monitoring station.

The project area has few major stationary sources of air pollution. A major industrial source of air pollution in the project vicinity is Hawai'i Electric Light Company's (HELCO) Keāhole Power Plant, which is located about 5.2 miles to the north of the Kealakehe WWTP. Air pollution emissions from the power plant consist mostly of sulfur dioxide and oxides of nitrogen.

Queen Ka'ahumanu Highway is the regional arterial roadway that carries the north-south traffic along the Kona coast. As such, it has the highest volume of traffic of any roadway in the region. Winds may sometimes carry emissions from motor vehicles traveling on this and other roadways toward the Kealakehe WWTP project site.

At this time, there are no reported measurements of lead, ozone, nitrogen dioxide or carbon monoxide in the project vicinity. These are primarily motor vehicle related air pollutants. Lead, ozone and nitrogen dioxide typically are regional scale problems. However, concentrations of lead and nitrogen dioxide generally have not been found to exceed AAQS elsewhere in the State. Carbon monoxide air pollution typically is a microscale problem caused by congested motor vehicular traffic. In traffic congested areas such as urban Honolulu, carbon monoxide concentrations have been found to occasionally exceed the State AAQS.

Greenhouse gases (GHGs) are components of the atmosphere that trap heat relatively near the surface of the earth, and therefore, contribute to the greenhouse effect and global warming. Most GHGs occur naturally in the atmosphere, but increases in their concentration result from human activities such as the burning of fossil fuels. Global temperatures are expected to continue to rise as human activities continue to add carbon dioxide, methane, nitrous oxide, and other greenhouse (or heat-trapping) gases to the atmosphere.

Increasing concentrations of GHGs in the atmosphere affect global climate. GHG emissions result from anthropogenic sources including the combustion of fossil fuels. GHGs are defined as including carbon CO2, methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). CO2 is the most important anthropogenic GHG as it is a long-lived gas that remains in the atmosphere for up to 100 years.

Climate change is a global phenomenon that can have local impacts. Scientific measurements show that Earth's climate is warming, with concurrent impacts including warmer air temperatures, increased sea level rise, increased storm activity, and an increased intensity in precipitation events. Research has shown there is a direct correlation between fuel combustion and GHG emissions.

Climate change is now observed globally. The scientific consensus presented in the global body of climate research, including the fifth report released by the United Nations' Intergovernmental Panel on Climate Change (IPCC) in 2013, is that warming of Earth's climate system is unequivocal (IPCC, 2013). The fifth IPCC assessment report concludes that it is "*extremely likely"* that most of the temperature increase since the mid-20th century is caused by increased concentrations of greenhouse gases from human activities. This finding is supported by detection of land and sea temperature increases, changes in global water cycle, reductions in snow and ice, sea-level rise, and changes in climate extremes.

The State of Hawai'i's Department of Health has established the Hawai'i GHG Program to combat the threat of climate change and sea level rise. The program utilizes the Air Pollution Control Permit process of the Clean Air Branch to regulate GHG emissions statewide. The Hawai'i GHG program works in conjunction with other federal and Hawai'i State programs to mitigate GHGs.

Act 234 of the 2007 Legislature established the foundation for the Hawai'i GHG Program. It declared a framework of action to serve as an example to other states, the federal government, and other countries to protect our fragile global environment. The framework had the purpose to reduce, by January 1, 2020, greenhouse gas emissions in the State to levels at or below the best estimations and updates of the inventory of greenhouse gas emissions estimates for 1990. Parts of Act 234 are codified in Chapter 342B-71 Hawai'i Revised Statutes. On June 30, 2014, Hawai'i Administrative Rules, Chapter 11-60.1 was amended to adopt the new Hawai'i GHG program. The main requirements of the program are set forth in Subchapter 11, Greenhouse Gas Emissions.

Impacts and Mitigation Measures

Short-term impacts on air quality could occur during construction of the proposed improvements. Short-term impacts from fugitive dust will likely occur during the construction phases. To a lesser extent, exhaust emissions from mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State DOH Administrative Rules, Title 11, Chapter 60-11.1 "Air Pollution Control," requires that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with State regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing any inactive areas that have been worked.

The R-1 Upgrade improvements include construction of the Chemical Addition and Generator Building. (See Section 2.1.1 and Figure 2-6.) A separate room in the chemical addition building will contain a1,250 KW emergency generator to provide power to the R-1 treatment processes in the event of a failure of the commercial power supply. The use of the emergency generator is subject to rules shown in Hawaii Administrative Rules Title 11 Department of Health Chapter 60.1, Air Pollution Control, Department of Health, Amendment and Compilation of Chapter 11-60.1 Hawaii Administrative Rules (HAR), June 19, 2014.

HAR §11-60.1-62, Applicability, states (a) Except as provided in subsections (d) and (g) and section 11-60.1-66, no person shall burn used or waste oil or begin construction, reconstruction, modification, relocation, or operation of an emission unit or air pollution control equipment of any noncovered source without first obtaining a noncovered source permit from the director.

HAR 11-60.1-6 (d) (8) Standby generators used exclusively to provide electricity, standby sewage pump drives, and other emergency equipment used to protect the health and welfare of personnel and the public, all of which are used only during power outages, emergency equipment maintenance and testing, and which:(A) Are fired exclusively by natural or synthetic gas; or liquified petroleum gas; or fuel oil No. 1 or No. 2; diesel fuel oil No. 1D or No. 2D; and (B) Do not trigger a PSD or covered source review, based on their potential to emit regulated or hazardous air pollutants; do not require a noncovered source permit.

Once construction is complete air quality will be affected by testing the emergency generator. The 1,250 KW standby emergency generator will be tested once or twice per month to ensure proper operation in the event of an outage of the HELCO system. The testing will involve starting the generator, testing the switching systems, and placing the system under load conditions to ensure proper operation. This testing should require operation of the generator for about 3 to 4 hours per month, or less than 50 hours per year. This level of testing of the emergency generator should not create adverse impacts to the air quality in the area.

In addition, after construction, motor vehicle traffic from County employees and others visiting the Kealakehe WWTP would be a source of increases in air pollution emissions. Also, the various pumps related to the R-1 treatment process would increase electrical

power demand which would result in air pollutant emissions at the HELCO power plant. However, given the low ambient levels of pollutants, both these increases would not result in exceedance of federal or State ambient air quality standards (AAQS) for the six criteria pollutants.

The implementation of the proposed action will result in the short-term irrevocable release of GHGs from construction activity. This quantity, however, will be negligible. No mitigation is required or proposed.

3.14 Odor

Wastewater treatment plants can be a source of nuisance odors to the surrounding community, if not properly designed and/or operated. Typically, nuisance odors are most commonly associated with anaerobic (without oxygen) conditions at the headworks, the facility where raw sewage enters the WWTP, and with residual solids processing. Hydrogen sulfide is the primary source of the nuisance odor.

The Kealakehe WWTP is currently equipped with an existing odor control system at the headworks. The channels in the headworks facility are covered to facilitate the collection and removal of foul air. Within the headworks, the foul air is directed to a chemical mist scrubber to remove hydrogen sulfide and other odorous compounds before the scrubbed air is released to the atmosphere.

The existing lagoons within the Kealakehe WWTP are not a source of nuisance odors as the lagoons are aerated to maintain dissolved oxygen concentrations in the lagoon water column at approximately 2.0 mg/L or greater at all times. The County recently completed an upgrade of the lagoon aeration system to ensure that sufficient aeration capacity is available to maintain aerobic lagoon conditions under foreseeable conditions. The aerated lagoons operate as partially-mixed reactors where wastewater solids are allowed to settle to the bottom of the lagoons where they slowly stabilize. Any odorous compounds released from the sludge layer at the bottom of the lagoon are oxidized as they rise through the aerobic water column. By the time the sludge needs to be removed, it is highly stabilized due to the long solids residence time. Thus, the sludge removal process is typically not a source of nuisance odors. Sludge is removed from the aerated lagoons infrequently, typically on a 20-year cycle.

Impacts and Mitigation Measures

In the long-term, the primary air quality concern will be the odor generated from the Kealakehe WWTP. The existing WWTP is equipped with an odor control system at the headworks, and the recently-upgraded lagoon aeration system ensures that the existing WWTP processes are not a source of nuisance odors. The feed water to the R-1 treatment process will have been oxidized in the aerated lagoon system prior to being pumped to the various R-1 treatment processes. Thus, the proposed R-1 treatment system will not be a source of nuisance odors. Solids removed by the R-1 filtration process will be returned to Lagoon 1 for further treatment. Similarly, since the subsurface flow constructed wetlands will receive oxidized aerated lagoon effluent, they will not be a source of nuisance odors.

Since the R-1 recycled water used for irrigation by the users will have been through the various processes at the Kealakehe WWTP, it should not be a source of nuisance odors.

The SAT will receive effluent from the Kealakehe WWTP that has been oxidized in the aerated lagoon system and denitrified in the subsurface flow constructed wetlands. Due to the treatment provided at the WWTP, the effluent pumped to the SAT site will not be a source of nuisance odors.

The use of highly-treated R-1 water is not associated with nuisance odor conditions. The SAT will receive WWTP effluent that has been treated in the aerated lagoon system and subsurface flow constructed wetland and will not be a source of nuisance odors.

3.15 Noise

The Kealakehe WWTP project site and surrounding area are located along the western coast of the island between Kailua-Kona and Keāhole. Although there are still currently undeveloped lands, over the years, this area of the Kona coast has been undergoing urbanization, including commercial and industrial development. Queen Ka'ahumanu Highway and Kealakehe Parkway are the major roadways that serve as the main access to the developed areas. As such, vehicle traffic on these roadways provide the main source of ambient noise in the area. Visitors to the Kaloko-Honokōhau National Historic Park and the Honokōhau Small Boat Harbor also contribute to ambient noise levels in the area. When completed, activities at the DLNR Community Conference Center and Administration Building facilities located near the entrance to the Small Boat Harbor will add to the noise level.

The County of Hawai'i zoning map shows the area of the KWWTP, buffer area and transmission pipelines is zoned "open". The area adjacent to the buffer site on the north is designated "planned development". This is the area that, in 2007, the State of Hawai'i Department of Hawaiian Home Lands had proposed to develop the Kona Kai Ola project, which was to include an 800-slip marina, and mix of uses including visitor and resident-serving commercial enterprises, hotels and time-share units. At this time, according to the County of Hawai'i Planning Department, there have been no activities related to the Kona Kai Ola project.

The lands south of the Kealekehe WWTP are zoned "agricultural A-5a", including the existing Queen Lili'uokolani Children's Center. Thus, except to the Children's Center, there are no designated residential or noise sensitive land uses near the Kealakehe WWTP, the buffer area, the SAT site and transmission pipelines.

Hawai'i Administrative Rules Title 11, Department of Health, Chapter 46, Community Noise Control, sets for the maximum permissible sound levels based on zoning districts. Class C zoning district include all areas equivalent to lands zoned agriculture, country, industrial, or similar type. The maximum permissible sound levels is 70 dBA at any point at or beyond (past) the property line. The 70dBA sound level applies to daytime (7:00 am to 10:00 pm) and nighttime (10:00 pm to 7:00 am) periods.

Impacts and Mitigation Measures

In the short-term, noise levels will increase from construction activities at the Kealakehe WWTP, the buffer area, the SAT site and along the areas adjacent to the transmission pipelines. It is expected the noise will be intermittent and unavoidable, since construction vehicles and heavy equipment generate noise as part of normal operations. The mitigation of noisy activities to inaudible levels will not be practical in all cases due to the intensity and exterior nature of the work. Ambient noise levels in the vicinity of construction sites can be expected during construction periods.

Construction activities will need to comply with the provisions of HAR Title 11, Chapter 46, Community Noise Control. The noise regulations require a noise permit, if the noise level from construction activity is expected to exceed allowable levels stated in the Chapter 11-46 rules. It will be the contractor's responsibility to minimize noise by properly maintaining noise mufflers and other noise-attenuating equipment and to maintain noise levels within regulatory limits.

The construction contractor will need to obtain the appropriate permit or approvals. Potential noise impacts will also be mitigated since the majority of construction work during daytime hours (as opposed to night work), thereby avoiding the creation of construction noise impacts during the quieter nighttime hours.

The R-1 Upgrade improvements include construction of the Chemical Addition and Generator Building. (See Section 2.1.1 and Figure 2-6.) A separate room in the chemical addition building will contain a1,250 KW emergency generator to provide power to the R-1 treatment processes in the event of a failure of the commercial power supply. The use of the emergency generator is subject to rules shown in Hawaii Administrative Rules Title 11 Department of Health Chapter 46, Community Noise Control.

Once construction is complete, testing of the emergency generator will be a noise source. However, HAR Chapter 46 §11-46-5, Exemptions, states this chapter shall not apply to the following (4) Operation of emergency generators, when installed and used as required and necessary for the protection of public health and safety, provided the best available control technology is implemented.

Based on the above, once construction is complete, the proposed improvements at the Kealakehe WWTP and buffer site and transmission pipelines are not expected to be a significant source of additional ambient noise. Operational activities at the Kealakehe WWTP and buffer site and transmission pipelines would be generally associated with low volumes of vehicle movements. Overall, the R-1 Upgrade improvements will not create adverse impacts to the noise environment in the area.

3.16 Traffic and Transportation

Queen Ka'ahumanu Highway (State Highway Route 19) is the major north-south roadway for this area of the Kona coast. State Route 19 has functional classification of principal arterial. In the vicinity of the Kealakehe WWTP, the State of Hawai'i Department of Transportation (HDOT) has completed improvements to Queen Ka'ahumanu Highway between Kailua-Kona and Kealakehe Parkway (State Route 197) to provide 4 travel lanes, 2 lanes in each direction, and a center median. The HDOT has also recently completed construction of phased improvements to Queen Ka'ahumanu Highway which will continue the 4 travel lanes and center median from Kealakehe Parkway northward to the entrance to the Ellison Onizuka Kona International Airport at Keāhole. These improvements, along with the recently constructed Ane Keohokalole Highway, will improve access and circulation along the Kona Coast.

The Queen Ka'ahumanu Highway intersection with Hale Makai Place and the Kealakehe WWTP access road is a signalized intersection with dedicated left and right turn lanes on Queen Ka'ahumanu Highway. Also, the Queen Ka'ahumanu Highway and Kealakehe Parkway intersection is a signalized intersection with dedicated left and right turn lanes. The posted speed limit is 45 miles per hour (mph) on Queen Ka'ahumanu Highway in the vicinity of these intersections.

The HDOT conducts 24-hour traffic counts at various locations on the island, including on Queen Ka'ahumanu Highway. These counts provide 2-way traffic volumes over a 24-hour period, including counts during morning and afternoon peak hours. Over the years, HDOT has conducted these counts at the Queen Ka'ahumanu Highway and Hale Makai Place intersection. The most recent count conducted September 3-4, 2015 showed a total 2-way volume of about 21,957 vehicles. The morning peak hour total 2-way volume was 1,544 vehicles between 10:45am to11:45am. The afternoon peak hour total 2-way volume was 1,942 vehicles between 2:00pm to 3:00pm.

Similar counts were conducted in April 13-14, 2010 at this location. The total 2-way volume at that time was 28,892 vehicles. Thus, the 2015 volume was about 25 percent lower than the 2010 volume.

Ellison Onizuka Kona International Airport at Keāhole is located about 5.25 miles north of the Kealakehe WWTP and serves as the main airport for the Kona coast. The airport is considered a public use airport that conducts operations for scheduled air carrier, commuter and general aviation aircraft. The airport runway (Runway 17-35) is located adjacent to the coastline. Runway 35 is located about 24,000 feet (4.5 miles) north of the Kealakehe WWTP facilities.

Impacts and Mitigation Measures

R-1 transmission pipelines will be constructed at various locations in the vicinity of the Kealakehe WWTP. From the Kealakehe WWTP access road (Hale Makai Place), the DEM will construct an approximately 3,700 foot long R-1 transmission pipeline northward to Kealakehe Parkway within the makai shoulder the right-of-way of the widened Queen Ka'ahumanu Highway. At the intersection of Queen Ka'ahumanu Highway and Kealakehe Parkway, the DEM will connect the R-1 transmission pipeline to a stub at the southwest corner of the Queen Ka'ahumanu Highway and Kealakehe Parkway intersection that was constructed by HDOT as part of the recently completed Queen Ka'ahumanu Highway Widening project.

In addition, the HDOT provided two other stubs at the Queen Ka'ahumanu Highway and Kealakehe Parkway intersection. One of the stubs will be available to connect the R-1 pipeline to the Honokohua Small Boat Harbor and the proposed Department of Land and Natural Resources facility. The other stub will extend mauka under the highway to the south side of Kealakehe Parkway.

In future phase(s), a R-1 water transmission pipeline will branch off of the proposed 24-inch diameter pipe in Queen Ka'ahumanu Highway near Hale Māka'i Place. This branch pipeline will extend approximately 4,000 feet (0.75 miles) east (mauka) to a future 2.0 million gallon R-1 water storage tank at elevation 200± feet that will serve the County's future regional park as well as future developments on Queen Lili'uokolani Trust lands mauka of the highway.

Short-term impacts on traffic would occur during construction of the various improvements. Construction of the R-1 treatment facilities will require bringing construction equipment, supplies, and material to the Kealakehe WWTP and to the SAT project site. Various types of construction equipment will be required to excavate the sites for construction of the treatment facilities, including the constructed wetlands and the SAT. Trucks will be needed to transport the excavated material from both sites to a disposal site. Also, various types of materials and supplies will be needed to construct the above ground structures and the administration building and to install the

pumps. The materials and supplies include rebar, concrete, piping, motors, pumps, conduits, process equipment, controls, and various fabricated items.

Construction equipment, supplies, and material will be brought to the Kealakehe WWTP and SAT project sites via trucks, trailers, and containers. Typically, contractors try to conduct these activities during off peak traffic hours to minimize disruptions to traffic flows. However, these disruptions would be for only short periods during the construction period. Once construction has been completed, there should be no disruption or adverse effects to traffic flows to the Kealakehe WWTP project site.

Work on the transmission pipelines will require excavation of an open trench along the shoulder area of Queen Ka'ahumanu Highway. The contractor will be required to prepare traffic control plans in the area of the open trench site. The traffic control plans will provide details for controlling traffic in the work area, including lane closures, if necessary, placement of signs, traffic delineators or barriers, flaggers to direct traffic, and, if needed, special duty officers to oversee conditions at the site. Normally, such plans call for these diversions or closings during non-peak travel times to minimize disruptions to the traffic flow. Also, when not in use, typically the excavated area will be covered with steel plates or have traffic barriers installed to prevent accidents. The traffic control plans will require review and approval by the HDOT or the County of Hawai'i, depending on the location of the construction. The traffic control plans will minimize impacts to traffic flows during the construction period. Once construction has been completed, the affected areas will be restored so that traffic can resume. Thus, the Proposed Action will have less than significant impacts to traffic and circulation.

Construction of the transmission pipelines at other locations will require similar traffic control plans at each site.

Although not affecting roadways, other R-1 transmission pipelines that will be constructed in the initial phase include an approximately 9,300-foot (1.76-mile) long transmission pipeline from the R-1 storage tank at the Kealakehe WWTP to the existing Kealakehe pump station within the County of Hawai'i Old Kona Airport Park. The R-1 transmission pipeline to Old Kona Airport Park will be located within the existing 25-foot wide easement that extends from the WWTP to southeast corner of the Park and then continues to the existing Kealakehe pump station located makai of Kuakini Highway near the Kona Bay Estates Drive intersection. About 50 percent of the pipeline (4,800 feet) lies within the easement and the remainder (4,500 feet) within the boundaries of the park.

On June 5, 2017, the State Department of Transportation provided comments to the EIS Preparation Notice, including the need to meet certain Federal Aviation Administration (FAA) requirements for construction near public use airports. As stated above, in addition to various underground trenches, the R-1 Upgrade improvements will include construction of various facilities within the Kealakehe WWTP. The improvements include 3 above ground structures, the chemical addition building, the concrete canopy over the R-1 treatment facility and the R-1 storage tank. The chemical addition will be about 10-12 feet above the surrounding grade, the canopy will be about 31 feet and the storage tank about 30 feet.

These facilities are located about 24,500 to 25,000 feet (4.64 to 4.73 miles) south of Runway 35. CFR Title 14 Part 77, Safe, Efficient Use and Preservation of the

Navigable Airspace sets forth requirements to provide notice to the FAA of certain proposed construction or alterations to determine the effect on the safe use of navigable airspace. CFR Title 14 §77.9 requires submission of FAA Form 7460-1, Notice of Proposed Construction or Alteration, for any construction or alteration more than 200 feet above ground level at its site or exceeds an imaginary surface extending outward of a slope of 100 to 1 for a horizontal distance of 20,000 feet from the nearest runway of a public use airport.

Based on this, construction of the R-1 Upgrade above ground structures will not require submittal of FAA Form 7460-1 and further will not adversely affect aircraft operations at Ellison Onizuka Kona International Airport at Keāhole.

3.17 Visual Resources

The existing KWWTP is surrounded by open fields of ʻaʻā and pāhoehoe lava. Public views of the KWWTP from Queen Kaʻahumanu Highway will be across the open fields toward the Kona coastline. The existing Kealakehe WWTP facilities will be appear as almost indistinguishable objects/facilities about a 0.5-mile away from the highway. The Kealakehe WWTP facilities are further obscured by the presence of a 14-foot high berm located on the eastern (mauka) side of the plant, or between the facilities and Queen Kaʻahumanu Highway.

The proposed above grade R-1 Upgrade improvements at the Kealakehe WWTP site include:

1. 10-12-foot high chemical addition building to house facilities to store and meter chemicals for the R-1 treatment process and a separate room for an emergency generator;

2. 31-foot high concrete canopy roof structure over the R-1 Upgrade facility to provide weather and sun protection for the partially below grade Rapid Mix and Flocculation system concrete tanks with associated mixing equipment and partially below-grade UV Disinfection System.;

3. 30-foot high above-grade R-1 500,000-gallon storage tank.

The other R-1 Upgrade improvements will be below grade facilities, including the pipeline and various pump stations and distribution facilities.

The SAT site will be surrounded by a security fences to prevent public access. However, the SAT site lies mauka of Queen Kaʻahumanu Highway such that public views to the coastline will not be affected.

Impacts and Mitigation Measures

The proposed improvements are not anticipated to have significant impacts on notable view planes nor adversely affect important public viewing points or visual resources. Except for the R-1 Upgrade facility, the proposed improvements at the Kealakehe WWTP will be about the same height above ground to the existing facilities and generally similar in visual character. The concrete canopy above the R-1 Upgrade facility will be about 31 feet above the surrounding grade. However, the canopy will be an open structure that will not obstruct views beyond the structure. The presence of the 14-foot high berm along the eastern boundary of the Kealakehe WWTP and the distance from Queen Kaʻahumanu Highway will mean makai public views remain similar to existing conditions. Thus, the R-1 improvements at Kealakehe WWTP will

not create adverse impacts to makai public views and the visual character of this area of the Kona coast.

The SAT facility will be located east (mauka) of Queen Ka'ahumanu Highway at elevations from 60 to 70 feet MSL. In this area, Queen Ka'ahumanu Highway lies at about 42 to 45 feet MSL. A 6-foot chain link security fence surrounding the SAT facility will be the only above grade structure. Public views looking mauka from the highway will be affected for a short distance by this fence.

3.18 Socio-Economic Characteristics

The County of Hawai'i has identified the West Hawai'i planning region as an area for directed urban growth. The Kealakehe WWTP and surrounding area are located within the North Kona area of West Hawai'i, which is expected to continue to grow because there is ample potential for expansion of the housing stock and commercial centers in this area.

In 2010, the area surrounding Kealakehe WWTP had a population of 24,528 residents, within the four census tracts (215.04, 215.09, 216.01, and 261.04), which approximates the area currently served by the Kealakehe WWTP. This population represented approximately 13.3 percent of the Hawai'i Island population of 185,079 residents (State of Hawai'i Department of Business, Economic Development and Tourism, 2015).

In March 2017, the State of Hawai'i Department of Business, Economic Development and Tourism, released 2016 population estimates for the state and counties. This estimate shows, in 2016, Hawai'i County with a resident population 198,449, which represents an annual increase of 1.169 percent from 2010. Based on this growth rate, for 2016, the Kealakehe WWTP and Kona area population would be about 26,300 residents.

The U.S Census Bureau provides the American Community Survey which updates selected demographic, social, and economic information for various years. The American Community Survey (ACS) produces population, demographic characteristics, including age and racial composition, and economic information, including employment and household income by Census Designated Place (CDP) for a number of locations in Hawai'i County. The CDPs in the area of the Kealakehe WWTP area are Kahalu'u-Keauhou and Kailua.

Information of small areas is in the 2017 version of the American Community Survey (5-Year Estimates) Hawai'i Geographic Area Profiles – Census Designated Places: Neighbor Islands. The American Community Survey (ACS) noted it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

The ACS shows the Kahalu'u-Keauhou and Kailua area population is younger than Hawai'i County with higher portions in the all age categories, except for the 20 to 34 years where the Kahalu'u-Keauhou and Kailua area shows 16.8 percent compared to 17.9 percent for the County. Similarly, the median age for the Kahalu'u-Keauhou and Kailua area is 45.2 years compared to 42.6 years for the County.

The racial composition of the population shows the Kahalu'u-Keauhou and Kailua area to have a higher portion of White 40.8 percent compared to 32.6 percent for the County. The Kahalu'u-Keauhou and Kailua area has lower portions of minority populations, including Native Hawaiians than Hawai'i County.

In terms of education, the Kahalu'u-Keauhou and Kailua area shows higher portions have completed high school, 53.3 percent, than the County, 37.4 percent, and lower portions with some college and associate degree and bachelor degree and graduate or professional degree.

The Kahalu'u-Keauhou and Kailua area had a lower portion with household incomes less than $49,999, 41.7 percent, than the County, 45.7 percent, and higher portions between $50,000 to $199,000, 56.2 percent, than the County, 48.4 percent. The Kahalu'u-Keauhou and Kailua area had higher median household income, $58,752, than the County, $55,750. A household consists of all people who occupy a housing unit regardless of relationship. A household may consist of a person living alone or multiple unrelated individuals or families living together.

Lastly, the Kahalu'u-Keauhou and Kailua area had portions of employment in Wholesale-Retail Trade, Transportation, 24.3 percent, compared to the County, 18.7 percent, and Arts, Entertainment, Recreation, 27.5 percent, compared to the County, 17.8 percent. Table 3-2 shows demographic, economic and social characteristics information.

Table 3-2 Demographic, Economic and Social Characteristics
Kahalu'u-Keauhou and Kailua and Hawai'i County

	Kahalu'u-Keauhou and Kailua		**Hawai'i County**	
Item	**Total**	**Percent**	**Total**	**Percent**
Demographic Characteristics				
Total Population	17,707	-----	198,449	-----
Under 5 to 19 years	4,404	25.9-	46,463	23.4
20 to 34 years	2,863	16.8	35,450	17.9
35 to 59 years	5,419	31.9	61,165	30.8
60 to 74 years	3,246	19.1	41,295	20.8
75 years and over	1,075	6.3	14,075	7.1
Median Age	45.2	-----	-------	-------
Race				
White	6,935	40.8	64,7140	32.6
African American (1)	71	0.04	1,879	0.9
Chinese	110	0.06	1,736	0.9
Filipino	1,466	8.6	18,815	9.5
Japanese	855	5.0	20,267	10.2
Other Asian	288	1.7	6,597	3.3
Native Hawaiian	1,637	9.6	20,263	10.2
Other Pacific Islander	1,207	7.1	6,637	3.3
Some other race	512	3.0	2,422	1.2
2 or more races	3,926	23.1	55,119	27.8
(1) incl American Indian/Alaska Native				

	Kahaluu-Keauhou and Kailua		Hawai'i County	
Item	**Total**	**Percent**	**Total**	**Percent**
Social Characteristics				
Less than 9th Grade	257	1.7	3,876	2.8.
High school to HS Graduate	7,965	53.3	52,300	37.4
Some college to associate degree	3,729	25.0	45,084	32.2
Bachelor degree	2,206	14.8	26,795	19.2
Graduate or professional degree	783	5.2	11,779	8.4
Household Income Characteristics				
Less than $24,999	1,265	20.9	15,058	21.6
$25,000 to 49,999	1,258	20.8	16,905	24.2
$50,000 to $99,999	2,250	37.2	21,152	30.3
$100,000 to $199,999	1,151	19.0	12,648	18.1
$200,000 or more	126	2.1	4,055	5.8
Median household income	$58,752	-----	$55,750	-----
Employment Characteristics				
Agriculture, Fishing, Construction,	941	12.0	8,877	10.4
Manufacturing and wholesale-trade	161	2.1	4,351	5.0
Retail trade	1,461	18.7	9,431	11.0
Transportation and utilities	351	4.5	4,473	5.2
Information tech, finance, real estate	503	6.4	6,465	7.6
Professional, scientific	628	8.0	8,519	10.0
Education and health care	929	11.9	16,963	19.9
Arts, Entertainment, Recreation	2,151	27.6	15,192	17.8
Other Services, Public Administration	687	8.8	11,158	13.1

Source: 2017 American Community Survey (5-Year Estimates) Hawai'i Geographic Area Profiles – Census Designated Places: Neighbor Islands.

Impacts and Mitigation Measures

In the short-term, construction of the Kealakehe WWTP R-1 Upgrade project will require a number of contractors and their subcontractors. For the most part, the contractors and subcontractors try to use workers already located on Hawai'i thereby avoiding the need to import workers from outside the local area and affecting the population of the local area and the related demand for housing.

The R-1 Upgrade project will generate employment as the contractor will need workers to undertake construction of the improvements at the Kealakehe WWTP, the buffer area and various R-1 transmission pipeline projects. This employment will generate wages and salaries paid to the contractor and subcontractor work forces. The wages and salaries paid to the work force will in turn generate purchases of goods and services in the local area which will result in taxes paid to the County and State of Hawai'i. In addition, the contractor and their subcontractors will need to rent or

purchase equipment, supplies, and materials, some of which will be purchased from local suppliers and vendors. Direct purchases of equipment, supplies, and materials by the contractor will also generate taxes County and the State. Overall, the R-1 Upgrade project will result in positive employment benefits which will result in higher levels of income and overall economic benefits to the local economy.

In the long term, the proposed R-1 Upgrade improvements are expected to require only 4 additional personnel to operate and monitor the R-1 treatment and transmission systems and to monitor the recycled water users. This level of additional personnel will negligibly increase resident population. Thus, the R-1 Upgrade improvements are not expected to affect the socio-economic characteristics of the area.

Based on the findings of the ACS, the Kahaluu-Keahoua and Kailua area population is younger than Hawaii County with higher portions in the all age categories, except for the 20 to 34 years where the Kahaluu-Keahoua and Kailua area shows 16.8 percent compared to 17.9 for the County. Similarly, the media age for the Kahaluu-Keahoua and Kailua area is 45.2 years compared to 42.6 years for the County.

The racial composition of the population shows the Kahaluu-Keahoua and Kailua area to have a higher portion of White 40.8 percent compared to 32.6 percent for the County. The Kahaluu-Keahoua and Kailua area has lower portions of minority populations, including Native Hawaiians than Hawaii County.

Based on the above, construction and operation of the R-1 Upgrade improvements would not have a disproportionately high adverse impact on the minority and low income population in the Kahaluu-Keahoua and Kailua community.

3.19 Recreational Facilities

The Kona coast contains two existing and one future recreational facilities. One of the existing facilities is under the jurisdiction of County of Hawaii and the other under the jurisdiction of the National Park service. The future facility is under the jurisdiction of the County.

Old Airport Park

The County's Kailua Park and the former Old Kona Airport State Recreation Area, "Old Airport Park" or "Maka'eo" comprises about 117 acres. The Old Airport Park is owned and operated by the County Department of Parks and Recreation (DPR). As the primary park serving the West Hawai'i area, the existing ballfields, gymnasium and swimming pool at the Old Airport Park are heavily utilized year-round by schools, sports leagues and clubs, and park programs, in addition to casual users. The majority of Park users participate in casual play and social activities, and large numbers also use the park for organized sports practice and games. The Park is the venue for regional and statewide meets and tournaments on a regular basis. According to DPR, the Old Airport Park is the most active park in the county. Information collected by DPR for various activities is shown in Table 3.3:

Table 3.3
Activities at Old Airport Park

Activity	Total Fiscal Year 2018	Total Fiscal Year 2017
Organized P&R Sport Games	2,904	3,779
Organized Non-P&R Sport Games	9,398	20,235
Organized Sports Practice	25,217	45,415
P&R Sports Instruction	1,970	3,144
Organized Physical Fitness	2,704	5,046
Casual Play, Table Games and Others	83,936	91,670
Arts & Crafts	808	500
Music & Dance	1,348	710
Drama/Storytelling & Puppetry	42	266
Outdoor Nature Activities	150	420
Social Activities	7,419	9,093
Special Events	4,300	15,636
Miscellaneous	73,017	117,220
Total	**213,213**	**313,134**
Kona Community Aquatic Center	**305,924(a)**	**221,365(b)**
	(a) 36 days closed	(b) 55 days closed

Source: Department of Parks and Recreation.

In February 2011, DPR issued the issued the Final Environmental Assessment Kaillua Park Master Plan, aka Old Airport Park. The Final EA stated existing uses in the Park include multi-purpose ball fields, an aquatic center and gymnasium, basketball and tennis courts, in-line roller hockey rink, temporary skateboard park, horseshoe pit, toddler playground, a multi-purpose events pavilion, beach pavilions and restrooms, temporary canoe hale, walking and jogging path, botanical garden and base yard operations for the State DLNR and County DPR. Most of the northern half of the Park is dominated by the former airport runway, which is used as a roadway to access the beach areas and the Maka'eo Walking and Jogging Path.

The need for additional recreational facilities in the Kona region is widely known, well-documented, and identified as a priority in recent County plans and policies. The master plan provides a long-range guide for development and use of the 117-acre property over the next 20+ years. Since the 98-acre State Old Kona Airport State Recreation Area is being conveyed to the County, a comprehensive plan was needed for the entire 117-acre park . The master plan recommendations address current and future demand for improving this district park in Kailua-Kona. It also identifies the recreational needs that would be appropriate to be located at other park sites or a future regional park in the Kailua-Kona area.

The project described in the Final EA includes a wide range of improvements such as additional restrooms and lockers, concessions, canoe hālau, youth and senior centers, 25-yard swimming pool, skate park, shared-use pedestrian and bicycle path, new access roads and parking and additional lawn and landscaped areas. A major proposal calls for removal of the old airport runway and creation of a new beach access road with parking. Northern areas of the site, which are rich in cultural resources, will remain undeveloped, protected, and maintained as a cultural preserve.

The proposed improvements may be implemented by the DPR or through joint efforts with other County, State or Federal agencies, or community groups.

Kealakehe Regional Park

Over the years, the County has discussed recreational uses of the 190-acre parcel (TMK: 7-4-020:007) located east (mauka) of Queen Ka'ahumanu Highway, south of Kealakehe Parkway, west (mauka) of Ane Keohokalole Highway, and north of the Kona Police substation. As previously discussed, the parcel was planned as municipal golf course which would have used effluent from the Kealakehe WWTP to irrigate the course. The most recent proposal for the parcel is for the Kealakehe Regional Park to be developed by DPR. The preferred plan for the park has identified the area to be used for SAT site and shows a variety of uses in the other areas including: tennis complex; community gardens, archery range; golf driving range; baseball complex; great lawn area; amphitheater; soccer complex; a football/rugby/soccer stadium, and parking areas. Access to the park would be from Kealakehe Parkway. The DPR has indicated R-1 recycled water would be used to irrigate the park.

Kaloko-Honokōhau National Historical Park Kaloko- Honokohau National Historical Park is under the jurisdiction of the US Department of Interior National Park Service. The Park encompasses 1,160 acres and extends from the shoreline to Queen Ka'ahumanu Highway and its southern boundary is located about 3,500 feet north of Kealakehe WWTP. The Park was established for the preservation, protection and interpretation of traditional native Hawaiian activities and culture and offers a unique look out how early Hawaiian settlements survived on the Kona coast.

On April 24, 2017, in response to the EIS Preparation Notice, the Kaloko-Honokōhau National Historical Park stated that, the Congress established Kaloko-Honokōhau National Historical Park in 1978 "...to provide a center for the preservation, interpretation, and perpetuation of traditional native Hawaiian activities and culture, and to demonstrate historic land use patterns as well as to provide a needed resource for the education, enjoyment, and appreciation of such traditional native Hawaiian activities and culture ..." by protecting the cultural and natural resources within the Park (16 U.S.C. § 396d(a)). The National Park contains more than 450 known archeological and cultural sites, including several heiau, networks of ancient and historic trails, seawalls, more than 180 anchialine pools, two Hawaiian fishponds with associated wetlands, and a fishtrap. It also contains 600 acres of marine waters containing coral reefs and other marine habitats. The land and waters within the National Park provide habitat for 17 federally listed, and candidate species for listing, under the Endangered Species Act. The 'Aimakapa Fishpond (a loko pu'uone style fishpond) and its associated wetlands are listed as a "Core Wetland" by the U.S. Fish and Wildlife Service for the recovery of two endangered waterbird species, the Hawaiian stilt (*Himantopus mexicanus knudseni*) and the Hawaiian coot (*Fulica americana alai*), and are important habitat for migratory shorebirds and waterfowl (USFWS 2011). The Kaloko Fishpond is a loko kuapa and is being restored so that it can be managed as a traditional Hawaiian fishpond.

Honokōhau Small Boat Harbor

The Honokōhau Small Boat Harbor is located about 2,500 feet north of the Kealakehe WWTP and falls under the jurisdiction of the State of Hawaii Department of Land and Natural Resources Division of Boating and Outdoor Recreation. The small boat harbor contains docking facilities for various sizes of boats, including those used for deep sea fishing, 3 boat launch ramps, a vessel washdown facility, a fuel facility and 2 comfort facilities.

Impacts and Mitigation Measures
Old Airport Park

The Old Airport Park is currently irrigated by potable water from the County of Hawaii Department of Water Supply. To conserve potable water, reduce irrigation costs to DPR, and to provide a use for R-1 recycled water, the DPR and the DEM have collaborated to use R-1 recycled water produced at the Kealakehe WWTP to irrigate the Old Airport Park. The DEM will construct the R-1 transmission pipeline from the Kealakehe WWTP to the existing Kealakehe pump station located near the southern boundary of the park. The transmission pipeline will be constructed within the boundaries of the existing easement was established when the existing force main from the park to the WWTP was constructed. Also, when the R-1 transmission pipeline is constructed, DEM will also install a redundant force main in the same trench. Thus, the easement will contain the R-1 transmission pipeline and side by side force mains.

The existing irrigation currently uses potable water. To use R-1 recycled water for irrigation purposes, it will be necessary for the DEM to install an R-1 irrigation system within the park to replace the existing potable system, which will be abandoned-in-place. Upon completion of the replacement irrigation system, the DPR will be the user/owner and operator of the system and will be required to comply with the conditions set forth by the DOH in the *2016 Reuse Guidelines.*

As previously discussed, the R-1 recycled water is anticipated to have high salinity so that the irrigated areas have to be planted with salt-tolerant plants and grass. Prior to installation of the irrigation system, areas to be irrigated will need to be verified that their existing plantings are salt-tolerant or need to be replanted with a salt-tolerant species. Salt-tolerant species of grass include seashore paspalum (*Paspalum vaginatum*) or Bermuda grass (*Cynodon dactylon*). Areas near shoreline will not be irrigated with recycled water to prevent runoff to the ocean as the DPR staff indicated that high surf sometimes washes up to the existing pavilions and restrooms located oceanside (*makai*) of the Maka'eo Walking and Jogging Park. The existing community garden will not be able to be irrigated with the R-1 recycled water since plantings by community members, which may be for consumption, would be difficult to be isolated. It is also unknown whether these plants would be able to tolerate the anticipated high salinity R-1 water.

Preliminary analysis shows about 20 to 25 acres of the park could be irrigated with R-1 recycled water. These areas include the 3 ballfields and the playing field and various landscaped areas located within the park. Irrigation of these areas will need to comply with the DOH Reuse Guidelines and will also need to be coordinated with the recreational uses of the areas to avoid adverse impacts to the park users and attendees.

One of the purposes of the R-1 Upgrade project is to provide recycled water that be used for irrigation in lieu of using potable water. Preliminary analysis shows the irrigated areas of the DPR uses about 210,000 to 220,000 gallons per day (gpd) of potable water. Thus, use of R-1 recycled water for irrigation at the Old Airport Park would conserve or retain the potable water for other purposes. This would be a positive or beneficial impact of the R-1 Upgrade project.

The DPR adherence to the DOH Reuse Guidelines will ensure use of R-1 recycled water does not result in adverse impacts to park users.

The various projects described in the Final EA would also need to be salt tolerant vegetation to use R-1 recycled water for irrigation purposes. Since these projects could result in an increase in the irrigated areas, the amount of R-1 recycled water used for irrigation could potentially be higher than 210,000 to 220,000 gpd shown for the existing uses. Thus, this would also be a beneficial impact of the R-1 Upgrade project.

Kealakehe Regional Park

The preliminary plans show a variety of uses that could use R-1 recycled water for irrigation, including the archery range; golf driving range; baseball complex; great lawn area; amphitheater; soccer complex; and the field in the football/rugby/soccer stadium. R-1 recycled water could be used for any landscaped areas adjacent to these uses and the various parking areas.

The DPR has indicated R-1 recycled would be used to irrigate the park.

Kaloko-Honokohau National Historical Park

As previously discussed, on April 24, 2107, the National Park Service submitted comments to the EIS Preparation Notice, including a request that the Draft EIS address specific issues related to: the polishing wetlands; the SAT system and the salinity content of the treated effluent.

Information regarding the subsurface constructed wetlands is in Section 2.1.2 and related impacts to surface water in Section 3.4, ground water resources in Section 3.5 and Appendix B. Information regarding the SAT system is in Section 2.1.1 and related impacts to ground water resources in Section 3.5- and Appendix B.

Discussions regarding the salinity content of the incoming wastewater and the treated effluent are in Section 1.5. The type of salt tolerant plant material includes seashore paspalum (*Paspalum vaginatum*) or Bermuda grass (*Cynodon dactylon*). Areas near shoreline will not be irrigated. See also Appendix B.

Section 3.10.2 provides discussions regarding the waterbird species found at the Kealakehe WWTP and related impacts and avoidance measures.

3.20 Public Services and Facilities

3.20.1 Police Protection

The broader Kailua-Kona area is served by the Hawai'i County Police Department's Area II Operations Bureau's Kona Patrol District. The patrol district extends from the South Kohala District at Waikoloa to the Ka'ū District at Kaulanamauna. The nearest police station to Kealakehe WWTP is the Kona Substation located on Hale Makai Place approximately 3,000 feet (0.6 miles) east or across Queen Ka'ahumanu Highway from the Kealakehe WWTP.

Impacts and Mitigation Measures

In the short term, an off-duty police officer may be needed as part of the traffic control plan at the transmission pipeline sites, especially for the trenching required along Queen Ka'ahumanu Highway. Once construction has been completed, no significant impacts on the services of the County of Hawai'i Police Department are anticipated as a result of the proposed improvements. The proposed improvements will not generate an increase in resident population and, as a result, is not expected to affect police services provided to area residents.

3.20.2 Fire Protection

Fire protection and related emergency services for the Kona area are provided by the County Fire Department. The nearest station to Kealakehe WWTP is the Kailua-Kona station, located at the intersection of Palani Road and Queen Ka'ahumanu Highway, approximately 1.5 miles to the south of the Kealakehe WWTP. Back-up fire protection service is provided by the Waikoloa and Waimea Fire Stations, as needed.

Impacts and Mitigation Measures

No significant impacts on the services of the County Fire Department are anticipated as a result of the proposed improvements. The R-1 Upgrade project does not include improvements that will require additional fire protection than currently provided to the existing facilities at the Kealakehe WWTP. The R-1 Upgrade project will not generate an increase in resident population and is, therefore, not expected to affect fire protection services provided to area.

3.20.3 Solid Waste

The County of Hawai'i, Department of Environmental Management, Solid Waste Division and Recycling Section operates and maintains all solid waste collection and disposal facilities in the County of Hawai'i. The facilities include two landfills and 22 transfer stations. Refuse collected in the region is taken to the West Hawai'i (Pu'uanahulu) Landfill, located in Waikoloa, for disposal.

The County does not provide trash pick-up to individual residential units. As such, residents must bring trash to the County transfer station for disposal by the County. The closest transfer station to the Kealakehe WWTP is located at the end of Hale Makai Place, directly east (muaka) of the WWTP. Trash collected by commercial services is taken to the landfill for disposal.

Impacts and Mitigation Measures

No significant impacts to solid waste disposal are anticipated from the construction and operation of the proposed project. Construction waste will be recycled or disposed of at an approved construction waste facility as determined by the selected contractor.

3.21 Infrastructure and Utilities

3.21.1 Water System

The County of Hawai'i Department of Water Supply provides water service along the Kona coast area. An existing 20-inch water main located along the west (makai) side of Queen Ka'ahumanu Highway services the Kealakehe WWTP via a connection along Hale Makai Place

Impacts and Mitigation Measures

No significant impacts are anticipated on the existing potable water system as a result of the construction and operation of the R-1 Upgrade improvements. Extension of a line to the chemical addition building will be required to service the emergency shower. The R-1 Upgrade improvements will not create a significant increase in potable water demand.

3.21.2 Electrical and Communication Systems

Electrical service is provided along the Kona coast is provided by Hawaiian Electric Light Company (HELCO) via pole mounted overhead lines located along roadways. In the area of the Kealakehe WWTP, these overhead lines are located along the east (mauka) side of Queen

Ka'ahumanu Highway. Electrical service is provided to the Kealakehe WWTP via underground pipelines located along Hale Makai Place.

Hawaiian Telcom is the primary telecommunications provider within the County of Hawai'i. Service is provided overhead and underground lines to the area of the Kealakehe WWTP.

Impacts and Mitigation Measures

Construction of the R-1 Upgrade improvements will require extension of the underground service within the Kealakehe WWTP to an electrical transformer and switchgear equipment. The R-1 treatment facility and the various pumps will increase the electrical demand to the WWTP. However, the increase in demand is not anticipated to have a significant impact on electrical and communication systems in the Kona area.

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4. INDIRECT AND CUMULATIVE IMPACTS

4.1. Indirect Impacts

Indirect or secondary effects are described as those effects caused by a project but occur later in time or farther removed in distance than direct impacts but are still reasonably foreseeable. Such effects may include impacts on environmental resources or public facilities that occur as a result of the project's influence on land use.

The proposed project is not expected to have secondary impacts on resident population or land use and settlement patterns. Changes to land use patterns and future development in the North Kona area are administered by the County of Hawai'i Planning Department through its Kona Community Development Plan. The R-1 Upgrade improvements will be able to accommodate the various land uses of the in the North Kona area as permitted by the County and those set forth in the Kona Community Development Plan. The R-1 Upgrade project is not a population generator, nor is the project anticipated to create an indirect growth in population.

Without a significant impact on population growth, the R-1 Upgrade project would not have significant secondary impacts on other infrastructure or governmental facilities and services. Thus, the project is not anticipated to indirectly increase demand for transportation, water or solid waste disposal that would necessitate additional long-term infrastructure improvements. Likewise, the project would not have a significant indirect impact on public facilities such as schools, medical facilities, and recreational facilities. Coordination with government agencies and utility companies will continue during the preparation of design plans to address any direct impacts on roadway and other infrastructure facilities.

Creation of short-term construction jobs may induce in-migrating of workers to the island to temporarily fill these positions. However, it is not anticipated that a significant number of these workers will become permanent residents on the island or in the Kona area. It is anticipated that qualified local contractors within the State of Hawai'i would be used for the majority of the work related to the project's construction. Therefore, construction of the project should not contribute to significant secondary impacts associated with in-migration of workers from outside of the State.

The R-1 Upgrade improvements will decrease the need for use of potable water to irrigate recreation uses, including playing fields, landscape areas and golf courses. As a result, the availability of R-1 recycled water to irrigate playing fields will allow the County of develop recreation facilities such as at the existing Old Airport Park and the planned Kealakehe Regional Park.

4.2 Cumulative Impacts

Cumulative impacts are typically defined as the effects on the environment which result from the incremental impact of a project when added to past, present, and reasonably foreseeable future actions. The estimation of future impacts is important for cumulative impact analysis. However, the focus must be on "reasonably foreseeable" actions which are those that are likely to occur or probable, rather than those that are merely possible or subject to speculation. The prediction of reasonably foreseeable impacts thus requires judgment based on information obtained from reliable sources such as adopted plans and similar documents.

Short-Term Cumulative Impacts

Cumulative short-term impacts would be associated with construction activities that may occur concurrently with other construction projects in the immediate vicinity. While no such overlap of construction activity is foreseeable at this time, it could contribute to increased temporary disruptions and nuisance effects such as noise, dust, and traffic delays. However, mitigation measures, as discussed in other sections of this document would reduce the intensity of any cumulative impacts.

Long-Term Cumulative Impacts

In terms of physical and biological resources, no significant long-term cumulative impacts at or within the vicinity of the Kealakehe WWTP and SAT project sites are anticipated, such as on soils, topography, flora, fauna, marine life, natural hazards, noise, air quality and aesthetics. Appropriate mitigation measures were identified to address direct impacts, which would primarily be associated with short-term construction-related activities.

In the vicinity of the Kealakehe WWTP, R-1 Upgrade improvements will not create a cumulative impact related to odors. The existing WWTP is equipped with an odor control system at the headworks, and the recently-upgraded lagoon aeration system ensures that the existing WWTP processes are not a source of nuisance odors. The R-1 treatment system and subsurface flow constructed wetlands improvements will be fed water that has already been oxidized in the aerated lagoons, therefore they will not be a source of nuisance odors.

5. FEDERAL CROSS-CUTTER AUTHORITIES

This project may be funded by federal funds provided by the US Environmental Protection Agency (EPA) through the State of Hawai'i's Clean Water State Revolving Fund (CWSRF) Program. The use of federal funds would constitute a federal action and will require the project to meet all National Environmental Policy Act (NEPA) (-42 U.S.C. §4321 et seq.) and Hawai'i, CWSRF program requirements. These requirements are set forth as "cross cutters" described as follows.

5.1 Archaeological and Historic Preservation Act, (54 U.S.C. § 312502)

The Archaeological and Historic Preservation Act (AHPA), also known as the Archeological Recovery Act and the Moss-Bennett bill, was passed and signed into law in 1974, amended and expanded the Reservoir Salvage Act of 1960. The AHPA built upon the national policy, set out in the Historic Sites Act of 1935, "*to provide for the preservation of historic American sites, buildings, objects, and antiquities of national significance*". The AHPA expanded the policy by focusing attention on significant resources and data, but does not require that they be shown to be of "national" significance. The AHPA required that federal agencies provide for "...the preservation of historical and archeological data (including relics and specimens) which might otherwise be irreparably lost or destroyed as the result of...any alteration of the terrain caused as a result of any Federal construction project of federally licensed activity or program."

54 U.S.C. §312502, (a) states: "*When any Federal agency finds, or is notified, in writing, by an appropriate historical or archeological authority, that its activities in connection with any Federal construction project or federally licensed project, activity, or program may cause irreparable loss or destruction of significant scientific, prehistorical, historical, or archeological data, the agency shall notify the Secretary, in writing, and shall provide the Secretary with appropriate information concerning the project, program, or activity*…"

54 U.S.C. 312502 (b) states: "When any Federal agency provides financial assistance by loan, grant, or otherwise to any private person, association, or public entity, the Secretary, if the Secretary determines that significant scientific, prehistorical, historical, or archeological data might be irrevocably lost or destroyed, may, with funds appropriated expressly for this purpose-

(A) Conduct, with the consent of all persons, associations, or public entities having a legal interest in the property, a survey of the affected site; and

(B) undertake the recovery, protection, and preservation of the data (including analysis and publication)."

The R-1 Upgrade improvements will be constructed within the existing Kealakehe WWTP parcel within an area with similar facilities and adjacent vacant/unimproved lands, within existing easements, which contain similar underground utilities, and vacant unimproved land covered with lava flows. Preliminary analysis shows these areas do not contain archeological resources. An Archeological Inventory Survey, including subsurface testing, if warranted, will be conducted to confirm archeological resources on these project areas.

The contract drawings will state that, should archaeological sites such as walls, platforms, pavements or mounds, or remains such as artifacts, burials, concentrations of shell or charcoal be encountered during construction activities, work shall cease immediately and the find shall be protected from further damage. The contractor shall immediately contact the State Historic Preservation Division at 808.981.2979, who will assess the significance of the find and recommend an appropriate mitigation measure, if necessary.

5.2 Bald and Golden Eagle Protection Act (16 U.S.C. §§ 668-668c)

The Bald Eagle Protection Act (16 U.S.C. §§ 668-668c) prohibits any act to take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner any bald eagle commonly known as the American eagle or any golden eagle, alive or dead, or any part, nest, or egg thereof of the foregoing eagles.

No bald or golden eagles are found in Hawai'i.

5.3 Clean Air Act (42 U.S.C. §7401)

The Federal Air Pollution Control Act 42 U.S.C. §7506(c), Clean Air Act, was preceded by a series of legislation affecting air quality. Over the years, there have been a number amendments adopted related to air quality and all called the Clean Air Act. The first federal legislation regarding air pollution *control was the Clean Air Act of 1963*. The Clean Air Act of 1970 (1970 CAA) authorized the development of comprehensive federal and state regulations to limit emissions from both stationary (industrial) sources and mobile sources.

The 1970 CAA set forth four major regulatory programs affecting stationary sources: the National Ambient Air Quality Standards (NAAQS), State Implementation Plans (SIPs), New Source Performance Standards (NSPS), and National Emission Standards for Hazardous Air Pollutants (NESHAPs). In Hawai'i, the DOH, Clean Air Branch, Air Quality program is defined by HAR Chapter 11-60 and serves as the SIP approved by the Environmental Protection Agency (EPA).

The DOH operates a network of air quality monitoring stations at various locations around the State. In December 2016, the DOH issued the Annual Summary 2015 Air Quality Data report which provides the results from the network of air quality monitoring stations. The DOH air quality monitoring site closest to the Kealakehe WWTP R-1 Upgrade site is located about 11.8 miles to the south in Kealakekua at the Konawaena High School. Both sulfur dioxide (SO2) and particulate matter (PM 2.5) are monitored at this site. Measurements of SO2 concentrations at this location during the 2011-2015 monitoring period were consistently low with annual average concentrations below 0.005 ppm, which is below the federal and State standard of 0.03 ppm. No exceedances of the federal/State 3-hour and 24-hour AAQS for SO2 were recorded at the Konawaena High School monitoring station.

Volcanic eruptions are considered natural events and therefore EPA may exclude the exceedances of the 1-hour NAAQS from attainment determinations.

Short-term impacts on air quality could occur during construction of the proposed improvements. Short-term impacts from fugitive dust will likely occur during the construction phases. To a lesser extent, exhaust emissions from mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State DOH Administrative Rules, Title 11, Chapter 60-11.1 "Air Pollution Control," requires that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with State regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing any inactive areas that have been worked.

After construction, motor vehicle traffic from County employees and others visiting the Kealakehe WWTP would be a source of increases in air pollution emissions. Also, the various pumps related to the R-1 treatment process would increase electrical power demand which would result in air

pollutant emissions at the HELCO power plant. However, given the low ambient levels of pollutants, both of these increases would not result in exceedance of federal or State ambient air quality standards (AAQS) for the six criteria pollutants.

5.4 Coastal Barrier Resources Act (16 U.S.C. §3501)

In 1982, Congress passed the Coastal Barrier Resources Act (CBRA) (16 U.S.C. §3501) which established the John H. Chafee Coastal Barrier Resources System (CBRS), comprised of undeveloped coastal barriers along the Atlantic, Gulf, and Great Lakes coasts. The law encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting federal expenditures that encourage development, such as Federal flood insurance through the National Flood Insurance Program.

The Coastal Barrier Resources Reauthorization Act of 2000 reauthorized the Coastal Barrier Resources Act (CBRA) and directed the U.S. Fish and Wildlife Service to complete a Digital Mapping Pilot Project that includes digitally produced draft maps for up to 75 John H. Chafee Coastal Barrier Resources System (CBRS) areas and a report to Congress that describes the feasibility and costs for completing digital maps for all CBRS areas.

The purpose the CBRA is to minimize the loss of human life, wasteful expenditure of federal revenues, and the damage to fish, wildlife, and other natural resources associated with the coastal barriers along the Atlantic and Gulf coasts and along the Great Lakes by restricting future federal expenditures and financial assistance which have the effect of encouraging development of coastal barriers.

Based on its location, the CBRA is not applicable to Hawai'i.

5.5 Coastal Zone Management Act (16 U.S.C. §1451)

The Coastal Zone Management Act of 1972 (CZMA), 16 U.S.C § 1451-1464, was passed to establish a national policy to preserve, protect, develop, and where possible, restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations and to encourage coastal states to develop and implement coastal zone management programs (CZMPs). Each federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone shall be carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved State management programs. Each federal agency carrying out an activity subject to the Act shall provide a consistency determination to the relevant State agency designated under section 1455(d)(6) of this title at the earliest practicable time.

In 1977, Hawai'i enacted Chapter 205A, HRS, Hawai'i Coastal Zone Management (CZM) Program. The CZM area encompasses the entire state, including all marine waters seaward to the extent of the state's police power and management authority, including the 12-mile U.S. territorial sea and all archipelagic waters. The objective and policies of the CZM is set forth §205A-2, HRS. See detail discussion in Section 6 Plans, Policies and Controls. A summary follows.

(1) Recreational Resources

Objective:
Provide coastal recreational opportunities accessible to the public.

Policies:

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

The nearest public shoreline access is located about 3,500 feet west of the existing WWTP on lands controlled by the State of Hawai'i Department of Land and Natural Resources (DLNR). The Kealakehe WWTP project would not affect this shoreline area. Thus, the existing public access would be maintained.

(2) Historic Resources

Objective:

(A) 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:

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

An Archaeological Literature Review and Field Inspection for the project site was conducted for the property in April 2018. The project area lies within the southernmost extent of the Kekaha region, in which the uplands were used for residences and farming, and the coastal lands for residence, fishing, and aquaculture. The lands located between the coast and uplands settlements, in which the majority of the project area is situated, contained networks of trails along which shelter and water collection caves, quarries, and scattered agricultural sites were located. Historically, the area was used widely for ranching.

Background research indicated the presence of 119 previously identified archaeological sites/historic properties overlapping or within 330 feet of the bounds of the project area. Most of

these are pre-Contact sites associated with agriculture, habitation, transportation, resource procurement, ceremony, burial, artistic expression, and/or recreation. Historic era sites included trails (such as State Inventory of Historic Places [SIHP] #50-10-27-00002, Māmalahoa Trail), habitation areas, a cemetery, and ranching-related features like boundary walls.

The field inspection confirmed 30 of 119 previously identified archaeological sites and possibly relocated portions of eight previously identified sites; these 38 sites are within or immediately adjacent to the project area. In addition, archaeologists documented 16 newly identified archaeological features/feature complexes within or directly adjacent to the project area.

In general, efforts to minimize potential effects on historic properties will be made in the project design phase. Such efforts will include limiting ground disturbance within previously undisturbed areas as much as possible (e.g., propose installation of transmission lines within existing roadbeds or graded areas).

The contract drawings will state that, should archaeological sites such as walls, platforms, pavements or mounds, or remains such as artifacts, burials, concentrations of shell or charcoal be encountered during construction activities, work shall cease immediately and the find shall be protected from further damage. The contractor shall immediately contact the State Historic Preservation Division at 808.981.2979, who will assess the significance of the find and recommend an appropriate mitigation measure, if necessary.

(3) Scenic and Open Space Resources

Objective:

(A) Protect, preserve, and where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies:

(A) Identify valued scenic resources in the coastal zone management area;

(B) Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;

(C) Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and

(D) Encourage those developments which are not coastal dependent to locate in inland areas.

The Kealakehe WWTP R-1 Upgrade improvements project would be consistent in visual character with the existing facilities at the WWTP. The chemical addition building and the ultra violet (UV) facility would be about 12 to 14 high, or about the same height as the existing administration and operations buildings and the roof structure over the effluent pump station. The R-1 storage tank would be about 30 feet above the surrounding grade. There is an existing about 14-foot high berm located along the eastern boundary of the WWTP which would act the screen the project improvements when viewed from Queen Kaahumanu Highway. Thus, the Kealakehe WWTP R-1 Upgrade improvements project would not affect coastal views.

The nearest public shoreline access is located about 3,500 feet west of the existing WWTP on lands controlled by the State of Hawai'i Department of Land and Natural Resources (DLNR) and, as such, coastal scenic and open space resources would not be affected

(4) Coastal Ecosystems

Objective:

(A) Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.

Policies:

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

(B) Improve the technical basis for natural resource management;

(C) Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;

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

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

During construction of the various improvements, storm water runoff may carry increased amounts of sediment into the storm drain system due to erosion from soils exposed during excavation and grading activities. This runoff could potentially impact the water quality of coastal waters in the area. However, excavation and grading activities associated with the construction of the proposed project will be regulated by the County's grading ordinance. In addition, for those improvements anticipating an area of soil disturbance greater than one acre, an NPDES Individual Permit for Storm Water Associated with Construction Activity, administered by the State DOH, will be required to control storm water discharges. Mitigation measures will be instituted in accordance with site-specific assessments, incorporating appropriate structural and/or non-structural BMPs such implementing erosion control measures such as silt fences and sediment basins and minimizing time of exposure between construction and landscaping improvements. These measures will protect the coastal ecosystems of the area.

(5) Economic Uses

Objective:

(A) Provide public or private facilities and improvements important to the State's economy in suitable locations.

Policies:

(A) Concentrate coastal dependent development in appropriate areas;

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

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

(i) Use of presently designated locations is not feasible;

(ii) Adverse environmental effects are minimized; and

(iii) The development is important to the State's economy.

The R-1 Upgrade improvements will be located about 3,500 feet from the shoreline. The improvements are sited within the existing Kealakehe WWTP which has been operating since the early 1990s and provides a suitable location to serve the Kailua Kona community.

(6) Coastal Hazards
Objectives:
(A) Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.

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

According to the Flood Insurance Rate Map (FIRM) (Community Panel Numbers 1551660466C, 1551660468C, 1551660681C and 1551660683C, Effective Date: September 16, 1988 prepared by the Federal Emergency Management Agency (FEMA)), the project site is located within Zone "X", defined as "Areas determined to be outside the 0.2% annual chance floodplain."
The project site is located outside of the tsunami inundation zone. Construction and operation of the proposed project are not anticipated to increase flood risks or cause any adverse flood-related impacts at the project site or lower elevation properties.

The entire island of Hawai'i is designated Seismic Zone 4, the highest rating among the major Hawaiian Islands. The proposed improvements will be designed and built to Seismic Zone 4 standards of the International Building Code (IBC) to ensure that potential seismic activities do not adversely affect the project buildings.

During construction of the various improvements, storm water runoff may carry increased amounts of sediment into the storm drain system due to erosion from soils exposed during excavation and grading activities. This runoff could potentially impact the water quality of coastal waters in the area. However, excavation and grading activities associated with the construction of the proposed project will be regulated by the County's grading ordinance. In addition, for those improvements anticipating an area of soil disturbance greater than one acre, an NPDES Individual Permit for Storm Water Associated with Construction Activity, administered by the State DOH, will be required to control storm water discharges. Mitigation measures will be instituted in accordance with site-specific assessments, incorporating appropriate structural and/or non-structural BMPs such implementing erosion control measures such as silt fences and sediment basins and minimizing time of exposure between construction and landscaping improvements. These measures will protect the coastal ecosystems of the area.

(7) Managing Development
Objective:
(A) Improve the development review process, communication, and public participation in the management of coastal resource and hazards.

Policies:
(A) Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;
(B) Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and

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

The Hawai'i State environmental review process, as set forth Chapter 343, HRS, and Hawai'i Administrative Rules Title 11, State of Hawai'i Department of Health, Chapter 200, Environmental Impact Statement Rules requires project review by government agencies and affords the public and organizations the opportunity to provide comments on the assessed impacts of the proposed project. The proposed improvements are also subject to the Special Management Area (SMA) permit process as discussed in Section 6.2.5. Applicable State and County requirements will be adhered to in the design and construction phases of the proposed improvements.

In addition, the KWWTP project has been the subject of a series of workshops (September 2016), focus group interviews (February 2017) and the EIS scoping meeting (April 2017).

(8) Public Participation
Objective:
(A) Stimulate public awareness, education, and participation in coastal management.

Policies:
(A) Promote public involvement in coastal zone management processes;

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

(C) Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.

The Hawai'i State environmental review process, as set forth Chapter 343, HRS, and Hawai'i Administrative Rules Title 11, State of Hawai'i Department of Health, Chapter 200, Environmental Impact Statement Rules requires project review by government agencies and affords the public and organizations the opportunity to provide comments on the assessed impacts of the proposed project. The proposed improvements are also subject to the Special Management Area (SMA) permit process as discussed in Section 6.2.5. Applicable State and County requirement will be adhered to in the design and construction phases of the proposed improvements.

In addition, the Kealakehe WWTP R-1 Upgrade project has been the subject of a series of workshops (September 2016), focus group interviews (February 2017) and the EIS scoping meeting (April 2017).

(9) Beach Protection

Objective:
(A) Protect beaches for public use and recreation.

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

(B) Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and
(C) Minimize the construction of public erosion-protection structures seaward of the shoreline.

The R-1 Upgrade improvements project does not involve the construction of improvements in the shoreline setback nor require any shoreline erosion-protection structures.

(10) Marine Resources

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

Policies:
(D) Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;
(E) Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;
(F) 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;
(G) Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and
(H) Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

The Kealakehe WWTP R-1 Upgrade improvements do not involve construction or development within coastal waters. Thus, the improvements are not anticipated to have any direct impacts on marine and coastal resources. Potential water quality impacts to nearshore coastal waters during construction of the improvements will be mitigated by adherence to State water quality regulations governing grading, excavation and stockpiling. In addition, since the improvements anticipating an area of soil disturbance greater than 1.0 acre, an NPDES Individual Permit for Storm Water Associated with Construction Activity, administered by the State DOH, will be required to control storm water discharges. Mitigation measures will be instituted in accordance with site-specific assessments, incorporating appropriate structural and/or non-structural BMPs such as implementing erosion control measures such as silt fences and sediment basins and minimizing time of exposure between construction and landscaping.

5.6 Endangered Species Act, (16 U.S.C. §1531)

On December 28, 1973, the Endangered Species Act, Pub L 93-205, was passed and, over the years, has been amended a number of times. The Act is set forth in 16 U.S.C. §1531. The original Act stated purpose was to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of various related the treaties and conventions. The provisions of the Act are administered by the U.S. Department of the Interior Fish and Wildlife Service (FWS) and the U.S. Department of the Interior National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS). The FWS has primary responsibility for terrestrial and freshwater organisms, while NOAA/NMSF is mainly responsible for marine wildlife.

16 U.S.C. §1536, Interagency Cooperation (Section 7 of the Act), states each federal agency shall, in consultation with and with the assistance of the Secretary of the Interior, insure that any action authorized, funded, or carried out by such agency (an "agency action") is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action.

In September 2017, botanical surveys were of the various project areas. The findings of the botanical survey show R-1 Upgrade project sites are a mix of undisturbed, slightly disturbed, but mostly greatly disturbed lava flows and roadways. A total of 32 plant species were recorded during the botanical survey, with 26 of the species (81 percent) non-native species. Of the 6 native and early Polynesian species listed in one is a native endemic species (*maiapilo; Capparis sandwichiana*), four are native indigenous species, and one a Polynesian introduction. The most ubiquitous indigenous native in the project area is '*uhaloa (Waltheria indica*), a common plant that is abundant over most of the surveyed areas, and occurs in both disturbed and undisturbed areas.

Maiapilo is widely found in essentially coastal areas in the Hawaiian Islands, but found nowhere else. Since this species population appears to be in slow decline, the International Union for Conservation of Nature (IUCN) regards the species as "vulnerable" due to development of the lowland environments. *Maiapilo* is not listed as threatened or endangered by US Fish and Wildlife Service (FWS) or the State of Hawai'i Department of Land and Natural Resources (DLNR). Similarly, none of the other plant species found during the botanical surveys are listed as threatened or endangered by the FWS or DLNR. No federally delineated critical habitat overlays any portion of the surveyed areas. No equivalent designation exists under State law.

Between September 20 and 22, 2017, avian surveys were conducted in the areas outside of the Kealakehe WWTP. Later, on March 9, 2018, waterbird surveys were conducted within the Kealakehe WWTP in the area of Lagoons 5 and 6. At the time of the survey, all five lagoons were being used as part of the treatment process.

A total of 926 individual birds of 32 species, representing 17 separate families, were recorded during station counts. Four of the species recorded are native resident species, two of which, Hawaiian Coot (*Fulica alai*) and the endemic sub-species of the Black-necked Stilt (*Himantopus mexicanus knudseni)* are listed as endangered species under both the federal and State of Hawai'i endangered species statutes. One species, Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*) is an indigenous resident water obligate species, and the Least Tern (*Sterna antillarum*), is a recently established breeding seabird species. Additionally, six other species recorded are migratory indigenous shorebird or waterbird species. The remaining 21 species are established alien species.

The principal potential impacts posed by the Project to endangered waterbirds are associated with construction activities creating disturbances of nesting birds during the year round nesting season within the small footprint of the proposed electrical and chemical buildings and a new underground waterline running parallel to the southern boundary fence, within the WWTP site. These activities, though of a short duration, could potentially disturb nearby nesting Hawaiian Stilts and Hawaiian Coots. Disturbance of this nature can result in birds abandoning their nest, eggs, and to a lesser degree, chicks.

As recommended in the biological report, to avoid impacts to the listed species, a sturdy silt fence or other suitable barrier system should be installed around the areas within the existing WWTP

facility that will be excavated to install the subsurface constructed wetlands distribution and return lines along the southern and western fence lines to prevent ingress of listed waterbird species into the construction disturbances areas. Also, daily waterbird monitoring should continue until all work within the WWTP fenced facility is complete

Based on the findings and the avoidance measures, the County will informally consult with the FWS.

5.7 Environmental Justice Executive Order 12898

Executive Order 12898, Environmental Justice (full title Federal Actions to Address Environmental Justice to Minority and Low Income Populations), was signed on February 11, 1994. The intent of Executive Order 12898 is to avoid disproportionately high adverse human health or environmental effects of projects on minority and low income populations. Executive Order 12898 also requires federal agencies ensure that minority and low income communities have adequate access to public information related to health and the environment.

The 2017 American Community Survey (5-Year Estimates) is the most recent information related to socioeconomic conditions in the state and County. The 2017 American Community Survey shows Hawai'i Geographic Area Profiles – Census Designated Places: Neighbor Islands. The ACS noted it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

The most recent version is the 2017 American Community Survey (5-Year Estimates) Hawaii Geographic Area Profiles – Census Designated Places: Neighbor Islands. The ACS noted it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

The ACS shows the Kahaluu-Keahoua and Kailua area population is younger than Hawaii County with higher portions in the all age categories, except for the 20 to 34 years where the Kahaluu-Keahoua and Kailua area shows 16.8 percent compared to 17.9 for the County. Similarly, the media age for the Kahaluu-Keahoua and Kailua area is 45.2 years compared to 42.6 years for the County.

The racial composition of the population shows the Kahaluu-Keahoua and Kailua area to have a higher portion of White 40.8 percent compared to 32.6 percent for the County. The Kahaluu-Keahoua and Kailua area has lower portions of minority populations, including Native Hawaiians than Hawaii County.

Based on the above, construction and operation of the R-1 Upgrade improvements would not have a disproportionately high adverse impact on the minority and low income population in the Kahaluu-Keahoua and Kailua community.

5.8 Farmland Protection Policy Act (7 U.S.C. §4201)

The Agriculture and Food Act (Public Law 97-98) was passed in 1981 and contained the Farmland Protection Policy Act (FPPA), Subtitle I of Title XV, Section 1539-1549. The stated purposes of the FPPA are to: 1) Minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses; and 2) Assure that federal programs are administered in a manner that, to the extent practicable, will be compatible

with State, unit of local government, and private programs and policies to protect farmland. "Farmland" subject to FPPA requirements does not have to be currently used for cropland.

The FPPA is administered by the US Department of Agriculture (USDA), National Resources Conservation Service. "Farmland", as used in the FPPA, includes prime farmland, unique farmland, and land of statewide or local importance, as defined by the State of Hawai'i Department of Agriculture (DOA).

The R-1 Upgrade improvements will be constructed within the existing Kealakehe WWTP parcel within an area with similar facilities and adjacent vacant/unimproved lands, within existing easements, which contain similar underground utilities and vacant unimproved land covered with lava flows. These areas are not considered farmlands

5.9 Fish and Wildlife Coordination Act (16 U.S.C §661)

The Fish and Wildlife Coordination Act, 16 U.S.C §661, was enacted on March 10, 1934 and was amended on August 12, 1958. The purpose of Act is to recognize vital contribution of wildlife resources to the Nation, the increasing public interest and significance, and to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation. 16 U.S.C. §666b defines wildlife and wildlife resources as birds, fishes, mammals and all other classes of wild animals, and all types of aquatic and land vegetation upon which wildlife is dependent.

The Secretary of the Interior is authorized (1) to provide assistance to, and cooperate with, Federal, State, and public or private agencies and organizations in the development, protection, rearing, and stocking of all species of wildlife, and their habitat, in controlling losses of the from disease or other causes, in minimizing damages from overabundant species, in providing public shooting and fishing areas, including easements across public lands (2) to make surveys and investigations of the wildlife of the public domain, including lands and waters acquired or controlled by any agency; and (3) to accept donations of land and contributions of funds in furtherance of the purposes of the Act.

16 U.S.C. §665. States the Secretary of the Interior, through the Fish and Wildlife Service and the U. S. Bureau of Mines, is authorized to make such investigations as he deems necessary to determine the effects of domestic sewage, mine, petroleum, and industrial wastes, erosion silt, and other polluting substances on wildlife, and to make reports to the Congress concerning such investigations and of recommendations for alleviating dangerous and undesirable effects of such pollution. These investigations shall include (1) the determination of standards of water quality for the maintenance of wildlife; (2) the study of methods of abating and preventing pollution, including methods for the recovery of useful or marketable products and byproducts of wastes; and (3) the collation and distribution of data on the progress and results of such investigations for the use of Federal, State, municipal, and private agencies, individuals, organizations, or enterprises.

In September 2017, botanical surveys were of the various project areas. The findings of the botanical survey show R-1 Upgrade the project sites are a mix of undisturbed, slightly disturbed, but mostly greatly disturbed lava flows and roadways. A total of 32 plant species were recorded during the botanical survey, with 26 of the species (81 percent) non-native species. Of the 6 native and early Polynesian species listed in one is a native endemic species (*maiapilo; Capparis sandwichiana*), four are native indigenous species, and one a Polynesian introduction. The most

ubiquitous indigenous native in the project area is '*uhaloa (Waltheria indica*), a common plant that is abundant over most of the surveyed areas, and occurs in both disturbed and undisturbed areas.

Maiapilo is widely found in essentially coastal areas in the Hawai'ian Islands, but found nowhere else. Since this species population appears to be in slow decline, the International Union for Conservation of Nature (IUCN) regards the species as "vulnerable" due to development of the lowland environments. *Maiapilo* is not listed as threatened or endangered by US Fish and Wildlife Service (FWS) or the State of Hawai'i Department of Land and Natural Resources (DLNR). Similarly, none of the other plant species found during the botanical surveys are listed as threatened or endangered by the FWS or DLNR. No federally delineated critical habitat overlays any portion of the surveyed areas. No equivalent designation exists under State law.

Between September 20 and 22, 2017, avian surveys were conducted in the areas outside of the Kealakehe WWTP. Later, on March 9, 2018, waterbird surveys were conducted within the Kealakehe WWTP in the area of Lagoons 5 and 6. At the time of the survey, all five lagoons were being used as part of the treatment process.

A total of 926 individual birds of 32 species, representing 17 separate families, were recorded during station counts. Four of the species recorded are native resident species, two of which, Hawaiian Coot (*Fulica alai*) and the endemic sub-species of the Black-necked Stilt (*Himantopus mexicanus knudseni)* are listed as endangered species under both the federal and State of Hawai'i endangered species statutes. One species, Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*) is an indigenous resident water obligate species, and the Least Tern (*Sterna antillarum*), is a recently established breeding seabird species. Additionally, six other species recorded are migratory indigenous shorebird or waterbird species. The remaining 21 species are established alien species.

The principal potential impacts posed by the Project to endangered waterbirds are associated with construction activities creating disturbances of nesting birds during the year round nesting season within the small footprint of the proposed electrical and chemical buildings and a new underground waterline running parallel to the southern boundary fence, within the WWTP site. These activities, though of a short duration, could potentially disturb nearby nesting Hawaiian Stilts and Hawai'ian Coots. Disturbance of this nature can result in birds abandoning their nest, eggs, and to a lesser degree, chicks.

As recommended in the biological report, to avoid impacts to the listed species, a sturdy silt fence or other suitable barrier system should be installed around the areas within the existing WWTP facility that will be excavated to install the subsurface constructed wetlands distribution and return lines along the southern and western fence lines to prevent ingress of listed waterbird species into the construction disturbances areas. Also, daily waterbird monitoring should continue until all work within the WWTP fenced facility is complete

Based on the findings and the avoidance measures, the County will informally consult with the FWS.

5.10 Floodplain Management (Executive Order 19888, as amended by Executive Orders 1248 and 13690)

Executive Order 11988, Floodplain Management, dated May 24, 1977 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain

development wherever there is a practicable alternative. The 2 amendments did not affect the content of Executive Order 11988.

In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities.

The R-1 Upgrade improvements will be constructed within the existing Kealakehe WWTP parcel within an area with similar facilities and adjacent vacant/unimproved lands, within existing easements, which contain similar underground utilities and a vacant unimproved land covered with lava flows. These areas are not located within a floodplain area.

5.11 Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. §1801

The 1996 Sustainable Fishery Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act and subsequent Essential Fish Habitat (EFH) Regulatory Guidelines (NOAA, 2002) describe provisions to identify and protect habitats of federally-managed marine and anadromous fish species. Under the various provisions, federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with the National Marine Fisheries Service (NMFS).

Congress defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH is further defined by the existing regulations (MSFCMA, 1996; NOAA, 2002). "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters,

The R-1 Upgrade improvements project does not involve the construction of improvements near the shoreline or any other water bodies, streams or estuaries so would not affect essential fish habitat.

5.12. Marine Mammal Protection Act (16 U.S.C. §§703 *et seq.)*

The Marine Mammal Protection Act (MMPA), 16 U.S.C. §§1361 *et seq*., protects all marine mammals. It was the first legislation to mandate an ecosystem-based approach to marine resource management. The ecosystem approach has been incorporated in other U.S. statutes including the Magnuson–Stevens Fishery Conservation and Management Act, and in international agreements such as the Convention for the Conservation of Antarctic Marine Living Resources. The MMPA includes a general moratorium on the taking and importing of marine mammals. The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. Jurisdiction for MMPA is shared by U.S. Fish and Wildlife Service and the National Marine Fisheries Service. The U.S. Fish and Wildlife Service's Branch of Permits is responsible for issuing take permits when exceptions are made to MMPA. Under the exception for incidental taking, the Fish and Wildlife Service or the National Marine Fisheries Service must find that the total taking over the five-year period will have a "negligible impact" and will not adversely affect the availability of the marine mammal species or stock for subsistence use by Alaskan natives.

The R-1 Upgrade improvements project does not involve the construction of improvements near the shoreline so would not affect marine mammals.

5.13 Migratory Bird Treaty Act (16 U.S.C. §§ 703 *et seq.*)

The Migratory Bird Treaty Act and EO 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds) provide for the protection of migratory birds. The Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-712) makes it unlawful to, among other things, pursue, hunt, take, capture, kill, transport or import any species listed under the Act. The Act implements conventions between the U.S., Great Britain, Mexico, Japan, and the former Soviet Union.

EO 13186 was issued to assist federal agencies with their efforts to comply with the MBTA. It should be noted that the EO does not constitute any legal authorization that in any way supersedes the requirements outlined in the MBTA. The EO directs federal agencies undertaking actions that have or are likely to have a measurable adverse impact on migratory bird populations to develop and implement a Memorandum of Agreement with the USFWS addressing the conservation of these populations.

The principal potential impacts posed by the Project to endangered waterbirds are associated with construction activities creating disturbances of nesting birds during the year round nesting season within the small footprint of the proposed electrical and chemical buildings and a new underground waterline running parallel to the southern boundary fence, within the WWTP site. These activities, though of a short duration, could potentially disturb nearby nesting Hawai'ian Stilts and Hawai'i an Coots. Disturbance of this nature can result in birds abandoning their nest, eggs, and to a lesser degree, chicks.

As recommended in the biological report, to avoid impacts to the listed species, a sturdy silt fence or other suitable barrier system should be installed around the areas within the existing WWTP facility that will be excavated to install the subsurface constructed wetlands distribution and return lines along the southern and western fence lines to prevent ingress of listed waterbird species into the construction disturbances areas. Also, daily waterbird monitoring should continue until all work within the WWTP fenced facility is complete

Based on the findings and the avoidance measures, the County will informally consult with the FWS.

5.14 National Historic Preservation Act (U.S.C 54 §300101)

The National Historic Preservation Act (NHPA) of 1966 (Public Law 89-665; U.S.C. 54 §300101 requires a federal agency undertaking an action/project consider of the effect of the project on any historic property defined as a district, site, building, structure, or object that is included in or eligible for inclusion in the National Register Historic Places.

U.S.C. 54 §306108 (commonly called Section 106 of the NHPA), requires a federal agency having direct or indirect jurisdiction over a federal or federally assisted undertaking to take into account the effect of the undertaking to on any historic property. 54 U.S.C § 306102 requires the federal agency's preservation-related activities are carried out in consultation with other federal, State, and local agencies, Indian tribes, Native Hawaiian organizations.

An Archaeological Literature Review and Field Inspection for the project site was conducted for the property in April 2018. The project area lies within the southernmost extent of the Kekaha region, in which the uplands were used for residences and farming, and the coastal lands for residence, fishing, and aquaculture. The lands located between the coast and uplands settlements, in which the majority of the project area is situated, contained networks of trails along which shelter and water collection caves, quarries, and scattered agricultural sites were located. Historically, the area was used widely for ranching.

Background research indicated the presence of 119 previously identified archaeological sites/historic properties overlapping or within 330 feet of the bounds of the project area. Most of these are pre-Contact sites associated with agriculture, habitation, transportation, resource procurement, ceremony, burial, artistic expression, and/or recreation. Historic era sites included trails (such as State Inventory of Historic Places [SIHP] #50-10-27-00002, Māmalahoa Trail), habitation areas, a cemetery, and ranching-related features like boundary walls.

The field inspection confirmed 30 of 119 previously identified archaeological sites and possibly relocated portions of eight previously identified sites; these 38 sites are within or immediately adjacent to the project area. In addition, archaeologists documented 16 newly identified archaeological features/feature complexes within or directly adjacent to the project area.

In general, efforts to minimize potential effects on historic properties will be made in the project design phase. Such efforts will include limiting ground disturbance within previously undisturbed areas as much as possible (e.g., propose installation of transmission lines within existing roadbeds or graded areas).

The contract drawings will state that, should archaeological sites such as walls, platforms, pavements or mounds, or remains such as artifacts, burials, concentrations of shell or charcoal be encountered during construction activities, work shall cease immediately and the find shall be protected from further damage. The contractor shall immediately contact the State Historic Preservation Division at 808.981.2979, who will assess the significance of the find and recommend an appropriate mitigation measure, if necessary.

5.15 Protection of Wetlands (Executive Order 11990l (1977), as amended by Executive Order 12608 (1997))

Executive Order 11990, Protection of Wetlands, dated 1977 requires federal agencies to avoid, preserve, or mitigate effects of new construction projects on lands which have been designated wetlands. EO 11990 states in order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative, it is hereby ordered as follows: Section 1. (a) Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of Federal lands and facilities; and (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.

In March 2018, a biological resources field survey was conducted of the R-1 Upgrade improvements project sites, including the existing Kealakehe WWTP, the buffer parcel, the SAT site, and along the various transmission line alignments. The biological resources field survey report stated no federal jurisdictional waters occur in the areas covered by the survey. The R-1 Upgrade project does not involve the construction of improvements near the shoreline or any other water bodies, streams or estuaries.

5.16 Rivers and Harbors Act (33 U.S.C. § 403)

Originally enacted on March 3, 1899, the "Rivers and Harbors Appropriation Act of 1899" affects navigable waters of the U.S. The Act states the creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is prohibited; and it shall not be lawful to build or commence the building of any wharf, pier, dolphin,

boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of the Army; and it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor or refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army prior to beginning the same.

The nearest shoreline is located about 3,500 feet west of the existing Kealakehe WWTP and, as such, coastal ecosystems would not be adversely affected. Based on this, the R-1 Upgrade improvements will not affect navigable waters of the U.S.

5.17 Safe Drinking Water Act (42 U.S.C. §300f)

The Safe Drinking Water Act (SDWA), 42 U.S.C. §300f was established to protect the quality of all waters actually or potentially designed for drinking use from both underground and aboveground sources. The SDWA authorizes EPA to establish minimum standards to protect potable water with which all owners or operators of public water systems must comply; to oversee the agencies which can be approved to implement these rules on EPA's behalf, such as State governments; and to encourage attainment of secondary standards (nuisance-related). The SDWA also establishes the Sole Source Aquifer Program, under which EPA also may evaluate Federal-funded projects to determine whether they have the potential to contaminate a sole source aquifer.

The Safe Drinking Water Act (SDWA) 42 U.S.C. §300f was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources, rivers, lakes, reservoirs, springs, and ground water wells. (SDWA does not regulate private wells which serve fewer than 25 individuals.) SDWA authorizes the Environmental Protection Agency (EPA) to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water. The EPA, states, and water systems then work together to make sure that these standards are met. T

Section 1424(e) of the Safe Drinking Water Act of 1974 (Public Law 93-523, 42 U.S.C. 300 et. seq), also established the Sole Source Aquifer program which states that no commitment for federal financial assistance (through a grant, contract, loan guarantee, or otherwise) may be entered into for any project which the EPA Administrator determines may contaminate such aquifer through a recharge zone so as to create a significant hazard to public health.

The Underground Injection Control (UIC) program, administered by the State DOH's Safe Drinking Water Branch, was established to protect the quality of underground sources of drinking water from contamination by subsurface disposal of fluids. Chapter 340 E, HRS, and Title 11, Hawai'i Administrative Rules Department of Health Chapter 23, Underground Injection Control set forth the requirements related to protection of underground sources of drinking water. The DOH has also established maps that show the UIC line as the boundary between non-drinking water aquifers, generally located makai of, or below, the UIC line, and underground sources of drinking water, generally located mauka, or above, of the UIC Line.

The UIC line is generally located along the 500-foot MSL topographic contour line in the area of the Kealakehe WWTP. Further, the DOH maps indicate that the Kailua-Kona area, including

Kealakehe WWTP, is located below the UIC line. The Kealakehe WWTP is located at about 50 to 56 feet MLS and the SAT basins at approximately 60 to 70 feet MSL. Thus, these areas will be about 410 to 450 feet vertically and approximately 6,000 to 8,200 feet horizontally below the UIC line. Thus, the R-1 Upgrade improvements would not affect drinking water sources of the Kailua Kona community.

5.18 Wild and Scenic Rivers Act (16 U.S.C §1271-1287)

The Wild and Scenic Rivers Act, 16 U.S.C. 1271-1287, declares that certain selected rivers with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historical, cultural, or other similar values, shall be preserved in their free-flowing condition for the enjoyment of present and future generations.

The State of Hawai'i has no designated wild and scenic rivers. The Wild and Scenic Rivers Act is not applicable to this project.

6. RELATIONSHIP to PLANS, POLICIES, and CONTROLS

This section discusses the State and County of Hawai'i land use plans, policies and controls relating to the proposed project.

6.1 State Land Use Plans and Policies

6.1.1 Hawai'i State Plan

The Hawai'i State Plan, Chapter 226, HRS, as amended, provides goals, objectives, policies, and priorities for the State. The purpose of the Hawai'i State Plan is to set forth a plan that shall serve as a guide for the future long-range development of the State; identify the goals, objectives, policies, and priorities for the State; provide a basis for determining priorities and allocating limited resources, such as public funds, services, human resources, land, energy, water, and other resources; improve coordination of federal, state, and county plans, policies, programs, projects, and regulatory activities; and to establish a system for plan formulation and program coordination to provide for an integration of all major state, and county activities The proposed project's consistency with applicable objectives and policies are in Table 6.1.

Table 6.1 Hawai'i State Plan Objectives and Policies
PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES

Objectives and Policies of the Hawai'i State Plan	Discussion
§226-4 State goals. In order to ensure, for present and future generations, those elements of choice and mobility that ensure that individuals and groups may approach their desired levels of self-reliance and self-determination, it shall be the goal of the State to achieve: (1) A strong, viable economy, characterized by stability, diversity, and growth, that enables the fulfillment of the needs and expectations of Hawaii's present and future generations. (2) A desired physical environment, characterized by beauty, cleanliness, quiet, stable natural systems, and uniqueness, that enhances the mental and physical well-being of the people. (3) Physical, social, and economic well-being, for individuals and families in Hawai'i, that nourishes a sense of community responsibility, of caring, and of participation in community life.	The proposed project will support the State economy by providing a wastewater collection system and a treatment and disposal facility to enhance the community and the community's physical well-being. This will result in positive health and environmental benefits.
§226-5 Objective and policies for population. (a) It shall be the objective in planning for the State's population to guide population growth to be consistent with the achievement of physical, economic, and social objectives contained in this chapter.	The proposed project will provide R-1 quality water and reduce and improve effluent disposal for the existing Kealakehe WWTP. Hence, the proposed project does not include facilities or improvements that could guide or otherwise affect population growth in the Kona area
§226-6 Objectives and policies for the economy--in general. (a) Planning for the State's economy in general shall be directed toward achievement of the following objectives…	The proposed project will provide R-1 quality water and reduce and improve effluent disposal for the existing Kealakehe WWTP. Hence, it does not have a direct role in planning for the State's economy.

Objectives and Policies of the Hawai'i State Plan	Discussion
§226-7 Objectives and policies for the economy--agriculture. (a) Planning for the State's economy with regard to agriculture shall be directed towards achievement of the following objectives…	The proposed project would produce R-1 quality recycled water that can be used for a number of uses, including for agriculture, although no such use if foreseeable at this time.
§226-8 Objective and policies for the economy--visitor industry. (a) Planning for the State's economy with regard to the visitor industry shall be directed towards the achievement of the objective of a visitor industry that constitutes a major component of steady growth for Hawai'i's economy	The proposed project would produce R-1 quality recycled water that can be used for irrigating visitor-oriented golf courses and resort facility landscaping as well as for other approved uses of recycled water at visitor facilities in the Kona area.
§226-9 Objective and policies for the economy--federal expenditures. (a) Planning for the State's economy with regard to federal expenditures shall be directed towards achievement of the objective of a stable federal investment base as an integral component of Hawai'i's economy.	The proposed project may utilize federal funds through the State of Hawai'i DOH Clean Water State Revolving Fund (CWSRF) Program which uses federal funds from the US Environmental Protection Agency.
§226-10 Objective and policies for the economy--potential growth and innovative activities. (a) Planning for the State's economy with regard to potential growth and innovative activities shall be directed towards achievement of the objective of development and expansion of potential growth and innovative activities that serve to increase and diversify Hawai'i's economic base.	The proposed project is innovative in its production of R-1 quality recycled water and its reduction of effluent volume as well as improvement in the quality of the effluent to be disposed.
§226-10.5 Objectives and policies for the economy--information industry. (a) Planning for the State's economy with regard to telecommunications and information technology shall be directed toward recognizing that broadband and wireless communication capability and infrastructure are foundations for an innovative economy and positioning Hawai'i as a leader in broadband and wireless communications and applications in the Pacific Region.	The proposed project does not include facilities or improvements that would affect the information industry of the Kona area.
§226-11 Objectives and policies for the physical environment--land-based, shoreline, and marine resources with objectives: (1) Prudent use of Hawai'i's land-based, shoreline, and marine resources. (2) Effective protection of Hawai'i's unique and fragile environmental resources.	The proposed project includes facilities to produce R-1 quality recycled water, reduce effluent volume as well as improve the quality of the effluent to be disposed. Thus, the proposed project will help to protect the unique and fragile environmental resources of this area of the Kona coast.
§226-12 Objective and policies for the physical environment--scenic, natural beauty, and historic resources. (b) To achieve the scenic, natural beauty, and historic resources objective, it shall be the policy of this State to: (3) Promote the preservation of views and vistas to enhance the visual and aesthetic enjoyment of mountains, ocean, scenic landscapes, and other natural features.	The proposed project facilities would not affect the views and vistas of the Kona area. The Proposed project improvements would be similar to the existing facilities at the WWTP. The chemical addition building and the ultra violet (UV) facility would be about 12 to 14 high, or about the same height as the existing administration and operations buildings and the roof structure over the effluent pump station. The R-1 storage tanks would be about 30 feet above the surrounding grade. Thus, the Kealakehe WWTP R-1 Upgrade project would not affect coastal views.

Objectives and Policies of the Hawai'i State Plan	Discussion
§226-13 Objectives and policies for the physical environment--land, air, and water quality. (b) To achieve the land, air, and water quality objectives, it shall be the policy of this State to: (2) Promote the proper management of Hawai'i's land and water resources. (3) Promote effective measures to achieve desired quality in Hawai'i's surface, ground, and coastal waters.	The proposed project facilities would produce R-1 quality recycled water which could be used for variety of uses including irrigation of playing fields thereby preserving potable water resources for other uses in the Kona area. The project will also reduce the release the level of nutrient disposal to the environment thereby improving water quality.
§226-14 Objective and policies for facility systems--in general. (b) To achieve the general facility systems objective, it shall be the policy of this State to: (1) Accommodate the needs of Hawai'i's people through coordination of facility systems and capital improvement priorities in consonance with state and county plans. (2) Encourage flexibility in the design and development of facility systems to promote prudent use of resources and accommodate changing public demands and priorities. (3) Ensure that required facility systems can be supported within resource capacities and at reasonable cost to the user.	The proposed project construction plans would be coordinated between the County and DOH to ensure the facility meets the DOH requirements. Further, the R-1 upgrades will be designed to ensure the County can support the systems.
§226-15 Objectives and policies for facility systems--solid and liquid wastes. (b) To achieve solid and liquid waste objectives, it shall be the policy of this State to: (1) Encourage the adequate development of sewerage facilities that complement planned growth. (2) Promote re-use and recycling to reduce solid and liquid wastes and employ a conservation ethic. (3) Promote research to develop more efficient and economical treatment and disposal of solid and liquid wastes.	The proposed project will provide facilities to produce R-1 quality recycled water which would be consistent with the re-use of liquid wastes. Further, the R-1 facilities upgrade will support the Kealakehe WWTP in accommodating the planned growth of the Kailua-Kona area.
§226-16 Objective and policies for facility systems--water. (a) Planning for the State's facility systems with regard to water shall be directed towards achievement of the objective of the provision of water to adequately accommodate domestic, agricultural, commercial, industrial, recreational, and other needs within resource capacities.	The proposed project facilities would produce R-1 quality recycled water which could be used for variety of uses including irrigation for landscape and agricultural purposes, domestic and industrial cooling systems, cleaning, and firefighting, thereby preserving potable water resources of the Kona area.
§226-17 Objectives and policies for facility systems--transportation. (a) Planning for the State's facility systems with regard to transportation shall be directed towards the achievement of the following objectives:	The proposed project does not include facilities or improvements which would affect the transportation systems of the Kona area.
§226-18 Objectives and policies for facility systems--energy. (a) Planning for the State's facility systems with regard to energy shall be directed toward the achievement of the following objectives, giving due consideration to all:	The proposed project does not include facilities or improvements which would affect the energy systems of the Kona area.
§226-18.5 Objectives and policies for facility systems--telecommunications. (a) Planning for the State's telecommunications facility systems shall be directed towards the achievement of dependable, efficient, and economical statewide telecommunications systems capable of supporting the needs of the people.	The proposed project does not include facilities or improvements which would affect telecommunication systems of the Kona area.

Objectives and Policies of the Hawai'i State Plan	Discussion
§226-19 Objectives and policies for socio-cultural advancement--housing. (a) Planning for the State's socio-cultural advancement with regard to housing shall be directed toward the achievement of the following objectives:	The proposed project does not include facilities or improvements which would affect housing of the Kona area.
§226-20 Objectives and policies for socio-cultural advancement--health. (a) Planning for the State's socio-cultural advancement with regard to health shall be directed towards achievement of the following objectives:	The proposed project does not include facilities or improvements which would affect the health of the Kona area.
§226-21 Objective and policies for socio-cultural advancement--education. (a) Planning for the State's socio-cultural advancement with regard to education shall be directed towards achievement of the objective of the provision of a variety of educational opportunities to enable individuals to fulfill their needs, responsibilities, and aspirations	The proposed project does not include facilities or improvements which would affect education of the Kona area.
§226-22 Objective and policies for socio-cultural advancement--social services. (a) Planning for the State's socio-cultural advancement with regard to social services shall be directed towards the achievement of the objective of improved public and private social services and activities that enable individuals, families, and groups to become more self-reliant and confident to improve their well-being.	The proposed project does not include facilities or improvements which would affect social services of the Kona area.
§226-23 Objective and policies for socio-cultural advancement--leisure. (a) Planning for the State's socio-cultural advancement with regard to leisure shall be directed towards the achievement of the objective of the adequate provision of resources to accommodate diverse cultural, artistic, and recreational needs for present and future generations.	The proposed project does not include facilities or improvements which would affect the leisure activities of the Kona area.
§226-24 Objective and policies for socio-cultural advancement--individual rights and personal well-being. (a) Planning for the State's socio-cultural advancement with regard to individual rights and personal well-being shall be directed towards achievement of the objective of increased opportunities and protection of individual rights to enable individuals to fulfill their socio-economic needs and aspirations.	The proposed project does not include facilities or improvements which would affect individual rights and personal well-being within the Kona area.
§226-25 Objective and policies for socio-cultural advancement--culture. (a) Planning for the State's socio-cultural advancement with regard to culture shall be directed toward the achievement of the objective of enhancement of cultural identities, traditions, values, customs, and arts of Hawai'i's people.	The proposed project does not include facilities or improvements which would affect the cultural advancement of the Kona area.
§226-26 Objectives and policies for socio-cultural advancement--public safety. (a) Planning for the State's socio-cultural advancement with regard to public safety shall be directed towards the achievement of the following objectives:	The proposed project does not include facilities or improvements which would affect public safety of the Kona area

Objectives and Policies of the Hawai'i State Plan	Discussion
§226-27 Objectives and policies for socio-cultural advancement--government. (a) Planning the State's socio-cultural advancement with regard to government shall be directed towards the achievement of the following objectives:	The proposed project does not include facilities or improvements which would affect the advancement of government of the Kona area.
§226-4 State goals. In order to ensure, for present and future generations, those elements of choice and mobility that ensure that individuals and groups may approach their desired levels of self-reliance and self-determination, it shall be the goal of the State to achieve: (1) A strong, viable economy, characterized by stability, diversity, and growth, that enables the fulfillment of the needs and expectations of Hawaii's present and future generations.	By providing R-1 water to the local community, the Kealakehe WWTP will strengthen the economic, physical, and social well-being of the State of Hawai'i by providing a source of water for non-potable uses which will preserve potable water sources for appropriate uses.

PART II. PLANNING COORDINATION and IMPLEMENTATION

Part II does not apply to the Kealakehe WWTP R-1 Upgrade project.

PART III. PRIORITY GUIDELINES

Objectives and Policies of the Hawai'i State Plan	Discussion
§226-103 Economic priority guidelines. (a) Priority guidelines to stimulate economic growth and encourage business expansion and development to provide needed jobs for Hawaii's people and achieve a stable and diversified economy. (e) Priority guidelines for water use and development: (1) Maintain and improve water conservation programs to reduce the overall water consumption rate. (2) Encourage the improvement of irrigation technology and promote the use of nonpotable water for agricultural and landscaping purposes.	The proposed project facilities would produce R-1 quality recycled water which could be used for variety of nonpotable uses including irrigation for landscape and agricultural purposes, domestic and industrial cooling systems, cleaning, and firefighting, thereby preserving potable water resources of the Kona area. The use of nonpotatble water for various uses will conserve potable water for needed uses.
§226-104 Population growth and land resources priority guidelines. (a) Priority guidelines to effect desired statewide growth and distribution:	The proposed project facilities would not affect population growth.
§226-105 Crime and criminal justice. Priority guidelines in the area of crime and criminal justice:	The proposed project facilities would not affect crime or criminal justice in the Kona area.
§226-106 Affordable housing. Priority guidelines for the provision of affordable housing:	The proposed project facilities would not affect affordable housing in the Kona area.
226-107 Quality education. Priority guidelines to promote quality education **:**	The proposed project facilities would not affect education in the Kona area.
[**§226-108] Sustainability**. Priority guidelines and principles to promote sustainability include: (5) Promoting decisions based on meeting the needs of the present without compromising the needs of future generations.	The proposed project facilities would provide nonpotable water for various uses which would preserve potable water sources for future generations.

Objectives and Policies of the Hawai'i State Plan	Discussion
[§226-109] Climate change adaptation priority guidelines. Priority guidelines to prepare the State to address the impacts of climate change, including impacts to the areas of agriculture; conservation lands; coastal and nearshore marine areas; natural and cultural resources; education; energy; higher education; health; historic preservation; water resources; the built environment, such as housing, recreation, transportation; and the economy.	The proposed project facilities are located at elevations around 30 to 40 mean sea level (MSL) and the SAT site at approximately 60 to 70 feet MSL such that these facilities would not be affected by climate change.

6.1.2 State Functional Plans

The Hawai'i State Plan directs appropriate State agencies to prepare Functional Plans to address Statewide needs, problems, and issues through recommended policies and actions. Fourteen Functional Plans were prepared to implement the State Plan provisions in the areas of agriculture, transportation, conservation lands, education, tourism, water resources, energy, recreation, historic preservation, health, housing, higher education, employment, and human services. The following presents a review of the Functional Plans which are applicable to the proposed project.

Agriculture Functional Plan

Objective I: Achievement of efficient and equitable provision of adequate water for agricultural use

> *Policy I(2): Expand agricultural water resources statewide*
>
> > *Action I(1)(a): Develop new, expanded, or improved water sources and delivery systems in support of agriculture and aquaculture, as needed and economically feasible. [AGR 141, LNR 404]*
> >
> > *Action I(1)(b): Monitor, evaluate, and increase efforts to use non-potable water for agricultural irrigation. [HTH 849]*

Discussion: The proposed project will produce R-1 recycled water to be used for irrigation purposes including agriculture and landscaping, thereby reducing the use of potable water resources.

Historic Preservation Functional Plan

Objective B: Protection of Historic Properties

> *Policy B.2. Establish and make available a variety of mechanisms to better protect historic properties.*

Objective C: Management and Treatment of Historic Properties

> *Policy C.3. Explore innovative means to better manage historic properties.*
>
> *Policy C.4. Encourage proper preservation techniques.*

Discussion: In April 2018, an Archaeological Literature Review and Field Inspection was conducted of the project area which lies within the southernmost extent of the Kekaha region. The uplands of the region were used for residences and farming, and the coastal lands for residence, fishing, and aquaculture. The lands located between the coast and uplands settlements, in which the majority of the project area is situated, contained networks of trails along which shelter and water collection caves, quarries, and scattered agricultural sites were located. Historically, the area was used widely for ranching.

Background research indicated the presence of 119 previously identified archaeological sites/historic properties overlapping or within 330 feet of the bounds of the project area. Most of these are pre-Contact sites associated with agriculture, habitation, transportation, resource procurement, ceremony, burial, artistic expression, and/or recreation. Historic era sites included trails (such as State Inventory of Historic Places [SIHP] #50-10-27-00002, Māmalahoa Trail), habitation areas, a cemetery, and ranching-related features like boundary walls.

The field inspection confirmed 30 of 119 previously identified archaeological sites and possibly relocated portions of eight previously identified sites; these 38 sites are within or immediately adjacent to the project area. In addition, archaeologists documented 16 newly identified archaeological features/feature complexes within or directly adjacent to the project area.

In general, efforts to minimize potential effects on historic properties will be made in the project design phase. Such efforts will include limiting ground disturbance within previously undisturbed areas as much as possible (e.g., propose installation of transmission lines within existing roadbeds or graded areas). Some portions of the project area are of potentially higher sensitivity given their known archaeological content:

- A section of the Māmalahoa Trail (SIHP # 50-10-27-00002) runs parallel to Queen Ka'ahumanu Highway within the Mauka Section in the vicinity of the proposed soil aquifer treatment (SAT) facility. A portion of this historic property within the project area has existing mitigations in place associated with the recently completed Queen Ka'ahumanu Highway Widening Phase 2 project. Impact to the Māmalahoa Trail will be avoided if possible by routing pipelines or other infrastructure through existing breaches along the trail.

- The portion of the Mauka Section relating to the future elevated storage tank has not been subjected to recent archaeological survey, and was found during the field inspection to contain several previously unrecorded archaeological features and lava tube openings. Lava tubes in this area commonly contain cultural modifications and/or deposits including but not limited to human burials.

- The section of the Initial Phase R-1 Transmission Line approaching the Old Kona Airport Park (Kailua Park) within the Makai Section is in direct proximity to several extensive previously identified site complexes. While many of these features are likely located a safe distance from the current project area, some are directly adjacent and could potentially by impacted. Difficulties in correlating present findings with the previously recorded sites—and the discovery of previously unrecorded features—highlight potential concerns with the existing body of archaeological coverage in this area.

Should any significant pre-Contact or historic deposits (i.e. subsurface concentrations of indigenous or historic era artifacts and/or structural remnants) or human burials be encountered during the course of development of the project site, the subsurface excavation work and/or surface grading will be halted in the immediate area and the SHPD will be notified immediately.

6.1.3 State Land Use District

The State Land Use Law, Chapter 205, HRS, is intended to preserve, protect and encourage the development of lands in the State for uses that are best suited to the public health and welfare of Hawai'i's people. Under Chapter 205, HRS all lands in the State of Hawai'i are classified by the State Land Use Commission (LUC) into four major categories referred to as State Land Use Districts. These districts are identified as the Urban District, Agricultural District, Conservation District, and Rural District.

The LUC's Land Use District Boundary map for the Island of Hawai'i shows the Kealakehe WWTP R-1 Upgrade project to be located in three districts: Urban, Conservation and Agricultural (see Figure 6-1). The R-1 improvements located within Kealakehe WWTP; the SAT site, and the future R-1 storage tank and related transmission line are located in the Urban District. Chapter 205, HRS, states*, "Urban Districts shall include activities or uses as provided by the ordinances or regulations of the county within which the urban district is situated*." These improvements are permitted uses in the Urban District and will be subject to the County of Hawai'i Zoning as discussed in Section 6.2.3.

The transmission line to Kailua Park is located in the Conservation and Agricultural Districts. Uses in the Conservation District are set forth in Hawai'i Administrative Rules, Title 13, Department off Land and Natural Resources, Subtitle 1 Administration, Chapter 5, Conservation District. The transmission line would be a public use defined as "*Public purpose use means not for profit land uses undertaken in support of a public service by an agency of the county, state, or federal government, or by an independent non-governmental entity, except that an independent non-governmental regulated public utility may be considered to be engaged in a public purpose use. Examples of public purpose uses may include but are not limited to public roads, marinas, harbors, airports, trails, water systems and other utilities, communication systems, flood or erosion control projects, recreational facilities, community centers, and other public purpose uses, intended to benefit the public in accordance with public policy and the purpose of the conservation district*." Since the transmission line would be new public use, a Departmental Permit issued by the Office of Coastal and Conservation Lands (OCCL) would be required. The project site's relationship to the conservation district and its subzones is shown in Figure 6-2.

P-9 STRUCTURES, ACCESSORY
(B-1) Construction or placement of structures accessory to existing facilities or uses.

Permissible uses in the Agricultural District are set forth in Chapter 205, HRS, §205-4.5 (7) "*Public, private, and quasi-public utility lines and roadways, transformer stations, communications equipment buildings, solid waste transfer stations, major water storage tanks, and appurtenant small buildings such as booster pumping stations, but not including offices or yards for equipment, material, vehicle storage, repair or maintenance, or treatment plants, or corporation yards, or other like structures"*. The R-1 transmission line would be considered a public utility line.

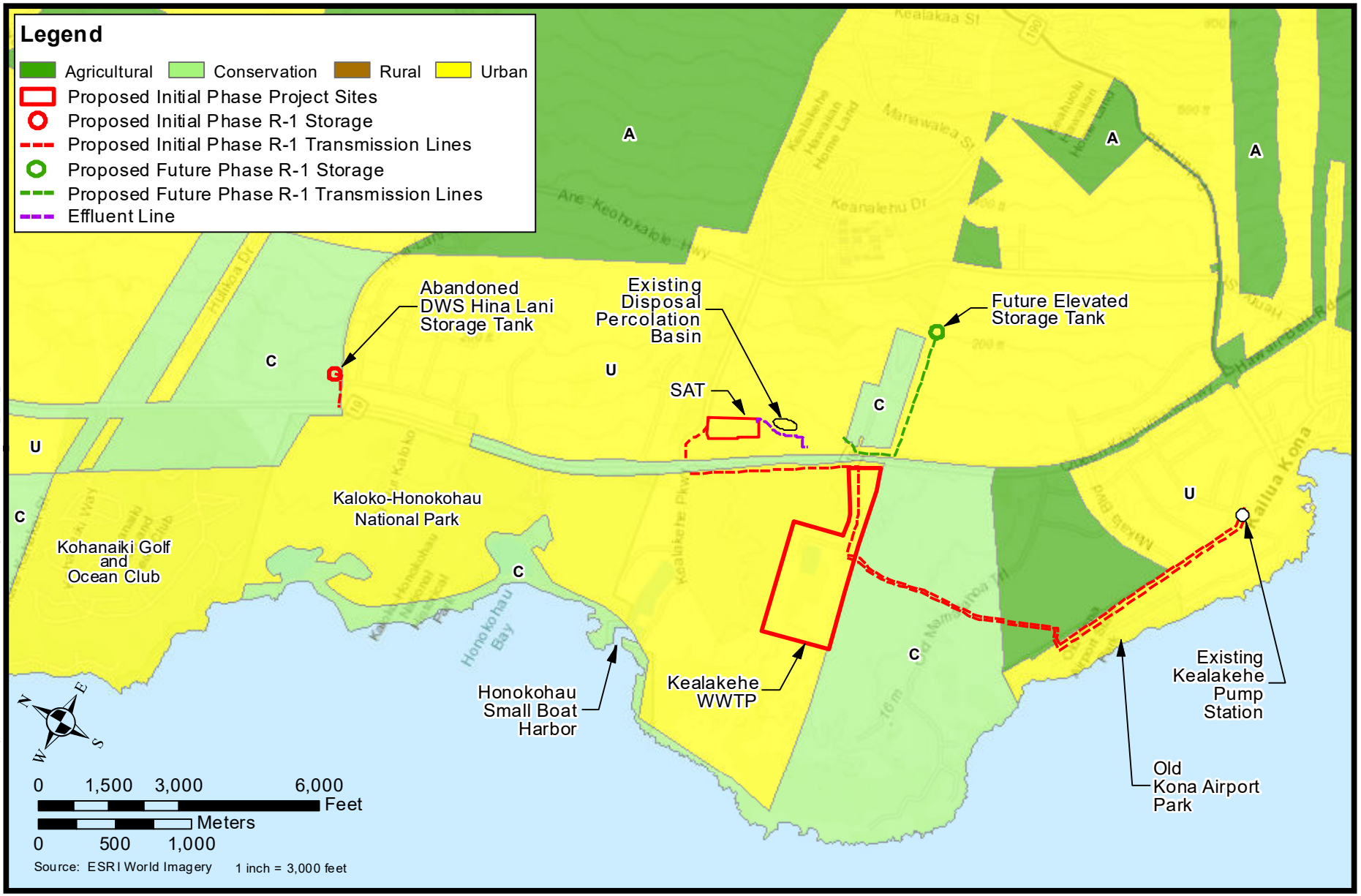

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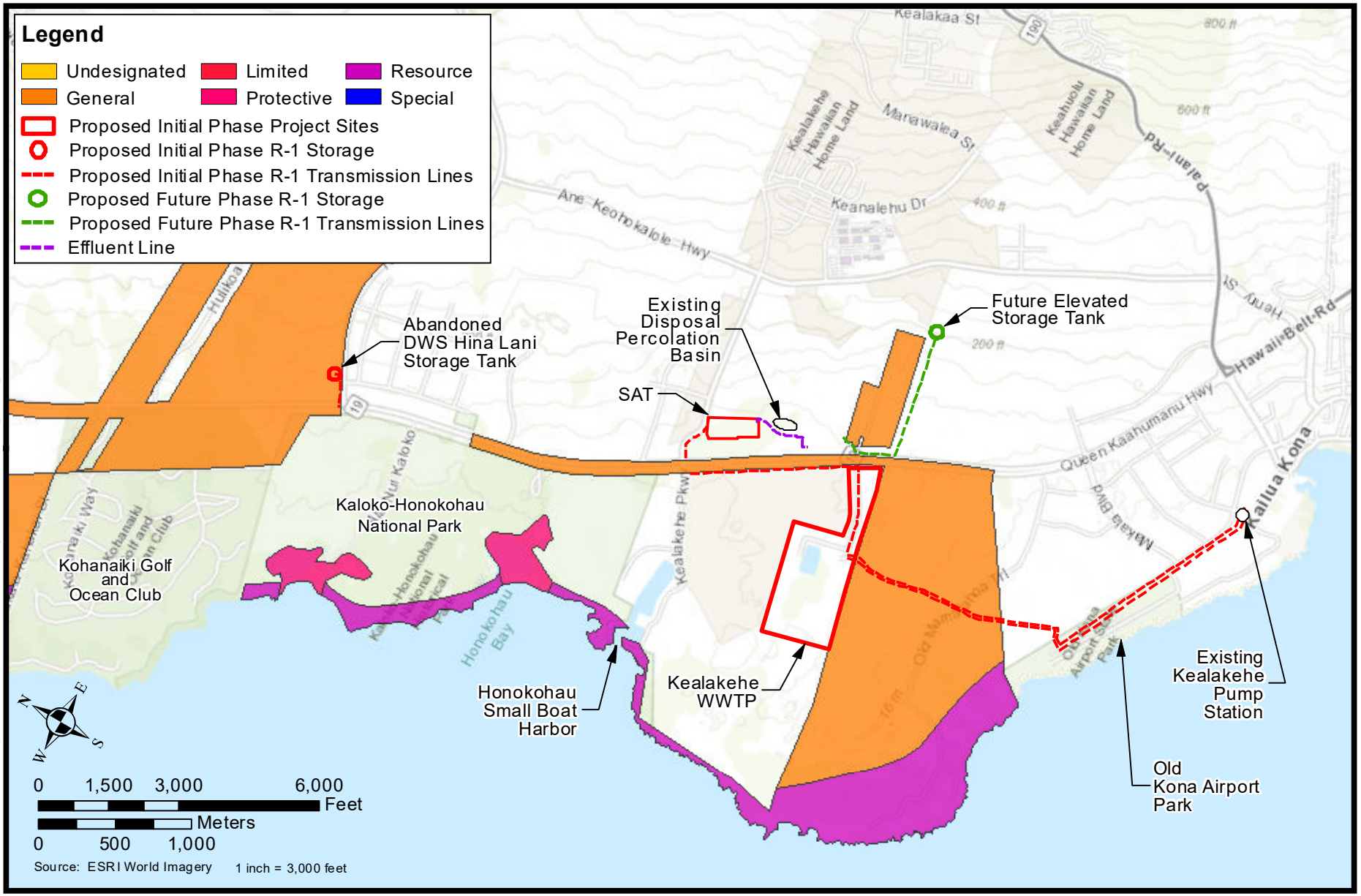
FIGURE 6-1

STATE LAND USE DISTRICTS MAP

Kealakehe WWTP R-1 Upgrade



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WILSON OKAMOTO CORPORATION

FIGURE 6-2

CONSERVATION DISTRICT SUBZONES MAP

Kealakehe WWTP R-1 Upgrade

6.1.4 Chapter 344, State Environmental Policy

The State's Environmental Police is contained in Chapter 344, HRS. The purpose of the Chapter 344, HRS, State Environmental Policy is to *"establish a state policy which will encourage productive and enjoyable harmony between people and their environment, promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, and enrich the understanding of the ecological systems and natural resources important to the people of Hawai'i."*

§344-3 Environmental policy provides: *It shall be the policy of the State, through its programs, authorities, and resources to:*

(1) Conserve the natural resources, so that land, water, mineral, visual, air and other natural resources are protected by controlling pollution, by preserving or augmenting natural resources, and by safeguarding the State's unique natural environmental characteristics in a manner which will foster and promote the general welfare, create and maintain conditions under which humanity and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of the people of Hawai'i.

(2) Enhance the quality of life by:
(D) Establishing a commitment on the part of each person to protect and enhance Hawai'i's environment and reduce the drain on nonrenewable resources.

§344-4 Guidelines states. *In pursuance of the state policy to conserve the natural resources and enhance the quality of life, all agencies, in the development of programs, shall, insofar as practicable, consider the following guidelines:*

(2) Land, water, mineral, visual, air, and other natural resources.
(A) Encourage management practices which conserve and fully utilize all natural resources;
(B) Promote irrigation and waste water management practices which conserve and fully utilize vital water resources;
(C) Promote the recycling of waste water;

Discussion: As previously discussed, among the objectives of the Proposed project is to implement water recycling within the service area to decrease the amount of potable water currently being used for irrigation (and other non-potable uses) and to reduce the quantity of WWTP effluent requiring disposal. The Proposed project will provide R-1 quality recycled water which can be used for a variety purposes that currently rely on sources of potable water, including for irrigation of golf courses, playing fields, cooling for industrial and domestic purposes and firefighting. Using recycled water in lieu of potable water would conserve that vital resource and would be consistent with the policies and guidelines of Chapter 344, HRS.

Further, another objective of the Proposed project is to replace the existing percolation basin disposal system with a land application system. This would be consistent with the State's objective of safeguarding the unique natural environmental characteristics of this area of Kona.

6.1.5 Hawai'i Coastal Zone Management Program

The Coastal Zone Management (CZM) Program was created through passage of the Coastal Zone Management Act of 1972. Hawai'i's CZM Program, adopted as Chapter 205A, HRS, provides a basis for protecting, restoring and responsibly developing coastal communities and resources. The Hawai'i CZM area includes all lands within the State and the areas seaward to the extent of the State's management jurisdiction. Thus, the Proposed project is located in the

CZM area. A discussion of the project's consistency with the objectives and policies of the CZM Program is provided below.

(1) Recreational Resources

Objective:
Provide coastal recreational opportunities accessible to the public.

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

The nearest public shoreline access is located about 3,500 feet west of the existing WWTP on lands controlled by the State of Hawai'i Department of Land and Natural Resources (DLNR). The Proposed project would not affect this shoreline area. Thus, the existing public access would be maintained.

During construction of the various improvements, storm water runoff could carry increased amounts of sediment into the shoreline area from soils exposed during excavation and grading activities. This runoff could potentially impact the water quality of coastal waters in the area. However, excavation and grading activities associated with the construction of the proposed project will be regulated by the County's grading ordinance. In addition, for those improvements anticipating an area of soil disturbance greater than 1-acre, an NPDES Individual Permit for Storm Water Associated with Construction Activity, administered by the State DOH, will be required to control storm water discharges. Mitigation measures will be instituted in accordance with site-specific assessments, incorporating appropriate structural and/or non-structural BMPs such as

implementing erosion control measures such as silt fences and sediment basins, minimizing time of exposure between construction and landscaping improvements.

(2) Historic Resources

Objective:

(A) 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:

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

An Archaeological Literature Review and Field Inspection for the project site was conducted for the property in April 2018. The project area lies within the southernmost extent of the Kekaha region, in which the uplands were used for residences and farming, and the coastal lands for residence, fishing, and aquaculture. The lands located between the coast and uplands settlements, in which the majority of the project area is situated, contained networks of trails along which shelter and water collection caves, quarries, and scattered agricultural sites were located. Historically, the area was used widely for ranching.

Background research indicated the presence of 119 previously identified archaeological sites/historic properties overlapping or within 330 feet of the bounds of the project area. Most of these are pre-Contact sites associated with agriculture, habitation, transportation, resource procurement, ceremony, burial, artistic expression, and/or recreation. Historic era sites included trails (such as State Inventory of Historic Places [SIHP] #50-10-27-00002, Māmalahoa Trail), habitation areas, a cemetery, and ranching-related features like boundary walls.

The field inspection confirmed 30 of 119 previously identified archaeological sites and possibly relocated portions of eight previously identified sites; these 38 sites are within or immediately adjacent to the project area. In addition, archaeologists documented 16 newly identified archaeological features/feature complexes within or directly adjacent to the project area.

In general, efforts to minimize potential effects on historic properties will be made in the project design phase. Such efforts will include limiting ground disturbance within previously undisturbed areas as much as possible (e.g., propose installation of transmission lines within existing roadbeds or graded areas). Should any significant pre-Contact or historic deposits (i.e. subsurface concentrations of indigenous or historic era artifacts and/or structural remnants) or human burials be encountered during the course of development of the project site, the subsurface excavation work and/or surface grading will be halted in the immediate area and the SHPD will be notified immediately.

(3) Scenic and Open Space Resources

Objective:

(A) Protect, preserve, and where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies:

(A) Identify valued scenic resources in the coastal zone management area;

(B) Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;

(C) Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and

(D) Encourage those developments which are not coastal dependent to locate in inland areas.

The Proposed project improvements would be similar to the existing facilities at the WWTP. The chemical addition building and the ultra violet (UV) facility would be about 12 to 14 high, or about the same height as the existing administration and operations buildings and the roof structure over the effluent pump station. The R-1 storage tank would be about 30 feet above the surrounding grade. There is an existing about 14-foot high berm located along the eastern boundary of the WWTP which would act the screen the project improvements when viewed from Queen Kaahumanu Highway. Thus, the Kealakehe WWTP R-1 Upgrade project would not affect coastal views.

The nearest public shoreline access is located about 3,500 feet west of the existing WWTP on lands controlled by the State of Hawai'i Department of Land and Natural Resources (DLNR) and, as such, coastal scenic and open space resources would not be affected.

(4) Coastal Ecosystems

Objective:

(A) Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.

Policies:

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

(B) Improve the technical basis for natural resource management;

(C) Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;

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

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

During construction of the various improvements, storm water runoff may carry increased amounts of sediment into the storm drain system due to erosion from soils exposed during excavation and grading activities. This runoff could potentially impact the water quality of coastal waters in the area. However, excavation and grading activities associated with the construction of the proposed project will be regulated by the County's grading ordinance. In addition, for those improvements anticipating an area of soil disturbance greater than one acre, an NPDES Individual Permit for Storm Water Associated with Construction Activity, administered by the State DOH, will be required to control storm water discharges. Mitigation measures will be instituted in accordance with site-specific assessments, incorporating appropriate structural and/or non-

structural BMPs such implementing erosion control measures such as silt fences and sediment basins and minimizing time of exposure between construction and landscaping improvements. These measures will protect the coastal ecosystems of the area.

The nearest public shoreline access is located about 3,500 feet west of the existing WWTP on lands controlled by the State of Hawai'i Department of Land and Natural Resources (DLNR) and, as such, coastal ecosystems would not be adversely affected.

(5) Economic Uses

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

Policies:
(A) Concentrate coastal dependent development in appropriate areas;
(B) Ensure that coastal dependent developments such as harbors and ports, and coastal related development such as visitor facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and
(C) Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:

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

The R-1 Upgrade improvements will be located about 3,500 feet from the shoreline. The improvements are sited within the existing Kealakehe WWTP which has been operating since the early 1990s and provides a suitable location to serve the Kailua Kona community.

(6) Coastal Hazards

Objectives:
(A) Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.

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

According to the Flood Insurance Rate Map (FIRM) (Community Panel No. 1551660692C (effective date: September 16, 1988) prepared by the Federal Emergency Management Agency (FEMA)), the project site is located within Zone "X", defined as "Areas determined to be outside the 0.2% annual chance floodplain."

The project site is located outside of the tsunami inundation zone. Construction and operation of the proposed project are not anticipated to increase flood risks or cause any adverse flood-related impacts at the project site or lower elevation properties.

The entire island of Hawai'i is designated Seismic Zone 4, the highest rating among the major Hawaiian Islands. The proposed improvements will be designed and built to Seismic Zone 4 standards of the International Building Code (IBC) to ensure that potential seismic activities do not adversely affect the project buildings.

(7) Managing Development

Objective:

(A) Improve the development review process, communication, and public participation in the management of coastal resource and hazards.

Policies:

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

(B) Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and

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

The Hawai'i State environmental review process, as set forth Chapter 343, HRS, and Hawai'i Administrative Rules Title 11, State of Hawai'i Department of Health, Chapter 200, Environmental Impact Statement Rules requires project review by government agencies and affords the public and organizations the opportunity to provide comments on the proposed project. The proposed improvements are also subject to the Special Management Area (SMA) permit process as discussed in Section 6.2.5. Applicable State and County requirement will be adhered to in the design and construction phases of the proposed improvements.

In addition, the KWWTP project has been the subject of a series of workshops (September 2016), focus group interviews (February 2017) and the EIS scoping meeting (April 2017).

(8) Public Participation

Objective:

(A) Stimulate public awareness, education, and participation in coastal management.

Policies:

(A) Promote public involvement in coastal zone management processes;

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

(C) Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.

The Hawai'i State environmental review process, as set forth Chapter 343, HRS, and Hawai'i Administrative Rules Title 11, State of Hawai'i Department of Health, Chapter 200, Environmental Impact Statement Rules requires project review by government agencies and affords the public

and organizations the opportunity to provide comments on the proposed project. The proposed improvements are also subject to the Special Management Area (SMA) permit process as discussed in Section 6.2.5. Applicable State and County requirement will be adhered to in the design and construction phases of the proposed improvements.

In addition, the Proposed project has been the subject of a series of workshops (September 2016), focus group interviews (February 2017) and the EIS scoping meeting (April 2017).

(9) Beach Protection

Objective:
(A) Protect beaches for public use and recreation.

Policies:
(A) Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;
(B) Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and
(C) Minimize the construction of public erosion-protection structures seaward of the shoreline.

The R-1 Upgrade improvements project does not involve the construction of improvements in the shoreline setback nor require any shoreline erosion-protection structures.

(10) Marine Resources

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

Policies:
(D) Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;
(E) Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;
(F) 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;
(G) Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and
(H) Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

The Kealakehe WWTP R-1 Upgrade improvements do not involve construction or development within coastal waters. Thus, the improvements are not anticipated to have any direct impacts on marine and coastal resources. Potential water quality impacts to nearshore coastal waters during

construction of the improvements will be mitigated by adherence to State water quality regulations governing grading, excavation and stockpiling. In addition, since the improvements anticipating an area of soil disturbance greater than 1.0 acre, an NPDES Individual Permit for Storm Water Associated with Construction Activity, administered by the State DOH, will be required to control storm water discharges. Mitigation measures will be instituted in accordance with site-specific assessments, incorporating appropriate structural and/or non-structural BMPs such as implementing erosion control measures such as silt fences and sediment basins and minimizing time of exposure between construction and landscaping.

6.2 Hawai'i County Land Use Plans and Policies

6.2.1 Hawai'i County General Plan

Hawai'i County last updated its General Plan in February of 2005. This plan serves as a policy document outlining long range comprehensive development on the island of Hawai'i, providing broad goals, objectives, policies, and implementing actions that portray the desired direction of the County's future. Purposes of the General Plan include:

(A) Guide the pattern of future development in this County based on long-term goals;
(B) Identify the visions, values and priorities important to the people of this County; and
(C) Effect political and technical coordination in community improvement and development.

In addition to the goals and policies outlined in the General Plan, the Land Use Pattern Allocation Guide (LUPAG) Map, which is included in the plan, identifies areas where development should occur. Figure 6-3 shows the General Plan LUPAG) Map. The LUPAG designates the majority of the Kealakehe WWTP and planted buffer as "Open Area." The project sites for the soil aquifer treatment (SAT) system and storage tank are designated "Urban Expansion". The project site for the gravity line is designated both "Open Area" and "Urban Expansion". However, as the area has been previously developed, the State Land Use District and County zoning designations supersede the LUPAG designation.

The proposed project is consistent with the following applicable goals, objectives, policies, and actions of the *Hawai'i County General Plan*:

Sewer

Goals:

Create a better sewer disposal system than individual cesspools, particularly in highly urbanized and shoreline areas.

Policies:

(e) Plans for wastewater reclamation and reuse for irrigation and biosolids composting (remaining solids from the treatment of wastewater is processed into a reusable organic material) shall be utilized where feasible and needed.

Discussion: The proposed project will provide a facility to treat sewage from the Kailua-Kona area. The R-1 Upgrade improvements will be designed to accommodate flows from current and future uses in the area. This will allow future users to use the Kealakehe WWTP instead of individual cesspools or other means to dispose their sewage.

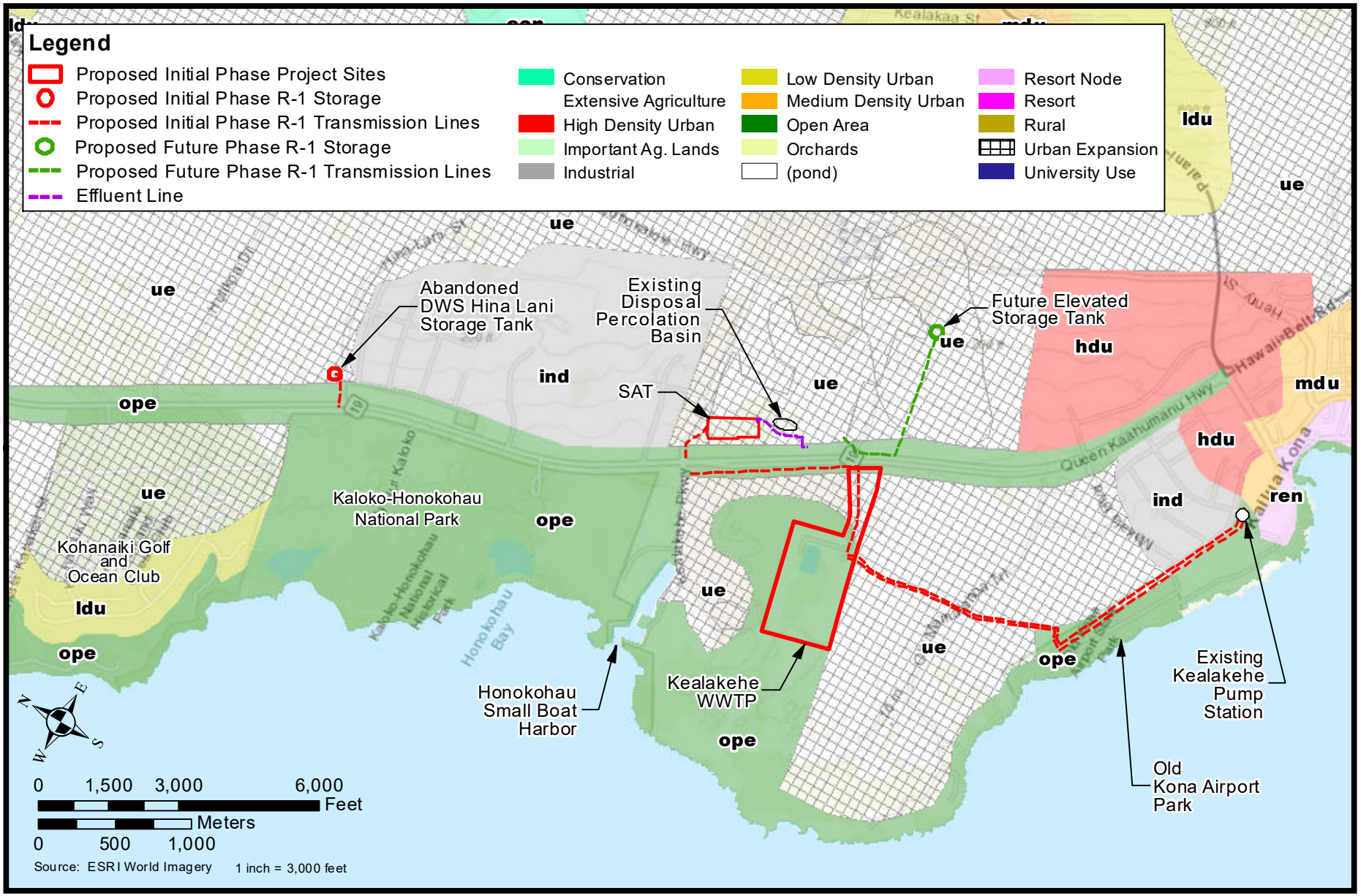

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FIGURE 6-3

LAND USE PLAN ALLOCATION GUIDE MAP

Kealakehe WWTP R-1 Upgrade

In addition, by producing R-1 quality recycled water, the proposed project will decrease the amount of potable water currently being used for irrigation and other non-potable uses. By replacing the existing percolation disposal basin with a soil aquifer treatment (SAT) system, the effluent that is not recycled will have a reduced nutrient load for disposal. This will reduce the quantity and improve the quality of effluent entering the groundwater and eventually, coastal waters.

6.2.2 Kona Community Development Plan

The County of Hawai'i General Plan calls for the preparation of community development plans (CDPs) "to translate the broad General Plan statement to specific actions as they apply to specific geographical areas." The Kona CDP is one of nine CDPs for Hawai'i County. The purpose of the Kona CDP is to:

- Articulate Kona's residents' vision for the planning area;
- Guide regional development in accordance with that vision, accommodating future growth while preserving valued assets;
- Provide a feasible infrastructure financing plan to improve existing deficiencies and proactively support the needs of future growth;
- Direct growth to appropriate areas;
- Create a plan of action where government and the people work in partnership to improve the quality of life in Kona for those who live, work, and visit; and
- Provide a framework for monitoring the progress and effectiveness of the plan and to make changes and update it, if necessary.

The proposed project is consistent with the following applicable guiding principles, objectives and policies of the Kona CDP:

1. *Protect Kona's natural resources and culture*
4. *Provide recreational opportunities*
6. *Provide infrastructure and essential facilities concurrent with growth*
7. *Encourage a diverse and vibrant economy emphasizing agriculture and sustainable economics*

Environmental Resources

Guiding Principles

1. *Protect Kona's natural resources and culture.*

Objectives and Policies

1. *In order to minimize impacts on the land, make use of best management planning practices for any land-based endeavor by balancing public and private rights, and taking advantage of an ever improving knowledge of resource sensitivity and natural processes.*
2. *To develop a networked system of appropriate access to all significant open space resources that enhances opportunities for residents and visitors for recreational, educational, subsistence, or gathering purposes.*

Discussion: Construction activities will involve land-disturbing activities, such as clearing, grading, and excavation that may result in some soil erosion and potential construction-related impacts to the quality of surface and coastal waters in the vicinity of the disturbances. Various mitigation measures will be incorporated into the project's construction plans and specifications to minimize soil disturbances and potential short-term erosion impacts during construction activities. Excavation and grading activities associated with construction of the proposed project

will be regulated by the County's grading ordinance and the NPDES permit requirement administered by the State DOH. A NPDES Individual Permit for Storm Water Associated with Construction Activity will be required for those projects anticipating soil disturbance exceeding one acre. Mitigation measures will be instituted in accordance with site-specific assessments, incorporating appropriate structural and/or non-structural BMPs such as minimizing time of exposure between construction and landscaping, and implementing erosion control measures such as silt fences and sediment basins. Following the associated construction activity, the excavated areas will be paved over or backfilled to its graded contours or re-vegetated to control erosion.

The proposed project is not anticipated to have any long-term impacts to land-based, shoreline, and marine resources. Following construction, exposed soils at the project site will have been built over, paved over, or re-vegetated to control erosion.

The proposed improvements are not anticipated to have significant impacts on notable view planes nor adversely affect important public viewing points or visual resources. The proposed improvements at the existing facilities at the Kealakehe WWTP and will be consistent with the visual character of the existing facilities and would be sensed as an intensification of the existing facility.

Cultural Resources

Guiding Principles

1. Protect Kona's natural resources and culture.

Objectives and Policies

1. Ensure that our Kanaka Maoli and island values and cultures are preserved and perpetuated.

Discussion: An Archaeological Literature Review and Field Inspection for the project site was conducted for the property in April 2018. The project area lies within the southernmost extent of the Kekaha region, in which the uplands were used for residences and farming, and the coastal lands for residence, fishing, and aquaculture. The lands located between the coast and uplands settlements, in which the majority of the project area is situated, contained networks of trails along which shelter and water collection caves, quarries, and scattered agricultural sites were located. Historically, the area was used widely for ranching.

Background research indicated the presence of 119 previously identified archaeological sites/historic properties overlapping or within 330 feet of the bounds of the project area. Most of these are pre-Contact sites associated with agriculture, habitation, transportation, resource procurement, ceremony, burial, artistic expression, and/or recreation. Historic era sites included trails (such as State Inventory of Historic Places [SIHP] #50-10-27-00002, Māmalahoa Trail), habitation areas, a cemetery, and ranching-related features like boundary walls.

The field inspection confirmed 30 of 119 previously identified archaeological sites and possibly relocated portions of eight previously identified sites; these 38 sites are within or immediately adjacent to the project area. In addition, archaeologists documented 16 newly identified archaeological features/feature complexes within or directly adjacent to the project area.

In general, efforts to minimize potential effects on historic properties will be made in the project design phase. Such efforts will include limiting ground disturbance within previously undisturbed areas as much as possible (e.g., propose installation of transmission lines within existing

roadbeds or graded areas). Should any significant pre-Contact or historic deposits (i.e. subsurface concentrations of indigenous or historic era artifacts and/or structural remnants) or human burials be encountered during the course of development of the project site, the subsurface excavation work and/or surface grading will be halted in the immediate area and the SHPD will be notified immediately.

Public Facilities, Infrastructure, and Services

Guiding Principles

3.. Ensure infrastructure supports growth of TODs in a manner that reduces waste and pollution, conserves water, and generally minimizes environmental impacts.

6. Set a standard of excellence in the construction, operation, and maintenance of all public facilities and the supportive role of the community to promote civic pride.

Objectives and Policies

Policy PUB-4.5: Wastewater Treatment and Effluent Release

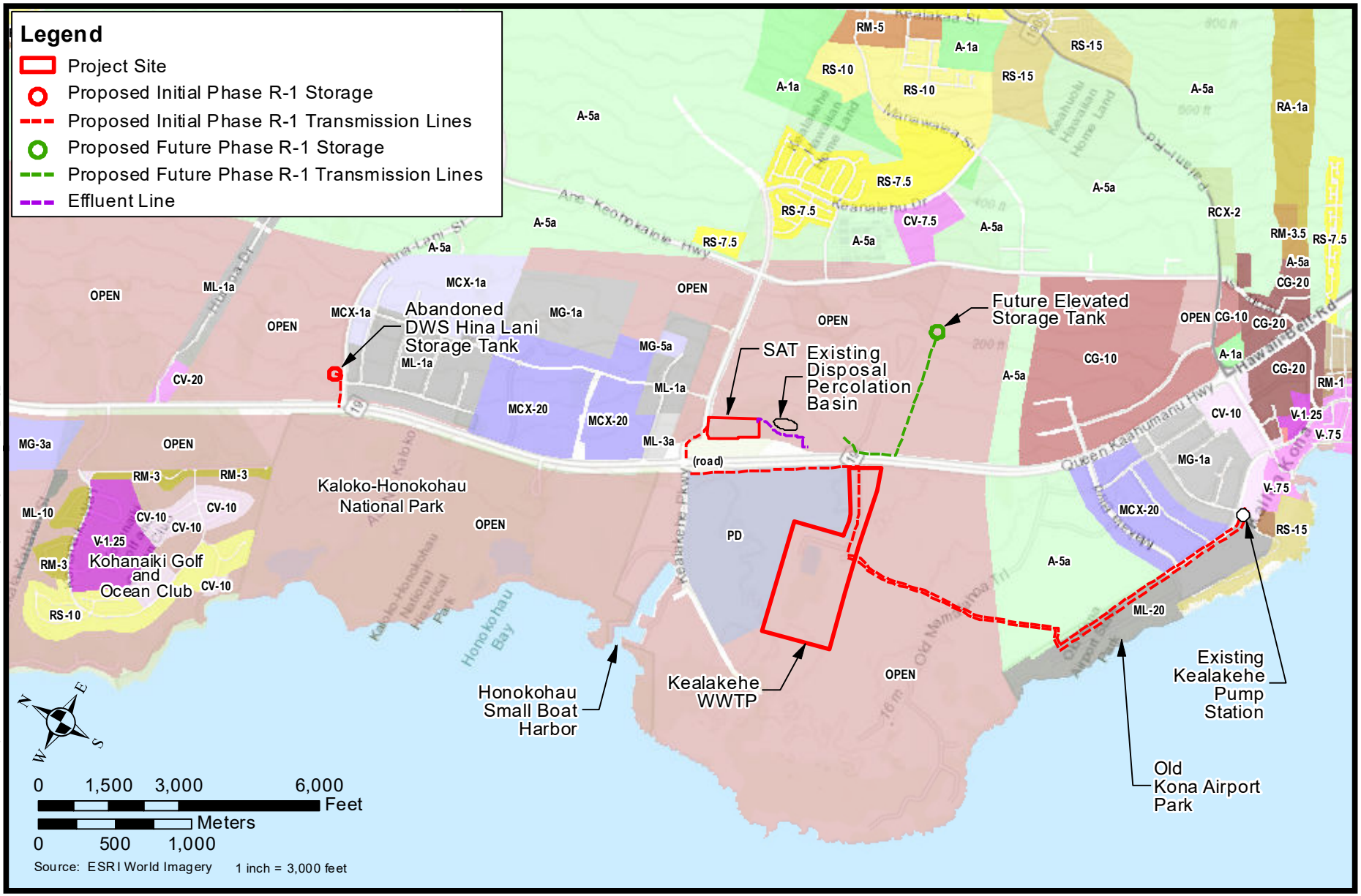
Discussion: The Kealakehe WWTP R-1 Upgrade improvements will be undertaken to improve and enhance the treatment processes so that the effluent can be used for more beneficial uses, including those in which the effluent would displace the use of potable water

6.2.3 County of Hawai'i Zoning

Chapter 25 of the Hawai'i County Code regulates land use in accordance with adopted land use policies and it is also often referred to as the zoning ordinance. The County Code presents permitted uses and structures, development standards, and height controls for each zoning district. The zoning designations for the existing Kealakehe WWTP and the proposed improvements are shown in Figure 6-3.

The developed portions of the WWTP and segments of the R-1 transmission lines are zoned "Open". According to Section 25-5-160 of the County Code, "the Open district applies to areas that contribute to the general welfare, the full enjoyment, or the economic well-being of open land type use which has been established, or is proposed. The objective of this district is to encourage development around it such as a golf course and park, and to protect investments which have been or shall be made in reliance upon the retention of such open type use, to buffer an otherwise incompatible land use or district, to preserve a valuable scenic vista or an area of special historical significance, or to protect and preserve submerged land, fishing ponds, and lakes (natural or artificial tide lands)." Improvements proposed within the Open district include the improvements to the Kealakehe WWTP, onsite subsurface flow wetlands, the SAT facility, portions of the recycled water transmission lines, and recycled water storage. As the proposed improvements are public uses and structures, they are allowable in the Open district. The proposed improvements identified as public uses and structures will need to get a plan approval from the County Planning Department before construction in order to be in compliance with the County zoning districts.

Sections of the proposed R-1 transmission lines cross an Agricultural-minimum 5 acre building site (A-5a). According to Section 25-5-70 of the County Code, "the A (agricultural) district provides for agricultural and very low density agriculturally-based residential use, encompassing rural areas of good to marginal agricultural and grazing land, forest land, game habitats, and areas where urbanization is not found to be appropriate."



Document Path: E:\P Drive\T\Projects\10079-01 Kealakehe WWTP EIS\Working\FINAL\Fig 6-4 Kealakehe_Zoning_REV.mxd

WILSON OKAMOTO CORPORATION

FIGURE 6-4

COUNTY OF HAWAII ZONING MAP

Kealakehe WWTP R-1 Upgrade

In congruence with Section 21-15 of the County Code, "[a]ll sewage works construction shall be performed in accordance with the latest edition of the standard specifications for public works construction and the standard details for public works construction." Should sewage be disposed into a natural outlet after treatment, the Kealakehe WWTP will adhere to Section 21-11 of the County Code which states, "[w]here sewage is to be discharged into any natural outlet, primary or complete treatment facilities shall be provided in accordance with regulations and requirements of the State department of health. The type, capacity and location of the treatment plant shall be approved by the director." The Kealakehe WWTP will not discharge into a natural outlet.

6.2.4 County of Hawai'i Special Management Area

Pursuant to the Hawai'i CZM Program, Chapter 205A, HRS, the counties have enacted ordinances establishing Special Management Areas (SMA). Any "development" within the SMA requires an SMA Use permit administered by the County of Hawai'i Planning Department. Through the SMA permit system, the County assesses and regulates developments proposed for areas located within the SMA and the proposed developments are evaluated for compliance with the CZM objectives and policies and SMA guidelines set forth in Chapter 205A, HRS. The entire Kealakehe WWTP property and a portion of the proposed R-1 transmission lines are located within the SMA. (See Figure 1-4 SMA Map) The proposed improvements are consistent with the CZM objectives and policies as previously described in Section 6.1.5.

On January 31, 1989, the County of Hawai'i Planning Commission approved Special Management Area Use Permit No. 280 to allow the construction of the Kealakehe Wastewater Treatment Plant and related improvements at Kealakehe, North Kona, Hawai'i within TMK: 7-4-008: portion of 3. The application was for the 53+ acre area to be used for the wastewater treatment plant and related improvements. The applicant was to submit a metes and bounds description of the 53+ acre area. (See Figure 1-4, Special Management Area Map)

The approval stated, the requested Special Management Area Use Permit Application will not have any significant adverse environmental or ecological effects. The project site is located on pahoehoe lava with little soil and vegetation. Endangered species have not been associated with this site. Additionally, no historic or archaeological sites have been associated with the project site.

Further, the development was determined to be consistent with the objectives and policies provided by Chapter 205A, HRS, and the Special Management Area Guidelines. Also, the project did not involve dredging or filling; did not reduce the size of a beach or recreational area; did not reduce access to the shoreline; did not interfere with the line of sight from the Queen Ka'ahumanu Highway to the shoreline; and did not adversely affect the coastal water quality, fisheries, wildlife habitats or agricultural use of land.

Also, the development was found to be consistent with the County General Plan and zoning. The project is sited in the Urban District, in an area designated as Alternate Urban Expansion and is a use permitted in the Zoning Code. This project is part of a coordinated development effort involving the County and State of Hawai'i.

Further, no adverse impacts on air and water quality are expected to be generated by the proposal. The nature of these additional improvements is such that no unusual air emissions will be produced by the aerated lagoon treatment. The municipal golf course is seen as the field which will consume the chemical nutrients found in the effluent used for irrigation.

The Planning Commission found, although the proposed use will alter the essential character of the land, it is determined that such a change may make the highest and best use of land involved for the public welfare at the present time.

6.3 Permits and Approvals

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

Federal

U.S. Fish and Wildlife Service

- Endangered Species Act, Section 7 Consultation

State of Hawai'i

Department of Health

- National Pollutant Discharge Elimination System (NPDES) Individual Permit for Storm Water Associated with Construction Activity
- Approval to Construct Wastewater Treatment Works
- Authorization to Operate Wastewater Treatment Works

Department of Land and Natural Resources Office of Coastal and Conservation Lands

- Conservation District Use Permit

Department of Land and Natural Resources, State Historic Preservation Division

- Section 106 of the national Historic Preservation Act
- Chapter 6E, HRS, State Historic Preservation Law

Department of Transportation

- Work within the State right-of-way

Office of Planning

- Coastal Zone Management (CZM) Federal Consistency Certification

County of Hawai'i

- Special Management Area Use Permit
- Grading/Grubbing Permit
- Building Permit

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

7.1 Short-Term Effects

The proposed project alternatives will involve short-term uses of the environment during the construction phase. These uses will have both positive and negative impacts. Construction activities associated with the proposed project alternatives will create temporary adverse impacts, including increased noise, airborne dust, traffic disruptions, and loss of on-street parking in the vicinities of the Kealakehe WWTP.

In the short-term, the proposed improvements will also confer some positive economic benefits in the local area. Direct economic benefits will result from construction expenditures both through the purchase of materials from local suppliers and through the employment of local labor. Indirect economic impacts may include benefits to local retail businesses resulting from construction activities.

7.2 Long-Term Effects

In the long-term, the proposed project associated improvements will have beneficial impacts on long-term enhancement of the environment, including potential improvements to coastal water quality, ecosystems, public health, and safety. The purpose of the Kealakehe WWTP R-1 Upgrade project is to construct the necessary improvements to provide effluent treatment for the production of R-1 recycled water. "Recycled water" means treated wastewater that by design is intended to be used for beneficial purposes. Use of recycled water has become more significant due to the growing population of the Kona area, limited potable water resources, and wastewater disposal issues. Implementing the use of R-1 recycled water will decrease the amount of potable water currently being used for irrigation (and other non-potable uses) and reduce the quantity of the WWTP effluent requiring disposal. This decrease in potable water demand is especially relevant due to the relatively arid conditions found along the Kona coast, the limited availability and cost of developing new potable water sources, and the demand for potable water for domestic consumption.

The R-1 Upgrade improvements will increase nutrient removal within the wastewater treatment process and thus reduce the nutrient load in the effluent to be disposed. By replacing the existing percolation disposal basin with an EPA-recognized land application system, additional environmental protection will be provided to ground water resources and to coastal waters. In addition, the R-1 Upgrade improvements will provide for the wastewater management needs of the service area for the next 20 years.

A substantial amount of financial resources will be required to construct, operate, and maintain the proposed alternatives and associated improvements. The funds would be drawn from a generally limited pool of assessment and operating fees. Therefore, the capital improvement and annual operating costs associated with the proposed facility improvements would result in an increase in sewer rates for the wastewater system customers on Hawai'i Island.

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8. IRRETRIEVABLE AND IRREVERSIBLE COMMITMENTS OF RESOURCES

In the short-term, construction of the proposed R-1 Upgrade facilities will require an irreversible and irretrievable commitment of a number of resources, including land, capital, construction materials, labor, energy, fuel, and water. Material, labor resources and financial resources will also be irretrievably committed to the planning and design of the improvements.

There will be a long-term commitment to the use of land with the proposed action. Although almost all of the R-1 transmission line facilities would be located within existing public rights-of-way, the portion of the transmission lines on private properties would encumber those lands with easements for the lines. The transmission lines on private properties would be located along property boundaries to minimize impacts to the landowner. Also, the width of the easement would be limited the area needed for placement of the line and to allow access for maintenance of the line.

Effective operation of the R-1 facilities will also require irreversible and irretrievable commitment of labor, materials and resources in the form of consumption of electrical power and potable water. Fuel would be needed to operate the emergency generator during periods of commercial power outage and when the system is being tested. Certain fuels, however, may be derived from renewable sources.

Financial resources used for construction and operation of the proposed R-1 facilities, once committed and used for the project, will not be available for other uses. Although operation of the R-1 facilities would consume financial resources, this would be offset by a corresponding decrease in resources needed to support production of potable water that would be displaced by the use of R-1 recycled water.

The extent of irreversible and irretrievable financial commitment towards capital expenses will increase steadily with time as the value of the facilities decline due to the effects of age and depreciation. The funds used for operation and maintenance of the facilities are largely irreversible and irretrievable upon expenditure.

In the long-term, the impact of undertaking these irreversible and irretrievable commitments of resources should be weighed against the environmental benefits to be derived from the decrease in use potable water that would be displaced by using R-1 recycled water for the same purpose. Moreover, use of R-1 recycled water would preserve potable water for it highest and best use.

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9. PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

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

9.1 Short-Term Effects

Unavoidable short-term impacts, despite mitigation efforts, include those related to noise and air quality, and water quality.

Noise: Construction noise will be unavoidable during the duration of the R-1 Upgrade Improvements and the transmission pipelines. Short-term increases in noise levels will result from use of construction equipment and vehicle movements on public roads and at the Kealakehe WWTP project site. Despite compliance with Chapter 46, Title 11, *Community Noise Control*, DOH, Hawai'i Administrative Rules (HAR), noise generated by construction activities will adversely impact nearby land uses. The use of muffled equipment, noise barriers, and restrictions on construction hours, as well as adherence to State DOH regulations on noise mitigation, will minimize construction equipment and vehicle noise. For construction work to be performed at night or on weekends and holidays, a Community Noise Variance permit from the DOH will be required if it exceeds regulatory noise levels.

Air Quality: Construction-related air quality impacts would result from airborne dust and exhaust emissions from internal combustion engines during site preparation and earth moving activities, the movement of construction vehicles on unpaved areas of the site, and from construction equipment. The construction contractor is responsible for complying with State DOH regulations which prohibit visible dust emissions at property boundaries. Nevertheless, open-air areas and naturally ventilated structures located in the vicinity of the project sites could be affected by dust in spite of compliance with these regulations.

Water Quality: No significant impacts on coastal waters are anticipated as a result of constructing and operating the proposed improvements. Construction activities will involve land-disturbing activities that may result in some short-term surface runoff and soil erosion. The construction plans will include erosion control plans for the WWTP site, the buffer and soil aquifer treatment sites, and along transmission line work areas.

Traffic: During construction, traffic near the Kealakehe WWTP will be impacted for the period of the construction activity. This could occur along Queen Ka'ahumanu Highway when the transmission line is constructed in the shoulder area. To avoid potential traffic congestion, the construction traffic control plan will minimize construction-related traffic on the adjacent roadway. The increased traffic from construction-related vehicles should be insignificant during the construction period.

9.2 Long-Term Effects

Unavoidable long-term impacts resulting from development of the proposed wastewater facility improvements include those on air quality, noise, aesthetics, and energy consumption.

Air Quality: The primary air quality concern associated with wastewater treatment plants is that they can be a source of nuisance odors to the surrounding community, if not properly designed and/or operated. Typically, nuisance odors are most commonly associated with anaerobic (without oxygen) conditions at the headworks, the facility where raw sewage enters the WWTP, and with residual solids processing. Hydrogen sulfide is the primary source of the nuisance odor.

The Kealakehe WWTP is currently equipped with an existing odor control system at the headworks. The channels in the headworks facility are covered to facilitate the collection and removal of foul air. Within the headworks, the foul air is directed to a chemical mist scrubber to remove hydrogen sulfide and other odorous compounds before the scrubbed air is released to the atmosphere.

The existing lagoons within the Kealakehe WWTP will not be a source of nuisance odors as the lagoons are aerated to maintain dissolved oxygen concentrations in the lagoon water column at approximately 2.0 mg/L or greater at all times. The County's recently completed upgrade of the lagoon aeration system will ensure that sufficient aeration capacity is available to maintain aerobic lagoon conditions under foreseeable conditions.

The feed water to the R-1 treatment process will have been oxidized in the aerated lagoon system prior to being pumped to the various R-1 treatment processes. Thus, the proposed R-1 treatment system will not be a source of nuisance odors. Since the R-1 recycled water used for irrigation by the users will have been through the various processes at the Kealakehe WWTP, it should not be a source of nuisance odors.

The SAT will receive effluent from the Kealakehe WWTP that has been oxidized in the aerated lagoon system and denitrified in the subsurface flow constructed wetlands. Due to the treatment provided at the WWTP, the effluent pumped to the SAT site will not be a source of nuisance odors.

Water Quality: The State of Hawai'i has set forth the general policy of water quality, which is to protect and maintain existing uses and the level of water quality. Hawai'i Administrative Rules (HAR) Title 11, Chapter 54, Water Quality Standards (revised November 15, 2014), show that the entire Kona coast, including the area in the vicinity of the Kealakehe WWTP project site is classified as AA Marine waters. Class AA Marine waters are recognized as high quality coastal waters with the objective that "these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions".

HAR Title 11, Chapter 54, shows the waters inside Honokōhau Harbor are Class A. The DOH objective for Class A waters is to protect "their use for recreational purposes and aesthetic enjoyment".

No significant impacts on coastal waters in the greater project vicinity are anticipated as a result of the construction and operation of the proposed improvements. The soil aquifer treatment (SAT) system will be the final step to remove nutrients and other constituents from the treated effluent. SAT is an EPA-recognized form of land treatment and will replace the percolation disposal basin method currently in use. Effluent, which has been treated through the vegetated wetlands to remove nitrogen from the effluent, will be further treated by the SAT system to remove phosphorus, heavy metal and trace organic compounds, and endocrine disrupting chemicals. The SAT system uses a sand media to achieve removal of the effluent constituents. This combination of natural processes will ensure that treated effluent can be returned to the subsurface environment without adverse impacts. In addition, recycled water will reduce the amount of WWTP effluent requiring disposal as well as the nutrient load carried to the disposal system. This will, in turn, decrease the amount of WWTP effluent that will enter ground waters and potentially to coastal waters.

Noise: There may be instances when noise from the Kealakehe WWTP would be audible to residents in the vicinity. This may potentially occur during periods of no wind or southwesterly

(Kona) wind conditions as these climatic conditions create a channeling effect and thus could result in less attenuation of noise.

Aesthetics: Since the proposed R-1 Facility Improvements at the existing Kealakehe WWTP will be consistent in visual character to those of the existing facilities, the change in views from public places will be of an intensification of the existing uses. The proposed chemical addition building, the R-1 treatment facility concrete canopy, and the R-1 storage tank would be the above ground structure which would intensify the facility-type visual character of the Kealakehe WWTP. However, since the Kealakehe WWTP is located about 3,700 feet (0.70 miles) from Queen Ka'ahumanu Highway, the location of the nearest public views, the R-1 facilities would only appear as facilities in the distance.

Energy Consumption: Implementation of the proposed R-1 Facility Improvements alternative will increase energy demand to operate the pumps needed to control flows to the constructed wetlands, the R-1 storage tank and to the SAT site which is located about 30 to 40 feet higher and mauka (east) of the Kealakehe WWTP. Electrical power will also be required to operate the ultra-violet (UV) lights used for disinfection process. In the future, electrical power will be needed to pump R-1 water to the offsite storage tanks.

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10. SUMMARY OF UNRESOLVED ISSUES

No significant unresolved issues pertaining to the proposed action have been identified up to the publication of this Draft EIS. Potentially, issue(s) identified through the public review and comment period of the Draft EIS could be determined to constitute an unresolved issue(s), in which case it (they) would be documented in the Final EIS.

Inasmuch as the proposed improvements are still in the planning and conceptual design stages, especially those proposed for future phases of the proposed action, further refinements in design are anticipated before construction commences. It is not anticipated that such refinements would significantly alter the assessment of impacts documented in this Draft EIS. To that degree, such unforeseeable design refinements are unresolved.

Nevertheless, should major design changes be proposed that call into question the validity of the impact assessments in this Draft EIS, then a Second Draft EIS could be warranted to address those changes. If the Final EIS has been accepted by that time, then the need for a Supplemental EIS, specifically addressing those design changes, would be considered.

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11. CONSULTATION

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

11.1 Environmental Impact Statement Preparation Notice Consultation

The following agencies, organizations, and individuals were consulted during the Environmental Impact Statement Preparation Notice (EISPN) process. Consultation was conducted to solicit comments from the public regarding their concerns and agency requirements. In addition, the EISPN was sent to those agencies believed to have jurisdiction or expertise as well as those citizen groups and individuals reasonably believed to be affected by the Proposed Action. Notice of availability of the EISPN was published in the March 23, 2017 issue of *The Environmental Notice*. Copies of all written comments received along with response letters are reproduced and included in Appendix A.

List of Agencies; Organizations/Others	EISPN	Comments
Federal Agencies		
U.S. Army Corps of Engineers	X	
U.S. Department of Agriculture, Natural Resources Conservation Service	X	
U.S. Environmental Protection Agency	X	
U.S. Fish and Wildlife Service	X	
U.S. National Parks Service, Kaloko Honokohau National Historic Park	X	X
U.S. National Marine Fisheries Service	X	
U.S. Department of the Navy	X	
Federal Aviation Administration	X	
Federal Transit Administration	X	
Federal Highways Administration	X	
U.S. Department of Homeland Security	X	
National Oceanic and Atmospheric Association	X	
State Agencies	X	
Department of Agriculture	X	
Department of Accounting and General Services	X	
Department of Business, Economic Development and Tourism (DBEDT)	X	
DBEDT, Strategic Industries Division	X	
DBEDT, Hawai'i State Energy Office	X	
DBEDT, Land Use Commission	X	
DBEDT, Office of Planning	X	X
Department of Defense	X	

List of Agencies; Organizations/Others	EISPN	Comments
State Agencies		
Department of Education	X	
Department of Hawaiian Homelands	X	
Department of Health	X	
Department of Health, Environmental Management Branch	X	
Department of Health, Environmental Planning Office	X	X
Department of Health, Clean Water Branch	X	
Department of Health, Wastewater Branch	X	
Department of Health, Office of Environmental Quality Control	X	
Department of Land and Natural Resources (DLNR)	X	
DLNR, Historic Preservation Division	X	
DLNR, Division of Forestry and Wildlife	X	
DLNR, Engineering Division	X	
DLNR, Commission on Water Resource Management	X	
Department of Transportation	X	X
Department of Transportation, Airports Division	X	
Department of Transportation, Harbors Division	X	
Department of Transportation, Highways Division	X	
Office of Hawaiian Affairs	X	
University of Hawai'i Environmental Center	X	
University of Hawai'i Sea Grant	X	
County Agencies		
Fire Department	X	
Department of Parks and Recreation	X	
Department of Planning	X	
Department of Public Works	X	
Department of Water Supply	X	
Office of the Mayor	X	
Others		
Hawai'i Electric Light Company (HELCO)	X	
Verizon Hawai'i	X	
Hawai'i Gas	X	
Hawaiian Telcom	X	
Oceanic Time Warner Cable	X	
Queen Liliuokalani Trust	X	
Kohanaiki Golf & Ocean Club	X	
Aronson, Sue	X	
Aronson, Ron	X	

List of Agencies; Organizations/Others	EISPN	Comments
Others		
Bennett, Richard	X	
Clement, Jane	X	
Maile, David E	X	
Eoff, Karen	X	
Gaffney, Rick	X	
Holmes, Steve	X	
Kaapu, David	X	
Kahui, Bo	X	
Kanuha, Dru	X	
Kim, Susan	X	
Kunitake, Walter	X	
Leicher, Terri	X	
Moore, Bill	X	
Murata, Justin	X	
Nazara, Cynthia	X	
Palacat-Nelson, Shane	X	
Purdy, Mānā	X	
Root, Joe	X	
Sung, Shihwu	X	
Shibata, Michael	X	
Smith, Riley	X	
Taylor, Bill	X	
Wilson, Ross	X	
Zimpfer, Jeff	X	

Appendix A shows the comment and responses the Environmental Impact Statement Preparation Notice (EISPN).

11.2 Draft Environmental Impact Statement

Availability of the Draft EIS of review and comment will be published in the Office of Environmental Quality Control *Environmental Notice* dated February 23, 2019. The State DOH and the County will continue to consult with the State Historic Preservation Division in accordance with Section 106 of the National Historic Preservation Act and Chapter 6E, Hawaii Revised Statutes, and the US Fish and Wildlife Service in accordance with Section 7 of the Endangered Species Act.

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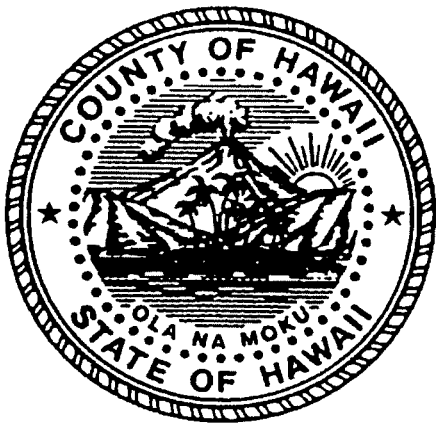

APPENDIX A

Harry Kim
Mayor

Darren J. Rosario
Fire Chief

Renwick J. Victorino
Deputy Fire Chief

County of Hawai'i
HAWAI'I FIRE DEPARTMENT
25 Aupuni Street • Suite 2501 • Hilo, Hawai'i 96720
(808) 932-2900 • Fax (808) 932-2928

April 4, 2017

Earl Matsukawa, AICP
Wilson Okamoto Corporation
Project Manager
1907 S. Beretania Street, Suite 400
Honolulu, Hawai'i 96826

RECEIVED
APR 06 2017
WILSON OKAMOTO CORPORATION

Dear Mr Earl Matsukawa:

SUBJECT: Environmental Impact Statement Preparation Notice
Kealakehe Wastewater Treatment Plant R1 Upgrade

We are in receipt of your letter dated March 23, 2017 in regards to a draft Environmental Impact and Anticipated finding of no significant Impact for the above listed subject.

The Hawai'i Fire Department has no issues or comments with regards to the request for a Environmental Impact – Kealakehe Wastewater Treatment and Anticipated finding of no significant Impact as noted above.

If you should have any questions, please feel free to contact my office at (808)932-2911.

Mahalo,

DARREN J. ROSARIO
Fire Chief

RP/ds

WILSON OKAMOTO CORPORATION
INNOVATORS • PLANNERS • ENGINEERS

10079-01
February 23, 2019

Mr. Darren J. Rosario
Fire Chief
Hawai'i Fire Department
County of Hawai'i
25 Aupuni St. Suite 2501
Hilo, Hawai'i 96720

Subject: Environmental Impact Statement Preparation Notice (EISPN)
Kealakehe Wastewater Treatment Plant R-1 Upgrade
Tax Map Key (TMK): (3) 7-4-008:058, 7-4-008:073, and 7-4-020:007 (por)
Kailua-Kona, Hawai'i

Dear Mr. Rosario:

Thank you for your letter dated April 4, 2017 regarding the subject EIS Preparation Notice. We offer the following in response to your comments:

We acknowledge that the Hawai'i Fire Department has no issues or comments with regards to the proposed project.

Your letter, along with this response, will be reproduced and included in the forthcoming Draft EIS. The Draft EIS has been published and made available for downloading, review and comment in the current issue of the Office of Environmental Quality Control's (OEQC) Environmental Notice. Please use the following link to view the current issue of the Notice:

(http://oeqc.doh.hawaii.gov/Shared%20Documents/Environmental_Notice/current_issue.pdf)

We appreciate your participation in the EIS Preparation Notice review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

1907 S. Beretania Street, Suite 400 • Honolulu, Hawaii • 96826 • (808) 946-2277

National Park Service
U.S. Department of the Interior

Kaloko-Honokōhau
National Historical Park

73-4786 Kanalani Street # 14
Kailua-Kona, Hawai'i 96740

808 329-6881 Phone
808 329-2597 Fax

Kaloko-Honokōhau

IN REPLY REFER TO:
L7621 (2017-3)

April 24, 2017

Mayor of the County of Hawai'i
The Honorable Harry Kim
74-5044 Ane Keohokalole Highway Bldg. C
Kailua-Kona, Hawai'i 96740

Subject: National Park Service Comments on the Environmental Impact Statement Preparation Notice for the Kealakehe Wastewater Treatment Plant R-1 Upgrade

Dear Mayor Kim:

Thank you for providing the National Park Service (NPS) with the opportunity to comment on the Environmental Impact Statement Preparation Notice (EISPN) for the Kealakehe Wastewater Treatment Plant R-1 Upgrade. The proposed project is approximately one mile from Kaloko-Honokōhau National Historical Park (National Park). The County of Hawai'i Department of Environmental Management (DEM) is proposing improvements to the Kealakehe Wastewater Treatment Plant (WWTP). According to the EISPN, the improvements will provide additional treatment to produce R-1 standard water suitable for reuse to meet the State of Hawai'i, Department of Health Reuse Guidelines. In addition, treated wastewater in excess of demand for reuse will be further treated through a proposed onsite subsurface flow wetlands and then conveyed to a proposed offsite soil aquifer treatment (SAT) facility for even further treatment and disposal. The recycled water will be used to irrigate a proposed landscaped buffer parcel surrounding the WWTP and DEM also proposes to construct underground recycled water transmission pipes to properties that plan to utilize the recycled water.

Congress established Kaloko-Honokōhau National Historical Park in 1978 "…to provide a center for the preservation, interpretation, and perpetuation of traditional native Hawaiian activities and culture, and to demonstrate historic land use patterns as well as to provide a needed resource for the education, enjoyment, and appreciation of such traditional native Hawaiian activities and culture…" by protecting the cultural and natural resources within the Park (16 U.S.C. § 396d(a)). The National Park contains more than 450 known archeological and cultural sites, including several heiau, networks of ancient and historic trails, seawalls, more than 180 anchialine pools, two Hawaiian fishponds with associated wetlands, and a fishtrap. It also contains 600 acres of marine waters containing coral reefs and other marine habitats. The land and waters within the National Park provide habitat for 17 federally listed, and candidate species for listing, under the Endangered Species Act. The 'Aimakapā Fishpond (a loko pu'uone style fishpond) and its associated wetlands are listed as a "Core Wetland" by the U.S. Fish & Wildlife

Service for the recovery of two endangered waterbird species, the Hawaiian stilt (*Himantopus mexicanus knudseni*) and the Hawaiian coot (*Fulica americana alai*), and are important habitat for migratory shorebirds and waterfowl (USFWS 2011). The Kaloko Fishpond is a loko kuapā and is being restored so that it can be managed as a traditional Hawaiian fishpond.

Approximately 150,000 visitors per year visit the National Park (https://irma.nps.gov/Stats/). Local residents, cultural practitioners, and visitors from around the world come to experience Kaloko-Honokōhau's unique seascape, and cultural and natural history, and to understand and exercise traditional Hawaiian practices.

Groundwater in the area of the National Park exists as a coastal freshwater-lens system and as inland impounded-groundwater. Groundwater in the freshwater-lens system flows from inland to the coast. The NPS is concerned that land uses from those neighboring the National Park may have negative impacts on water quality. The leading water-quality concerns for the NPS are the possible migration of nutrients and other contaminants into the Park from surrounding areas. Contaminants or constituents of concern include 1) pesticides and fertilizer nutrients from landscaping and agriculture; 2) nutrients and wastewater contaminants from cesspools and septic systems in industrial and residential areas; and 3) urban chemicals from stormwater runoff, spills and/or from improper disposal (Hunt 2014).

The NPS applauds the County of Hawai'i's determination to consider other methods to treat and dispose of wastewater that have lower environmental footprints than the current system of disposing partially treated wastewater into a seepage pit. The National Park's cultural and natural resources rely on the continuous flow of abundant freshwater.

The National Park Service respectfully requests that the concerns below be addressed in the Draft Environmental Impact Statement (DEIS).

1. The EISPN states

> 11) Polishing Wetlands
> The polishing/onsite subsurface flows wetlands system within the WWTP will further "polish" the secondary treated effluent by removing additional nutrients and other constituents. The polishing wetland will be above grade. The wetlands will be designed as a subsurface flow wetland whereby water flows through a gravel matrix in which emergent wetland vegetation is grown. Thus, there will be no exposed water surface that could attract birds. The wetland will have a geomembrane liner for containment. Appropriate Hawaiian native plant species will be selected and planted in the wetland. The polishing wetlands will cover about 12 acres and will be constructed within the existing WWTP parcel boundaries. A pump station will return water from the wetland to the WWTP.

The DEIS should describe the Polishing Wetlands system in detail to facilitate understanding of the treatment process. The DEIS should include an analysis of the proposed system's ability to

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The National Park Service cares for special places saved by the American people so that all may experience our heritage.

remove pollutants from wastewater, including references to studies that provide support as to the system's effectiveness in removing nutrients and other constituents. In particular, the DEIS should describe the structure and/or process by which water is prevented from pooling at the surface. More information on the geomembrane liner is also needed, including the manufacturer and the reason for its selection versus other materials. The DEIS should describe the anticipated life span of the system, what monitoring will be used to verify the system is functioning as planned and that it has not reached some saturation limit, and what actions will be taken if the system1) fails to remove pollutants as expected, 2) reaches a saturation limit, or 3) when the system reaches the end of its lifespan. The analysis for pollutant removal should include the fate of nutrients, pharmaceuticals, detergents, personal care products, and microplastics.

2. The EISPN states

> 13) Soil Aquifer Treatment
> The soil aquifer treatment (SAT) system will be the final step to remove nutrients and other impurities prior to release back to the environment. SAT is an EPA-recognized form of land treatment and will replace the disposal method that is currently in use. Soil Aquifer treated effluent will be applied over a large area, and will percolate downward through a soil system engineered to provide additional treatment and flow control. This combination of natural processes will ensure that treated water is safely returned to the environment.

The DEIS should also describe the SAT system in detail. The DEIS should provide an analysis of the proposed SAT system's ability to remove pollutants from wastewater, including references to studies that provide support to the conclusion that the disposal of wastewater via the SAT system will not lead to contamination of the aquatic ecosystems of the area. In particular the DEIS should describe the constructed soil system and depth necessary to achieve the desired results in an arid, soilless environment such as the central Kona Coast. The DEIS should describe the anticipated life span of the system, what monitoring will be used to verify the system is functioning as planned, and what actions will be taken if the system either fails to remove pollutants as anticipated initially or when the system reaches the end of its lifespan. The analysis for pollutant removal should include the fate of nutrients, pharmaceuticals, detergents, personal care products, and microplastics.

3. Dr. Jeff Zimpfer of my staff recently attended the April 20th Community Enterprises West Hawai'i forum. At the forum, William Kucharski, Director, DEM, stated something to the effect that wastewater pipelines delivering the wastewater from businesses and residences in Kona leak and that saltwater enters the lines resulting in fairly saline water after the wastewater treatment process. If this is indeed the situation, the treated wastewater may be too saline to irrigate landscaping. Understanding how much of the treated wastewater can realistically be used needs to be fully analyzed to understand the impacts of this project. The types and quantities of the pollutants removed via irrigation for landscaping purposes is likely different than pollutant removal via the SAT system. The DEIS should analyze this project's impacts to aquatic ecosystems for treated wastewater disposal via both landscape irrigation and the SAT system.

4. The Draft EIS should thoroughly analyze the direct, indirect, and cumulative impacts of the disposal of treated wastewater on coastal aquatic and marine ecosystems.

If you have any questions regarding this letter, please contact Dr. Jeff Zimpfer of my staff (808-329-6881 x1500 or jeff_zimpfer@nps.gov).

Sincerely,

William Thompson
Acting Superintendent

cc: B. Walsh, Department of Aquatic Resources, Kona Office

References

Hunt, C.D., Jr. 2014. Baseline water-quality sampling to infer nutrient and contaminant sources at Kaloko-Honokōhau National Historical Park, Island of Hawai'i, 2009: U.S. Geological Survey Scientific Investigations Report 2014-5158, 52 p., http://dx.doi.org/10.3133/sir20145158.

U.S. Fish and Wildlife Service. 2011. Recovery Plan for Hawaiian Waterbirds, Second Revision U.S. Fish and Wildlife Service, Portland, Oregon. http://www.fws.gov/pacific/ecoservices/endangered/recovery/plans.html

EXPERIENCE YOUR AMERICA
The National Park Service cares for special places saved by the American people so that all may experience our heritage.

WILSON OKAMOTO CORPORATION
INNOVATORS · PLANNERS · ENGINEERS

10079-01
February 23, 2019

Mr. William Thompson
Acting Superintendent
Nation Park Service
Kaloko-Honokōhau National Historic Park
73-4786 Kanalani Street #14
Kailua-Kona, Hawai'i 96740

Subject: Environmental Impact Statement Preparation Notice (EISPN)
Kealakehe Wastewater Treatment Plant R-1 Upgrade
Tax Map Key (TMK): (3) 7-4-008:058, 7-4-008:073, 7-4-020:007 (por.)
Kailua-Kona, Hawai'i

Dear Mr. Thomspon:

Thank you for your letter dated April 24, 2017 (ref: L7621 [2017-3]) regarding the subject EIS Preparation Notice. We offer the following in response to your comments:

We acknowledge that the NPS has expressed concern with the possible migration of nutrients and contaminants into the Park from surrounding areas. Specifically, these contaminants or constituents of concern include 1) pesticides and fertilizer nutrients from landscaping and agriculture; 2) nutrients and wastewater contaminants from cesspools and septic systems in industrial and residential areas; and 3) urban chemicals from stormwater runoff, spills and/or from improper disposal.

As requested, the forthcoming Draft EIS will include further discussion of the proposed project's treatment process, including both the Polishing Wetlands and Soil Aquifer Treatment systems as well as other operational and technical specifications and details pertaining to the processing and treatment of wastewater and the neutralization/disposal of contaminants. The Draft EIS will contain a discussion of the anticipated impacts of the proposed project on groundwater resources, as well as coastal aquatic and marine ecosystems in the vicinity of the project site.

Your letter, along with this response, will be reproduced and included in the forthcoming Draft EIS. The Draft EIS has been published and made available for downloading, review and comment in the current issue of the Office of Environmental Quality Control's (OEQC) Environmental Notice. Please use the following link to view the current issue of the Notice:

(http://oeqc.doh.hawaii.gov/Shared%20Documents/Environmental_Notice/current_issue.pdf)

We appreciate your participation in the EIS Preparation Notice review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

1907 S. Beretania Street, Suite 400 • Honolulu, Hawaii • 96826 • (808) 946-2277

DAVID Y. IGE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
3949 DIAMOND HEAD ROAD
HONOLULU, HAWAII 96816-4495

ARTHUR J. LOGAN
MAJOR GENERAL
ADJUTANT GENERAL

KENNETH S. HARA
BRIGADIER GENERAL
DEPUTY ADJUTANT GENERAL

April 17, 2017

Mr. Earl Matsukawa, AICP
Project Manager
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

RECEIVED
APR 20 2017
WILSON OKAMOTO CORPORATION

Dear Mr. Matsukawa:

Subject: Environmental Impact Statement Preparation Notice
Kealakehe Wastewater Treatment Plant R1 Upgrade
North Kona, Hawaii, TMK: (3)7-4-008:058, 7-4-008:073, 7-4-020:007 (por.)

Thank you for the opportunity to comment on the above project. The State of Hawaii Department of Defense has no comments to offer relative to the project.

If you have any questions or concerns, please have your staff contact Mr. Lloyd Maki, Assistant Chief Engineering Officer at (808) 733-8441.

Sincerely,

NEAL S. MITSUYOSHI
Colonel, Hawaii National Guard
Chief Engineering Officer

Cc: Mr. David Kennard / Ms. Havinne Okamura, Hawaii Emergency Management Agency

WILSON OKAMOTO CORPORATION
INNOVATORS · PLANNERS · ENGINEERS

10079-01
February 23, 2019

Mr. Neal Mitsuyoshi, P.E.
Chief Engineering Officer
Department of Defense
State of Hawai'i
3949 Diamond Head Road
Honolulu, Hawai'i 96816-4495

Subject: Environmental Impact Statement Preparation Notice (EISPN)
Kealakehe Wastewater Treatment Plant R1 Upgrade
Tax Map Key (TMK): (3) 7-4-008:058, 7-4-008:073, and 7-4-020:007 (por.)
Kailua-Kona, Hawai'i

Dear Mr. Mitsuyoshi:

Thank you for your letter dated April 17, 2017 regarding the subject Environmental Impact Statement Preparation Notice. We acknowledge that the Department of Defense has no comments to offer at this time.

Your letter, along with this response, will be reproduced and included in the forthcoming Draft EIS. The Draft EIS has been published and made available for downloading, review and comment in the current issue of the Office of Environmental Quality Control's (OEQC) Environmental Notice. Please use the following link to view the current issue of the Notice:

(http://oeqc.doh.hawaii.gov/Shared%20Documents/Environmental_Notice/current_issue.pdf)

We appreciate your participation in the pre-assessment consultation review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

1907 S. Beretania Street, Suite 400 • Honolulu, Hawaii • 96826 • (808) 946-2277

DAVID Y. IGE
GOVERNOR OF HAWAII

VIRGINIA PRESSLER, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:
File:

EPO 17-067

March 28, 2017

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretana Street, Suite 400
Honolulu, Hawaii 96826
Email: ematsukawa@wilsonokamoto.com

Dear Mr. Matsukawa:

SUBJECT: Draft Environmental Assessment (DEA) for Kealakehe Wastewater Treatment Plant R-1 Upgrade, Kailua-Kona, Hawaii
TMK: 7-4-008:058, 7-4-008:073 and 7-4-020:007 (por)

The Department of Health (DOH), Environmental Planning Office (EPO), acknowledges receipt of your DEA to our office via the OEQC link:
http://oeqc.doh.hawaii.gov/Shared%20Documents/EA_and_EIS_Online_Library/Hawaii/2010s/2017-03-23-HA-5B-EISPN-Kealakehe-Wastewater-Treatment-Plant-R-1-Upgrade.pdf

We understand from the OEQC publication form project summary that *"The County of Hawai'i Department of Environmental Management (DEM) is proposing improvements to the Kealakele Wastewater Treatment Plant (WWTP) that will provide additional treatment to produce R-1 standard water suitable for reuse in accordance with the State of Hawaii, Department of Health Reuse Guidelines. In addition, treated wastewater in excess of demand for reuse will be further treated through a proposed onsite subsurface flow wetlands and then conveyed to a proposed offsite soil aquifer treatment (SAT) facility for even further treatment and disposal."*

In the development and implementation of all projects, EPO strongly recommends regular review of State and Federal environmental health land use guidance. State standard comments and available strategies to support sustainable and healthy design are provided at: http://health.hawaii.gov/epo/landuse. Projects are required to adhere to all applicable standard comments.

EPO has recently updated the environmental Geographic Information System (GIS) website page. It now compiles various maps and viewers from our environmental health programs. The eGIS website page is continually updated so please visit it regularly at: http://health.hawaii.gov/epo/egis.

EPO also encourages you to examine and utilize the Hawaii Environmental Health Portal at: https://eha-cloud.doh.hawaii.gov. This site provides links to our e-Permitting Portal, Environmental Health Warehouse, Groundwater Contamination Viewer, Hawaii Emergency Response Exchange, Hawaii State and Local Emission Inventory System, Water Pollution Control Viewer, Water Quality Data, Warnings, Advisories and Postings.

We suggest you review the requirements of the Clean Water Branch (Hawaii Administrative Rules {HAR}, Chapter 11-54-1.1, -3, 4-8) and/or the National Pollutant Discharge Elimination System (NPDES) permit (HAR, Chapter 11-55) at: http://health.hawaii.gov/cwb. If you have any questions, please contact the Clean Water Branch (CWB), Engineering Section at (808) 586-4309 or cleanwaterbranch@doh.hawaii.gov. If your project involves waters of the U.S., it is highly recommended that you contact the Army Corps of Engineers, Regulatory Branch at: (808) 835-4303.

Please note that all wastewater plans must conform to applicable provisions (HAR, Chapter 11-62, "Wastewater Systems"). We reserve the right to review the detailed wastewater plans for conformance to applicable rules. Should you have any questions, please review online guidance at: http://health.hawaii.gov/wastewater and contact the Planning and Design Section of the Wastewater Branch (WWB) at (808) 586-4294.

You may also wish to review the draft Office of Environmental Quality Control (OEQC) viewer at: http://eha-web.doh.hawaii.gov/oeqc-viewer. This viewer geographically shows where some previous Hawaii Environmental Policy Act (HEPA) {Hawaii Revised Statutes, Chapter 343} documents have been prepared.

To better protect public health and the environment, the U.S. Environmental Protection Agency (EPA) has developed a new environmental justice (EJ) mapping and screening tool called EJSCREEN. It is based on nationally consistent data and combines environmental and demographic indicators in maps and reports. EPO encourages you to explore, launch and utilize this powerful tool in planning your project. The EPA EJSCREEN tool is available at: http://www.epa.gov/ejscreen.

We request that you utilize all this information on your proposed project to increase sustainable, innovative, inspirational, transparent and healthy design. Thank you for the opportunity to comment.

Mahalo nui loa,

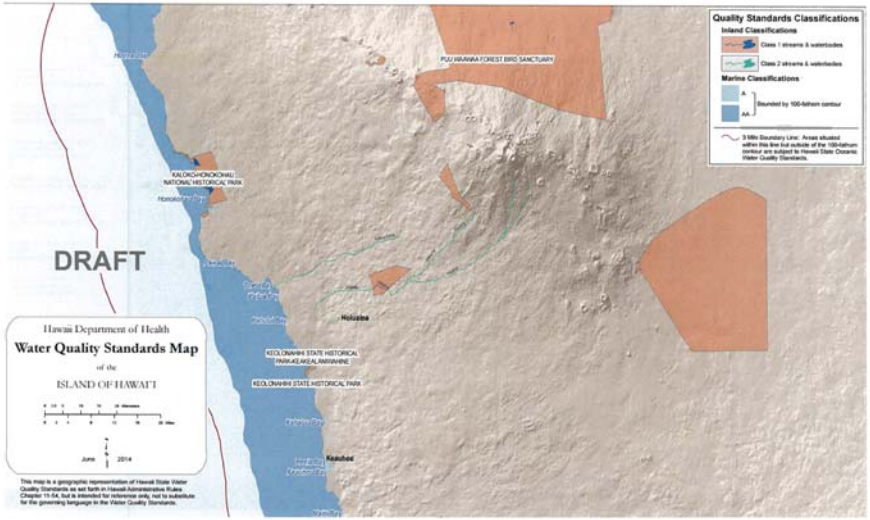
Laura Leialoha Phillips McIntyre, AICP
Program Manager, Environmental Planning Office

LM:nn

Attachment 1: Clean Water Branch: Water Quality Standards Map - Hawaii
Attachment 2: OEQC viewer (of past EA's, EIS's in area)

c: Lyle Hirota, County of HI, Dept. of Environmental Management (via email: Lyle.Hirota@hawaiicounty.gov)
Mayor Harry Kim, (via email: http://www.hawaiicounty.gov/office-of-the-mayor)
DOH: DHO HI, WWB, CWB {via email only}

Attachment 1: Clean Water Branch: Water Quality Standards Map - Hawaii



Attachment 2: OEQC viewer (of past EA's, EIS's in area)

WILSON OKAMOTO CORPORATION
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10079-01
February 23, 2019

Ms. Laura Leialoha Phillips McIntyre, AICP
Program Manager, Environmental Planning Office
Department of Health
State of Hawai'i
P.O. Box 3378
Honolulu, Hawai'i 96801-3378

Subject: Environmental Impact Statement Preparation Notice (EISPN)
Kealakehe Wastewater Treatment Plant R-1 Upgrade
Tax Map Key (TMK): (3) 7-4-008:058, 7-4-008:073, and 7-4-020:007 (por)
Kailua-Kona, Hawai'i

Dear Ms. Phillips McIntyre:

Thank you for your letters dated March 28, 2017 (EPO 17-067) regarding the subject EIS Preparation Notice. We offer the following in response to your comments:

The proposed project will adhere to all applicable standard comments outlined in the URL link provided in your letter. Further, the Department of Health's Hawai'i Environmental Health Portal and the updated Water Quality Standard Maps will be utilized as a reference resource throughout the design process for the subject project.

Your letter, along with this response, will be reproduced and included in the forthcoming Draft EIS. The Draft EIS has been published and made available for downloading, review and comment in the current issue of the Office of Environmental Quality Control's (OEQC) Environmental Notice. Please use the following link to view the current issue of the Notice:

(http://oeqc.doh.hawaii.gov/Shared%20Documents/Environmental_Notice/current_issue.pdf)

We appreciate your participation in the EIS Preparation Notice review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

1907 S. Beretania Street, Suite 400 • Honolulu, Hawaii • 96826 • (808) 946-2277

10079-01 EM KC

DAVID Y. IGE
GOVERNOR

FORD N. FUCHIGAMI
DIRECTOR

Deputy Directors
JADE T. BUTAY
ROSS M. HIGASHI
EDWIN H. SNIFFEN
DARRELL T. YOUNG

IN REPLY REFER TO:

STP 8.2143

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

June 5, 2017

Mr. Earl Matsukawa, AICP
Project Manager
Wilson Okamoto Corporation
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii 96826

RECEIVED
JUN 13 2017
WILSON OKAMOTO CORPORATION

Dear Mr. Matsukawa:

Subject: Kealakehe Wastewater Treatment Plant R1 Upgrade
Environmental Impact Statement Preparation Notice
Kailua-Kona, North Kona, Hawaii
TMK: (3) 7-4-008:058

Our Department of Transportation's (DOT) comments on the subject project are as follows:

Airports Division (DOT-AIR)

1. The nearest portion of the site area to the end of Runway 35 at the Ellison Onizuka Kona International Airport at Keahole (KOA) is approximately 2.7 miles. This is the distance to the proposed initial Phase R-1 Storage Area. The proposal also includes an offsite aquifer treatment facility (SAT) that is approximately 4.2 miles from the end of Runway 35. The Kealakehe Wastewater Treatment Plant (WWTP) is 4.7 miles from the end of Runway 35. All projects within five (5) miles of a state airport must comply with the requirements of the Technical Assistance Memorandum (TAM), to avoid incompatible airport land uses that may pose safety hazards to airport operations. The TAM is available at: http://files.hawaii.gov/dbedt/op/docs/TAM-FAA-DOT-Airports_08-01-2016.pdf.

2. The Federal Aviation Administration (FAA) requires the submittal of FAA Form 7460-1 Notice of Proposed Construction or Alteration according to the Code of Federal Regulations, Title 14, Part 77.9, if the construction or alteration is within 20,000 feet of a public use or military airport which exceeds a 100:1 surface from any point on the runway of each airport with its longest runway more than 3,200 feet. This requirement is also applicable to tall equipment, such as cranes, that may be used during construction. FAA Form 7460-1 and criteria for its submittal can be found at the following website: https://oeaaa.faa.gov/oeaaa/external/portal.jsp.

3. All fugitive dust generated by the project shall be mitigated according to Hawaii State Department of Health standards.

4. Any activity that can potentially attract wildlife within five miles of the airport are discouraged. The proposed project shall meet the requirements of FAA Advisory Circular 150/5200-33B Hazardous Wildlife Attractants on or Near Airports.

   Should the project require areas of open standing water that can potentially attract wildlife, netting or grid wire shall be installed over standing water bodies to deter avian attraction and use.

Highways Division (DOT-HWY)

The proposed upgrade project is not anticipated to have a significant impact to our State highway facilities in the area (Queen Kaahumanu Highway). However, it does appear that the installation of transmission lines will occur within the DOT Highways right-of-way. We will defer further comments until we review the Draft EIS regarding compatibility of the ongoing Queen Kaahumanu Highway widening and the associated transmission facilities.

If there are any questions, please contact Mr. Norren Kato of the DOT Statewide Transportation Planning Office at telephone number (808) 831-7976.

Sincerely,

FORD N. FUCHIGAMI
Director of Transportation

WILSON OKAMOTO CORPORATION
INNOVATORS · PLANNERS · ENGINEERS

10079-01
February 23, 2019

Mr. Ford Fuchigami
Director of Transportation
Department of Transportation
State of Hawai'i
869 Punchbowl Street
Honolulu, Hawai'I 96813-5097

Subject: Environmental Impact Statement Preparation Notice (EISPN)
Kealakehe Wastewater Treatment Plant R-1 Upgrade
Tax Map Key (TMK): (3) 7-4-008:058, 7-4-008:073, 7-4-020:007 (por.)
Kailua-Kona, Hawai'i

Dear Mr. Fuchigami:

Thank you for your letters dated July, 2017 (STP 8.2171) regarding the subject EIS Preparation Notice. We offer the following in response to your comments:

The proposed development will comply with the FAA Advisory Circular 150/5200-33B Hazardous Wildlife Attractants On or Near Airports and the FAA Form 7460-1 will be submitted prior to construction.

We ensure that approved Best Management Practices will be implemented to prevent pollutants from being discharged into the Kapalama Canal during construction.

Coordination with DOT will occur to ensure that State highway facilities will not be compromised.

Your letter, along with this response, will be reproduced and included in the forthcoming Draft EIS. The Draft EIS has been published and made available for downloading, review and comment in the current issue of the Office of Environmental Quality Control's (OEQC) Environmental Notice. Please use the following link to view the current issue of the Notice:

(http://oeqc.doh.hawaii.gov/Shared%20Documents/Environmental_Notice/current_issue.pdf)

We appreciate your participation in the EIS Preparation Notice review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

1907 S. Beretania Street, Suite 400 • Honolulu, Hawaii • 96826 • (808) 946-2277

OFFICE OF PLANNING
STATE OF HAWAII

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

DAVID Y. IGE
GOVERNOR

LEO R. ASUNCION
DIRECTOR
OFFICE OF PLANNING

Telephone: (808) 587-2846
Fax: (808) 587-2824
Web: http://planning.hawaii.gov/

Ref. No. P-15573

April 18, 2017

Mr. Earl Matsukawa, AICP
Project Manager
Wilson Okamoto Corporation
1907 S. Beretania Street, Suite 400
Honolulu, Hawaii 96826

Dear Mr. Matsukawa:

Subject: Environmental Impact Statement Preparation Notice – Kealakehe Wastewater Treatment Plant R1 Upgrade. Island of Hawaii
TMK: (3) 7-4-008:058, 7-4-008:073, and 7-4-020:007 (por)

Thank you for the opportunity to provide comments on this Environmental Impact Statement Preparation Notice (EISPN) for the Kealakehe Wastewater Treatment Plant R1 Upgrade located in Kailua-Kona, Island of Hawaii. The EISPN request review material was transmitted to our office via letter dated March 23, 2017.

It is our understanding that the County of Hawaii, Department of Environmental Management (DEM) proposes improvements to the Kealakele Wastewater Treatment Plant that will produce recycled R-1 water suitable for reuse as commercial irrigation use. In addition, the treated wastewater not converted for reuse will be directed through an onsite subsurface flow wetland and conveyed to an offsite soil aquifer treatment (SAT) facility for further treatment and disposal.

The recycled water will be used to irrigate a landscaped buffer parcel surrounding the facility. DEM also proposes the construction of underground recycled water transmission pipes to properties that plan to utilize the recycled water, which include the Old Kona Airport Park and the Queen Liliuokalani Trust Children's Center. A recycled water transmission line is also planned to run from the facility to the Kohanaiki Golf and Ocean Club, which plans to use the recycled water for irrigation. A new transmission pipe will branch off mauka along Hina Lani Street to an abandoned Department of Water Supply reservoir which will also store recycled water.

The Office of Planning (OP) has reviewed the transmitted material and has the following comments to offer:

1. Pursuant to Hawaii Administrative Rules (HAR) § 11-200-17(h) – relationship of the proposed action to land use plans, policies, and controls for the affected area; this project must demonstrate that it is consistent with state environmental, social, and economic goals and land-use policies. Hawaii Revised Statutes (HRS) Chapter 226, the Hawaii State Planning Act, provides goals, objectives, policies, and priority guidelines for growth, development, and the allocation of resources throughout the state in areas of state interest.

   The Draft Environmental Impact Statement (DEIS) should contain an analysis on the Hawaii State Planning Act to include a discussion on the project's ability to meet all of the goals, objectives, policies, and priority guidelines or clarify where it is in conflict with them. If any of these themes are not applicable to the project, the analysis should affirmatively state such determination, followed by discussion paragraphs.

2. The coastal zone management (CZM) area is defined 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" (see HRS § 205A-1).

   HRS Chapter 205A-5(b) requires all state and county agencies to enforce the CZM objectives and policies. The DEIS should include an assessment as to how the proposed action conforms to the goals and objectives of the Hawaii CZM program as listed in HRS § 205A-2. Compliance with HRS § 205A-2 is an important component for satisfying the requirements of HRS Chapter 343.

3. The EISPN acknowledges that this project site is located within the Special Management Area of the County of Hawaii. DEM should consult with the Department of Planning, County of Hawaii on the regulatory requirements for SMA use.

4. The use of recycled water has become more significant due to the state's growing population, limited potable water resources, and wastewater disposal issues. The DEIS should address the project's consistency with the Department of Health (DOH), Wastewater Branch's recycled water program. Increasing the percentage of recycled wastewater use is consistent with watershed management goals for the State of Hawaii.

   The DOH's recycled water program's Reuse Guidelines (2016) (Volume 1: Recycled

Water Facilities and Volume 2: Recycled Water Projects) can be found on their website at http://health.hawaii.gov/wastewater/home/reuse/.

5. Pursuant to HAR § 11-200-17(i) – probable impact of the proposed action on the environment, and impacts of the natural and human environment – in order to ensure that the coastal resources near the project site remain protected, the negative effects of stormwater inundation ensuing from any construction and development activities should be evaluated.

   According to the EISPN, environmental resource topics to be addressed will include surface waters and coastal waters. The DEIS should summarize the potential impact to nearshore marine and surface water resources from construction activities, as well as the cumulative impact of land-based pollutants carried by stormwater runoff on the coastal ecosystem. Related issues that should be evaluated include, but are not limited to, land use classification, urban density, drainage infrastructure, flooding issues, current erosion hazards, as well as the expected speed and volume of storm runoff. Pursuant to HAR § 11-200-17(m) – consider mitigation measures proposed to avoid, minimize, rectify, or reduce impact; these items, as well as the marine water quality classification, should be considered when developing mitigation measures for the protection of surface water resources and coastal ecosystem.

   Section 1.6.1, R-1 Treatment Facilities, page 1-8 of the EISPN states that the project will include a Buffer Parcel Irrigation System to treat wastewater. The buffer area will be graded and vegetated to provide a natural filtration area around the facility. Topsoil will be imported from an on-island source to provide a media for vegetation growth. An irrigation control system will also be used as a start and stop flow mechanism for irrigation water. Additionally, the SAT system will remove nutrients and other impurities prior to release back to the environment.

   The buffer irrigation system and SAT system can also be viewed as congruent with low impact development (LID) mitigation for stormwater runoff. Other LID design features may include bioretention basins, native plant rain gardens, grassed swales, and infiltration techniques that treat stormwater onsite.

   OP has developed resources available to assist in the development of projects which may assist in the mitigation of sediment loss and stormwater control. We recommend consulting these guidance documents and stormwater evaluative tools when developing strategies to address polluted runoff. They offer useful techniques to keep

land-based pollutants and sediment in place and prevent contaminating nearshore waters.

- Hawaii Watershed Guidance provides direction on mitigation strategies for urban development activities that will safeguard watersheds and implement watershed plans http://files.hawaii.gov/dbedt/op/czm/initiative/nonpoint/HI Watershed Guidance Final.pdf
- Stormwater Impact Assessments can be used to identify and evaluate information on hydrology, stressors, sensitivity of aquatic and riparian resources, and management measures to control runoff, as well as consider secondary and cumulative impacts to the area http://files.hawaii.gov/dbedt/op/czm/initiative/stomwater_impact/final_stormwater_impact_assessments_guidance.pdf
- Low Impact Development (LID), A Practitioners Guide covers a range of structural best management practices (BMP's) for stormwater control management and layout that minimizes environmental impacts http://files.hawaii.gov/dbedt/op/czm/initiative/lid/lid_guide_2006.pdf

We have no further comments at this time. If you have any questions regarding this comment letter, please contact Joshua Hekekia of our office at (808) 587-2845.

Sincerely,

Leo R. Asuncion
Director

WILSON OKAMOTO CORPORATION
INNOVATORS · PLANNERS · ENGINEERS

10079-01
February 23, 2019

Mr. Leo Asuncion
Director
Office of Planning
State of Hawai'i
235 S. Beretania St. 6th Floor
Honolulu, Hawai'I 96804

Subject: Environmental Impact Statement Preparation Notice (EISPN)
Kealakehe Wastewater Treatment Plant R-1 Upgrade
Tax Map Key (TMK): (3) 7-4-008:058, 7-4-008:073, 7-4-020:007 (por.)
Kailua-Kona, Hawai'i

Dear Mr. Asuncion:

Thank you for your letters dated April 18, 2017 regarding the subject EIS Preparation Notice. We offer the following in response to your comments:

We acknowledge that the Draft EIS shall include an analysis on the Hawai'i State Planning Act to discuss the project's ability to meet all the goals, objectives, policies, and priority guidelines or to clarify where it is in conflict with them.

The Draft EIS shall include an assessment as to how the Kealakehe Wastewater Treatment Plant R-1 Upgrade conforms to the objectives and policies of the coastal zone management (CZM). It is understood that increasing the percentage of recycled wastewater use shall be consistent with watershed management goals for the State of Hawai'i; therefore, the Draft EIS shall address the project's consistency with the Department of Health (DOH), Wastewater Branch's recycled water program.

Mitigation measures shall be considered to avoid, minimize, rectify, or reduce impact on land use classification, urban density, drainage infrastructure, flooding issues, current erosion hazards, speed and volume of storm runoff, and marine water quality classification for the protection of surface water resources and coastal ecosystems.

Your letter, along with this response, will be reproduced and included in the forthcoming Draft EIS. The Draft EIS has been published and made available for downloading, review and comment in the current issue of the Office of Environmental Quality Control's (OEQC) Environmental Notice. Please use the following link to view the current issue of the Notice:

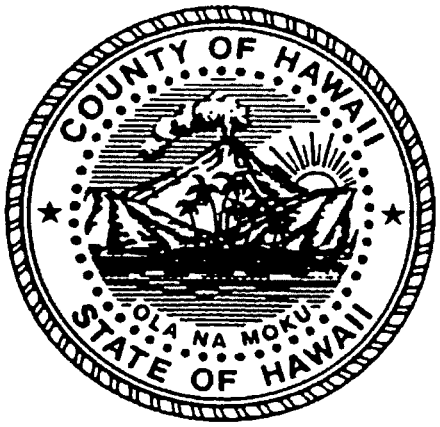
(http://oeqc.doh.hawaii.gov/Shared%20Documents/Environmental_Notice/current_issue.pdf)

We appreciate your participation in the EIS Preparation Notice review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

1907 S. Beretania Street, Suite 400 • Honolulu, Hawaii • 96826 • (808) 946-2277



APPENDIX B

Technical Report: Kealakehe WWTP
R1 Upgrade Project

Prepared for
County of Hawaii Department of Environmental Management
January 2019

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

Signature

April 30, 2020
Expiration Date of the License

Brown AND Caldwell

1955 Main Street, Suite 200
Wailuku, Hawaii 96793
Phone: 808.244.7005
Fax: 808.244.9026

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List of Abbreviations

ac	acre
ANSI	American National Standards Institute
bgs	below ground surface
BOD_5	5-day biochemical oxygen demand
CDPH	California Department of Public Health
cm	centimeter
cm^2	square centimeter
DEM	County of Hawaii Department of Environmental Management
DOH	State of Hawaii Department of Health
DPR	County of Hawaii Department of Parks and Recreation
DWS	County of Hawaii Department of Water Supply
EIS	Environmental Impact Statement
ft^2	square feet
ft^3	cubic feet
g	grams
gpd	gallons per day
gpm	gallons per minute
HDPE	high density polyethylene
HELCO	Hawaii Electric Light Company
HLR	Hydraulic loading rate
hp	horsepower
lbs	pounds
lf	linear feet
kW	kilowatt
m	meter
Mgal	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
mL	milileter
MSL	mean sea level
N	nitrogen
NTU	nephelometric turbidity units
NWRI	National Water Research Institute
QLT	Queen Liliuokalani Trust
P	phosphorous
ppd	pounds per day
psi	pounds per square inch
PVC	polyvinyl chloride
R-1	Highest quality category of recycled water in Hawaii
RO	reverse osmosis
rpm	revolutions per minute
SAT	soil aquifer treatment
SDR	standard dimension ratio
SPS	sewage pumping station
TM	technical memorandum
TSS	total suspended solids solids
µg/L	micrograms per liter
µWs	microWatts
UV	ultraviolet light
VFD	variable frequency drive
WWRF	wastewater reclamation facility
WWTP	wastewater treatment plant

Executive Summary

The County of Hawaii Department of Environmental Management (DEM) intends to upgrade the Kealakehe Wastewater Treatment Plant (WWTP) to implement water recycling, improve treatment, and change the method of treated effluent disposal. Initially, the Kealakehe WWTP R-1 Upgrade Project (Project) will consist of the following elements:

- Treatment upgrades at the WWTP that will allow recycled water to be produced.
- Pumping systems and pipelines to deliver the recycled water to users.
- Creation of green space on the buffer parcel that surrounds the WWTP that will be irrigated with recycled water.
- Irrigation improvements to the Kailua (Old Kona Airport) Park to allow recycled water to be used for irrigation.
- Creation of subsurface flow constructed wetlands at the WWTP to provide polishing treatment of water that requires disposal.
- Liner replacement in two aerated lagoons at the WWTP.
- Installation of baffle curtains and floating ball covers in two aerated lagoons at the WWTP.
- Installation of a redundant force main between the Kealakehe Sewage Pump Station and the WWTP.
- Creation of a soil aquifer treatment system for treated effluent that requires disposal.
- Closure of the existing disposal percolation basin.

Future related projects will include:

- Recycled water treatment capacity expansions.
- Recycled water pumping capacity expansions.
- Additional pipelines to recycled water users.
- Elevated storage tank(s) for recycled water transmission.

This Technical Report was prepared in support of the environmental impact statement (EIS) for the Project.

The future effluent management system at the Kealakehe WWTP will have two elements:

- A recycled water program to put effluent to beneficial use. Irrigated area is projected to increase from 90 acres initially to 565 acres at build-out, which will reuse up to 4.5 million gallons per day (mgd) of recycled water on an average annual basis.
- A constructed wetland and soil aquifer treatment system to provide treatment and land application (disposal) of effluent that is not recycled. This effluent disposal system will provide high-level treatment of an average of 0.9 mgd initially and 0.7 mgd at build-out but will have the capacity to accept all of the WWTP effluent (if needed).

Implementation of the new effluent management system will significantly reduce the mass of nitrogen and phosphorus that the community currently discharges to the environment via percolation to groundwater. The proposed improvements are projected to reduce the community's nitrogen and phosphorus mass loading rates to area groundwater by greater than 90 percent from the existing condition.

Section 1

Introduction

1.1 Overview

The County of Hawaii Department of Environmental Management (DEM) intends to upgrade the Kealakehe Wastewater Treatment Plant (WWTP) to implement water recycling, improve treatment, and change the method of treated effluent disposal. Initially, the Kealakehe WWTP R-1 Upgrade Project (Project) will consist of the following elements:

- Treatment upgrades at the WWTP that will allow the DEM to produce recycled water.
- Pumping systems and pipelines to deliver the recycled water to users.
- Creation of green space on the buffer parcel that surrounds the WWTP that will be irrigated with recycled water.
- Irrigation improvements to the Kailua (Old Kona Airport) Park to allow recycled water to be used for irrigation.
- Creation of subsurface flow constructed wetlands at the WWTP to provide polishing treatment of water that requires disposal.
- Liner replacement in two aerated lagoons at the WWTP.
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- Closure of the existing disposal percolation basin.

Future related projects will include:

- Recycled water treatment capacity expansions.
- Recycled water pumping capacity expansions.
- Additional pipelines to recycled water users.
- Elevated storage tank(s) for recycled water transmission.

This Technical Report was prepared in support of the environmental impact statement (EIS) for the Project.

1.2 Goals

The goals of the Project are:

- Provide for the effluent management needs of the service area.
- Implement non-potable water recycling within the service area. A water recycling program will enhance the area water supply situation by freeing up potable water that is currently being used for irrigation and other non-potable uses. A water recycling program will also reduce the quantity of effluent that requires disposal and will put nutrients in the effluent to beneficial use as fertilizer.

- Increase nutrient removal within the wastewater treatment process to reduce the amount of nutrients that are disposed.
- Replace the existing disposal percolation basin with a land application system that will provide additional environmental protection over the status quo.
- Minimize impacts to the ratepayers.
- Provide a reliable wastewater management system that is relatively simple to operate and maintain.

1.3 Report organization

This Technical Report is organized as follows:

- **Section 1, Introduction:** introduces the Project and its purpose.
- **Section 2, Flow Projections and Characteristics:** presents the flow and load projections for the Kealakehe WWTP.
- **Section 3, Effluent Management Systems:** introduces water recycling and effluent disposal needs for the WWTP.
- **Section 4, Recycled Water Treatment System:** discusses the regulatory requirements and the recommended recycled water treatment system components.
- **Section 5, Recycled Water Transmission System:** provides an overview of the reservoirs, pipelines, and pumping systems that will used to deliver recycled water to users.
- **Section 6, Buffer Parcel:** presents improvements to create green space on the buffer parcel that surrounds the WWTP that will be irrigated with recycled water.
- **Section 7, Old Kona Airport (Kailua) Park Improvements:** presents improvements to the park that will allow recycled water to be used for irrigation.
- **Section 8, Effluent Disposal System:** provides an overview of the proposed subsurface flow constructed wetlands and soil aquifer treatment system.
- **Section 9, Nutrient Reduction Benefits:** presents a summary of the nutrient reduction benefits achieved by the new elements of the WWTP treatment system.
- **Section 10, Other Options Considered:** discusses other options that were considered during the development of the Project.

Section 2

Flow Projections and Characteristics

This section presents the existing effluent flows at the Kealakehe WWTP and summarizes flow projections for the next 20 years.

2.1 Historical flows

The Kealakehe WWTP currently treats approximately 1.7 million gallons per day (mgd) of wastewater from the greater Kailua-Kona town area. Figure 2-1 shows the monthly average effluent flows for the period October 2013 through March 2017. The dotted trend line indicates a growth rate of less than 1 percent during the 42-month period. The extremely low effluent flow in November 2016 was due to construction activities.

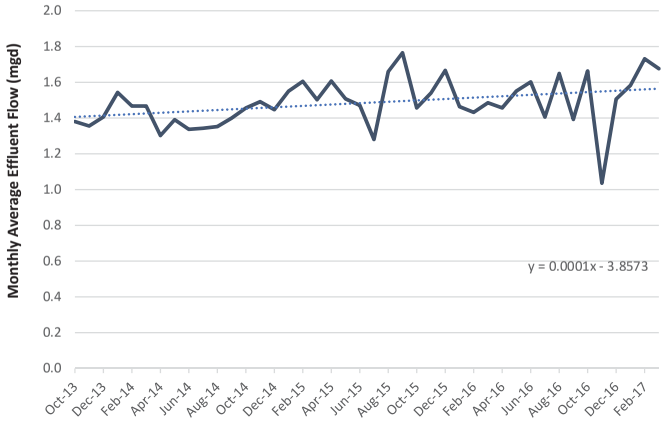


Figure 2-1. Historical Monthly Average Effluent Flow (October 2013 – March 2017)

Figure 2-2 shows the peak day effluent flows that occurred each month during the same time period. The high peak day flows in August and November of 2016 were due to construction activities.

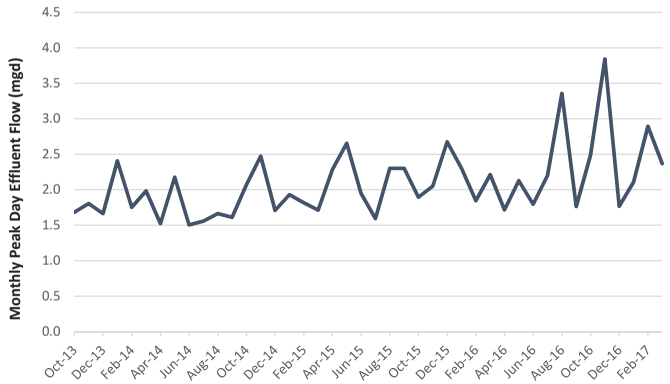


Figure 2-2. Peak Day Effluent Flows

Figure 2-3 shows the effluent discharge peaking factors experienced during the same time period. The peaking factor is derived by dividing the peak day flow by the monthly average flow. In general, the highest peak day peaking factors are between 1.5 and 2.0; the high peaking factor in November 2016 was due to construction activities and not indicative of typical operations. For planning purposes, a peak day peaking factor of 2.0 will be used.

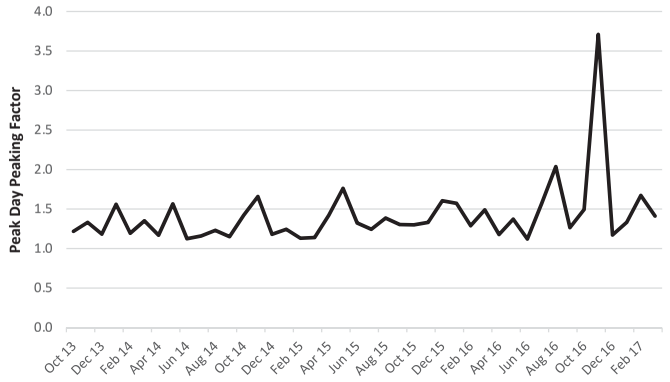


Figure 2-3. Historical Peak Day Peaking Factors

2.2 Effluent Flow Projections

Figure 2-4 shows monthly average flow projections for a 20-year planning period (through 2038), assuming a 3.2 percent growth rate within the service area. The County of Hawaii Department of Water Supply (DWS) has used a 3.2 percent growth rate to develop maximum potable water demand projections in the area (Fukunaga and Associates, Inc., August 2010). The monthly average flow rate is projected to increase from the current 1.7 mgd to approximately 3.2 mgd over the next 20 years. This flow projection is conservative when compared to the lesser growth seen in wastewater flow rates to the WWTP over the last 5 years.

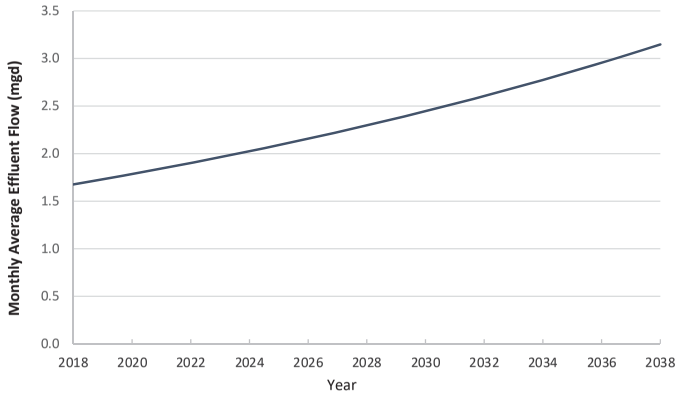


Figure 2-4. Monthly Average Flow Projections

Table 2-1 provides a summary of the flow projections for the 20-year planning period based on the analyses of the historical flow patterns at the facility.

Table 2-1. 20-Year Flow Projections

Description	Peaking Factor	Current Value (2018)	Future (20-Year) Value (2038)
Average flow	1.0	1.7 mgd	3.2 mgd
Peak day flow	2.0	3.4 mgd	6.4 mgd

Section 3

Effluent Management System

The future effluent management system at the Kealakehe WWTP will have two elements:

- A recycled water program to put effluent to beneficial use.
- A constructed wetland and soil aquifer treatment system to provide treatment and land application (disposal) of effluent that is not recycled.

Estimates of the recycled water demands and effluent disposal flows are discussed in the following sections.

3.1 Water Recycling

Most water recycling programs focus on irrigation reuse. The nutrients (e.g., nitrogen and phosphorus) in recycled water can provide some or all fertilizer needs of the irrigated vegetation. Water recycling puts treated wastewater to beneficial use, rather than disposing of it to the environment. The following subsections provide a summary of initial recycled water customers and potential future customers for the Kealakehe WWTP.

3.1.1 Initial Recycled Water Customers

Figure 3-1 shows the proposed initial recycled water customers in green. The use sites are discussed below.

3.1.1.1 WWTP Buffer Parcel

The DEM-owned WWTP buffer parcel will be graded, soil imported, and piping and sprinkler system installed to support irrigation of turf grass using recycled water.

Additional detail is provided in Section 6.

3.1.1.2 Old Kona Airport (Kailua) Park

The County of Hawaii Department of Parks and Recreation (DPR)-owned Old Kona Airport Park will use recycled water for irrigation purposes. DPR developed a master plan for the facility that included significant expansion of recreational facilities, and design documents prepared that included a booster pump and piping to use recycled water for irrigation purposes. Unfortunately, the construction bids to implement the master plan exceeded the available budget and the project was not constructed.

Currently, potable water is used to irrigate fields at the south end of the park and other vegetated areas. The existing irrigation systems will be replaced with new systems designed to use recycled water. The new park irrigation piping systems will be expandable when DPR implements the master plan improvements at the park.

Section 7 summarizes the park improvements needed to accommodate recycled water.

Brown AND Caldwell	SCALE: 1" = 2000'	KEALAKEHE WASTEWATER TREATMENT PLANT RECYCLED WATER USERS	FIGURE 3-1

Path: P:\Projects\Hawaii, County Of (HI)\149607 Kealakehe WWTP R-1 Water Upgrade_CAD\0-PROJECT\FIGURES\EIS_Report
File Name: 149607-FIG-R1_EIS Recycled Water Users Plot Date: July 2, 2018 3:06 PM Cadd User: Richard Sellona

3.1.1.3 Kohanaiki Golf and Ocean Club

A transmission system will be installed to deliver recycled water to the Kohanaiki Golf and Ocean Club. A low-head pumping system and pipeline will connect to a recycled water pipeline that was installed as part of the recently-completed Queen Kaahumanu Highway widening project. The connection point for the existing pipeline is located makai of the Kealakehe Parkway intersection. The new pipeline alignment will be located within an existing easement located makai of the highway.

The County of Hawaii Department of Water Supply (DWS) constructed a 1.0 million-gallon (Mgal) concrete potable water tank at elevation 125 feet mean sea level (MSL) on the north side of Hina Lani Street. The tank was never used and is being transferred to (DEM) for recycled water use.

Kohanaiki Golf and Ocean Club was constructed with a network of recycled water piping in anticipation of future recycled water deliveries. Currently, the development treats its wastewater to R-1 standards and is permitted to use the recycled water to irrigate approximately 9.1 acres of landscaping along its entrance road. The development obtains irrigation water by pumping brackish groundwater that is treated using reverse osmosis (RO) to reduce chlorides to approximately 900 milligrams per liter (mg/L). The brine from the RO process is disposed via an injection well. The RO water is used to irrigate the golf course and common areas. The RO system has capacity to produce up to 1.25 mgd of irrigation water.

Kohanaiki Golf and Ocean Club has indicated that it intends to initially use recycled water to irrigate the 9.1 acres that are currently permitted to use recycled water. Future use could include the development common areas, but irrigation piping changes will be required. Kohanaiki Golf and Ocean Club has indicated that they could use up to 0.5 mgd of R-1 water for their common area irrigation needs. Kohanaiki Golf and Ocean Club indicated they are hesitant to use recycled water on the golf course because the nutrients in recycled water increase the turf growth rate, and they will continue to produce RO water for this use. The R-1 transmission system will be designed to provide up to 1.25 mgd to Kohanaiki Golf and Ocean Club should they decide to use recycled water on their golf course in the future.

3.1.1.4 Makalapua Project

The Makalapua Project is a mixed-use development proposed by the Queen Liliuokalani Trust (QLT) that includes multi-family and single family residential, commercial, hotel, and community space. QLT has expressed a strong interest in using recycled water within the development. QLT's development schedule is such that it could start using R-1 water for construction, irrigation, and other approved purposes shortly after R-1 water becomes available. Therefore, the Makalapua Project is included as an initial recycled water customer.

3.1.2 Future Recycled Water Customers

Figure 3-1 shows potential future recycled customers users in blue. These potential users are not expected to be able to use recycled water when it first becomes available but could use recycled water at some point in the future when the respective development projects occur and the R-1 treatment and transmission systems are expanded to service the customers. The potential users are discussed below.

3.1.2.1 Old Kona Airport Park - Master Plan Improvements

When the DPR master plan for the Old Kona Airport Park is implemented there will be additional landscaped areas that will rely on recycled water for irrigation purposes. Section 7 presents additional details for the Old Kona Airport Park uses.

3.1.2.2 Kealakehe Regional Park

The DPR has developed a master plan for the Kealakehe Regional Park on the parcel shown in Figure 3-1. The master plan for the park includes fields for various sports, community gardens, a great lawn, and landscaping. Recycled water will be used to meet the irrigation needs of the park.

3.1.2.3 QLT Development

QLT intends to develop parcels mauka and makai of the Queen Kaahumanu Highway and has expressed interest in using recycled water for irrigation of parks, playgrounds, street landscaping, irrigation of common areas, and other DOH-approved uses of R-1 water.

3.1.2.4 Honokohau Small Boat Harbor

Recycled water can potentially be used to irrigate street landscaping along the entrance road to the Honokohau Small Boat Harbor, and other landscaping within the harbor.

Recycled water cannot be used for public boat washing purposes, because DOH prohibits standard hose bibs on recycled water systems. Recycled water could potentially be used for boat washing purposes within commercial boat yards, if runoff is contained, secured color-coded hose bibs are used, and other DOH requirements are met.

3.1.2.5 Lanihau Development

The proposed Lanihau Development includes the West Hawaii Business Park. In addition to landscape irrigation, other industrial uses of R-1 recycled water may develop within the area.

3.1.3 Recycled Water Demand Projections

Recycled water demand estimates are developed below.

3.1.3.1 Unit Irrigation Demands

Kohanaiki Golf and Ocean Club irrigation records for 2014 and 2015 were reviewed to develop unit irrigation demands for the area. The Kohanaiki Golf and Ocean Club irrigation systems are professionally managed, so they provide an excellent means for estimating future recycled water demands in the vicinity. Figure 3-2 shows unit irrigation demands in units of gallons per day (gpd) per acre throughout the year that were developed based on the Kohanaiki Golf and Ocean Club data. As shown in the figure, irrigation demands vary throughout the year due to temperature, precipitation, and evaporation rates. The highest irrigation demand occurs in August, at a rate of 9,300 gpd per acre. The lowest irrigation demand is projected to occur during the month of February, at a rate of 7,000 gpd per acre. The average unit demand throughout the year is estimated to be 8,200 gpd per acre.

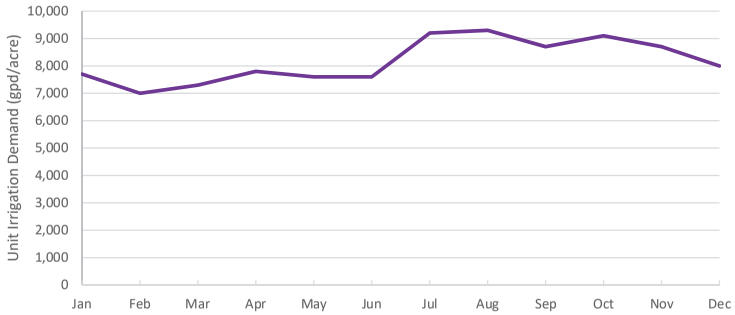


Figure 3-2. Unit Irrigation Demands

3.1.3.2 R-1 Demand – Initial Condition

Utilizing the estimated user seasonal irrigation demand graph and information gathered on initial recycled water sites, the anticipated daily total R-1 demand fluctuates between 0.6 and 0.8 mgd through the year, as shown in Table 3-1.

Table 3-1. Recycled Water Demand Estimate - Initial Condition

User	Irrigated Area (acres)	Peak Month Demand (mgd)	Low Month Demand (mgd)	Average Annual Demand (mgd)
WWTP buffer parcel	38	0.4	0.3	0.3
Old Kona Airport Park	22	0.2	0.2	0.2
Kohanaiki Golf and Ocean Club	30	0.3	0.2	0.3
Makalapua	12	0.1	0.1	0.1
Totals	**102**	**1.0**	**0.8**	**0.9**

3.1.3.3 Build Out R-1 Demand

Table 3-2 provides initial estimates of the recycled water demands at full build out, which is not anticipated to occur during the 20-year planning period. It should be noted that these estimates will change as development plans are refined. The table shows that a total of 565 acres of irrigated area will be required to create a peak month demand equal to 5.3 mgd, and an average annual demand of 4.6 mgd.

Table 3-2. Recycled Water Demand Estimate - Full Build Out

User	Irrigated Area (acres)	Peak Month Demand (mgd)	Low Month Demand (mgd)	Average Annual Demand (mgd)
WWTP buffer parcel	38	0.4	0.3	0.3
Old Kona Airport Park	55	0.5	0.4	0.4
Kohanaiki Golf and Ocean Club	50	0.5	0.4	0.4
Makalapua	12	0.1	0.1	0.1
QLT development	226	2.1	1.6	1.9
Kealakehe Regional Park	85	0.8	0.6	0.7
Honokohau Harbor	9	0.1	0.1	0.1
Lanihau development	90	0.8	0.6	0.7
Totals	**565**	**5.3**	**4.1**	**4.6**

3.1.3.4 R-1 Demand – Rate of Increase

The previous subsections provided estimates of the initial and ultimate buildout R-1 demands. The initial R-1 treatment capacity will be 1.8 mgd, with two future 1.8 mgd expansions planned to provide the full buildout capacity. The R-1 demand growth rate cannot be accurately predicted because it hinges on development projects by others, acceptance of recycled water by users and the public, etc. What is not known is when the R-1 treatment expansions will be needed. Table 3-3 provides known factors that will affect R-1 demand. In general, users that will increase R-1 demand without increases in flow to the WWTP (e.g., Kealakehe Regional Park) will likely incur sudden significant increases in R-1 demand without corresponding increases in WWTP influent flow. DEM will need to be careful not to over-commit to supplying R-1 water to these users before the WWTP influent flows are sufficient to support the users. The other class of users are development projects (e.g., QLT Development) that will develop over time, increasing WWTP influent flow, and providing wastewater to support their R-1 demand.

Future R-1 treatment expansions and transmission improvements will need to be implemented in a timeframe to support the future recycled water users.

Table 3-3. Known Factors that will Affect R-1 Demand

User	Description	WWTP Influent Flow Impact	Peak R-1 Demand Impact
WWTP buffer parcel	Buffer parcel irrigation can be reduced or curtailed if demand exceeds supply	0	-0.4 mgd
Old Kona Airport Park	Master planned improvements are implemented	Negligible (park restrooms)	+0.3 mgd
Kohanaiki Golf and Ocean Club	Irrigation improvements completed to use full 0.5 mgd as requested	0	+0.2 mgd
	Development requests to use R-1 on golf course in lieu of RO water	0	+0.75 mgd
Makalapua	Development occurs	0.2 mgd	+0.1 mgd
QLT Development	Development occurs	To be determined	To be determined
Kealakehe Regional Park	Park master plan is implemented	Negligible (park restrooms)	+0.8 mgd
Honokohau Harbor	Infrastructure improvements to use R-1 water are implemented in conjunction with project to deliver wastewater to Kealakehe WWTP and close existing onsite WWTP systems	+14,000 gpd based on onsite WWTP system capacities	+0.1 mgd
Lanihau Development	Development occurs	To be determined	+0.8 mgd

3.1.4 Recycled Water Quality – Chloride

Areas that use the recycled water will need to be planted with salt-tolerant vegetation due to elevated levels of chloride in the R-1 water. Chloride concentrations are projected to typically be in the 600 to 700 mg/L range. The reasons for the elevated chloride levels are:

- The drinking water in the Kailua-Kona has elevated chloride concentrations. The secondary drinking water standard maximum contaminant level established by USEPA for chloride is 250 mg/L for taste reasons.
- Chloride concentrations generally increase by approximately 50 mg/L through domestic use.
- Brackish groundwater infiltration into sewers that are located below groundwater elevation. DEM has put considerable effort into correcting collection system deficiencies that result in brackish groundwater infiltration, however infiltration into sewer laterals located on private property is believed to occur.

Potential users of recycled water will be instructed to plant salt-tolerant vegetation where R-1 water will be used. The Old Kona Airport Park and the WWTP buffer parcel will be planted with salt-tolerant vegetation. The Kohanaiki development is planted with salt-tolerant vegetation, as their current irrigation water source contains approximately 900 mg/L of chloride.

3.2 Disposal Flow Projections

Water recycling is preferred over disposal to maximize the use of available water resources and to beneficially use the nutrients in the effluent. However, effluent that is not recycled will require disposal. Monthly estimates of recycled and disposal flows for the initial and full build out conditions are developed in this section.

3.2.1 Disposal Flow – Initial Condition

The initial condition average daily WWTP effluent flow is assumed to be 1.7 mgd. Table 3-4 presents the effluent water balance for the initial condition. Figure 3-3 presents the information in graphical form.

Table 3-4. Disposal Flow Estimate – Initial Condition

Month	Average WWTP Effluent Flow (mgd)	Recycled Water Demand (mgd)	Disposal Flow (mgd)
January	1.7	0.8	0.9
February		0.7	1.0
March		0.8	0.9
April		0.8	0.9
May		0.8	0.9
June		0.8	0.9
July		0.9	0.8
August		0.9	0.8
September		0.9	0.8
October		0.9	0.8
November		0.9	0.8
December		0.8	0.9
Annual average	1.7	0.8	0.9

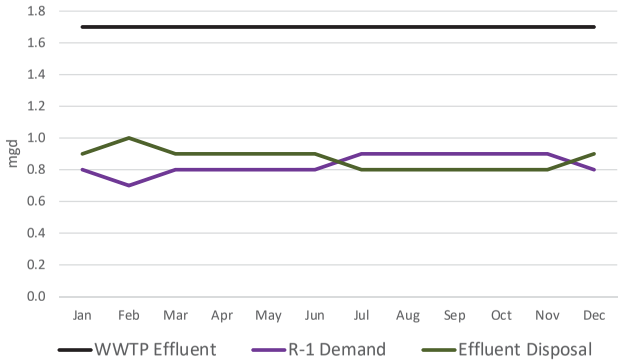


Figure 3-3. Effluent Water Balance – Initial Condition

3.2.2 Disposal Flow – Build Out Condition

The buildout condition average daily WWTP effluent flow is assumed to be 5.3 mgd. Table 3-5 presents the effluent water balance for the buildout condition, assuming the total irrigated acreage shown in Table 3-2 is available. Figure 3-4 presents the information in graphical form.

Table 3-5. Disposal Flow Estimate – Build Out Condition

Month	Average WWTP Effluent Flow (mgd)	Recycled Water Demand (mgd)	Disposal Flow (mgd)
January	5.3	4.4	0.9
February		4.0	1.3
March		4.1	1.2
April		4.4	0.9
May		4.3	1.0
June		4.3	1.0
July		5.2	0.1
August		5.3	0.0
September		4.9	0.4
October		5.1	0.2
November		4.9	0.4
December		4.5	0.8
Annual average	5.3	4.6	0.7

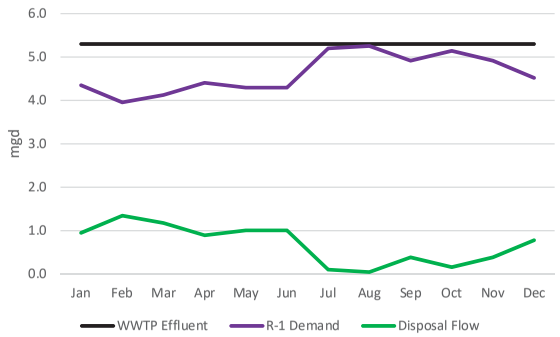


Figure 3-4. Effluent Water Balance – Buildout Condition

As shown in the tables and figures, the County can maintain average annual effluent disposal flows at the initial rates (i.e., less than 1.0 mgd) if the water recycling program is expanded as area development occurs. Further discussion regarding the nutrient disposal benefits associated with expansion of the water recycling program as the community grows is provided in Section 9.

Section 4

Recycled Water Treatment System

The recycled water treatment system will be designed to reliably produce R-1 recycled water in accordance with current State of Hawaii Department of Health (DOH) guidelines.

4.1 Overview

The Kealakehe WWTP receives and treats less than 2.0 mgd of wastewater from the greater Kailua-Kona town area. Wastewater influent is passed through bar screens and grit chambers for solids and grit removal. It is then sent to a series of five aerated lagoons that provide secondary treatment and clarification. Wastewater is drawn off the last lagoon into the effluent pump station and pumped to a percolation basin for disposal. A basic flow schematic of the WWTP equipment and processes is shown in Figure 4-1.

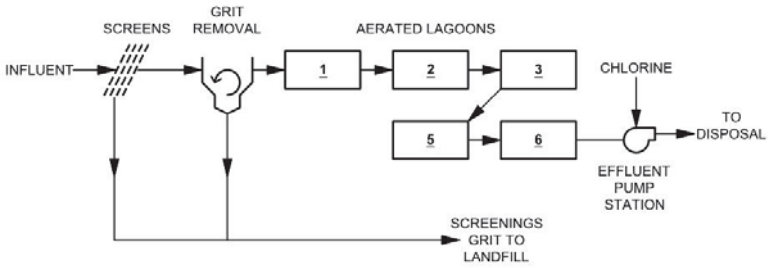
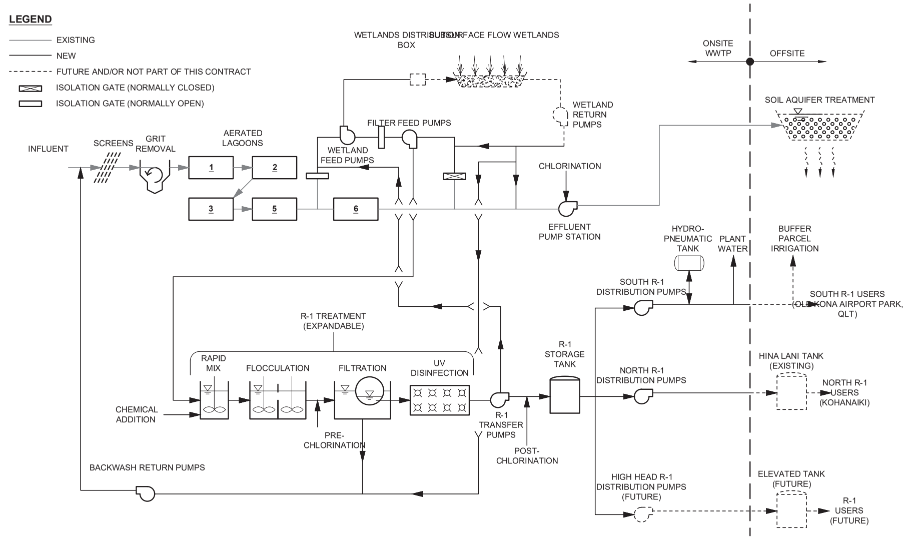


Figure 4-1. Kealakehe WWTP Existing Process Schematic

The existing treatment processes are not capable of producing effluent that meets R-1 recycled water requirements. The following processes will be added create R-1 recycled water:

- Chemical addition
- Flocculation
- Filtration
- UV disinfection

All recycled water systems will be required to meet current DOH Reuse Guidelines. Figure 4-2 is a schematic process diagram of the Kealakehe WWTP including the proposed R-1 recycled water systems, while Figure 4-3 is a preliminary site layout.



Brown AND Caldwell

SCALE: NONE

KEALAKEHE WASTEWATER TREATMENT PLANT

FUTURE PROCESS SCHEMATIC

FIGURE 4-2

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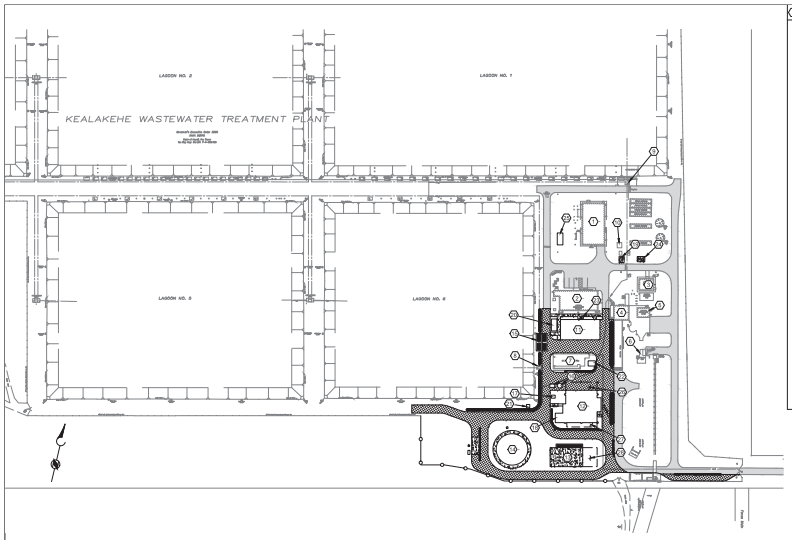
File Name: 149607-FIG-Future Process Schematic   Plot Date: November 2, 2018 3:39 PM   Cadd User: Irina Constantinescu



KEY NOTES

1. EXISTING OPERATIONS BUILDING
2. EXISTING ADMINISTRATIVE BUILDING
3. EXISTING SCRUBBER BUILDING
4. EXISTING GRIT WASH ROOM
5. EXISTING COMPRESSOR ROOM
6. EXISTING INFLUENT BOX
7. EXISTING EFFLUENT PUMP STATION
8. EXISTING FLOW DIVERSION BOX 6
9. EXISTING FLOW DIVERSION BOX 1A
10. EXISTING TRANSFORMER
11. NEW CHEMICAL ELECTRICAL BUILDING
12. NEW R-1 TREATMENT FACILITY
13. NEW R-1 DISTRIBUTION PS
14. NEW R-1 STORAGE TANK
15. NEW PROCESS FEED PS
16. NEW BACKWASH RETURN PS
17. NEW FLOW METER VAULT
18. NEW R-1 TRANSFER PS
19. NEW TRANSFORMER
20. NEW FUEL TANK
21. NEW WETLAND STRAINER
22. NEW EPS STRAINER
23. NEW CONDENSING UNIT
24. NEW ELECTRICAL SWITCHGEAR
25. NEW BULK FUEL STORAGE TANK
26. FUTURE FILTER BASIN EXPANSION
27. FUTURE UV BAY EXPANSION
28. FUTURE R-1 DISTRIBUTION PS EXPANSION

Brown and Caldwell	SCALE: NONE	KEALAKEHE WASTEWATER TREATMENT PLANT PRELIMINARY SITE LAYOUT	FIGURE 4-3

4.2 Regulatory Requirements

Use of recycled water in the State of Hawaii has become more prominent due to a growing population, limited potable water resources, and wastewater disposal issues. The DOH advocates the use of recycled water if public health and water resources are not compromised in the process. Requirements for the safe use of recycled water are outlined in the Guidelines for the Treatment and Use of Recycled Water (Reuse Guidelines), which consists of two volumes:

- Volume 1: Recycled Water Facilities – addresses technical requirements that must be met for the various qualities of recycled water as well as requirements to construct or modify a wastewater reclamation facility (WWRF)
- Volume 2: Recycled Water Projects – covers the application process to use recycled water for purposes such as irrigation, dust control, cleaning, and fire-fighting and establishes best management practices that apply to the end user.

Although the Reuse Guidelines address different grades of recycled water, the remainder of the discussion focuses on R-1 water only. The DOH defines R-1 water as water that is at all times oxidized, then filtered, and then exposed to a disinfection process that produces a median density of fecal coliform that does not exceed any of the following:

- 2.2 per 100 mL using the bacteriological results of the last seven days for which analyses have been completed.
- 23 per 100 mL in more than one sample in any 30-day period.
- 200 per 100 mL in any sample.

To produce R-1 recycled water requires secondary treatment followed by an approved filtration process that is capable of achieving turbidity performance requirements and an approved disinfection process capable of achieving the disinfection performance requirements listed above.

4.3 Capacity

Table 4-1 summarizes the design flows for the proposed R-1 water recycling system at the Kealakehe WWTP. The DEM will be able to increase recycled water production capacity in three phases as both WWTP influent flow and recycled water demands increase.

Table 4-1. Design Flows for R-1 Water Recycling System

Description	Value
Design Flow, Initial (Phase 1)	1.8 mgd
Design Flow, Intermediate (Phase 2)	3.6 mgd
Design Flow, Ultimate (Phase 3)	5.4 mgd

4.4 Filter Feed Pump Station

4.4.1 Design Criteria

The Filter Feed Pump Station will consist of pumps, a wet well, a discharge force main, and supporting appurtenances. This section presents the required pump capacity, hydraulic analysis, and equipment selection. Table 4-2 presents a summary of the design criteria for the Filter Feed Pump Station.

Table 4-2. Filter Feed Pump Station Design Criteria Summary

Parameter	Value
Pumps	
Type	Submersible, non-clog
Number of pumps, initial (Phase 1)	2 (1 duty, 1 standby)
Number of pumps, intermediate (Phase 2)	3 (2 duty, 1 standby)
Number of pumps, ultimate (Phase 3)	4 (3 duty, 1 standby)
Rated capacity, each	2.0 mgd / 1,390 gpm
Motor horsepower, each	15 hp
Motor drive type	Constant speed
Speed, maximum	1,800 rpm
Wet Well	
Type	Trench-style
Material	Concrete
Force Main	
Diameter	20 inches
Material	PVC
Flow meter	Magnetic

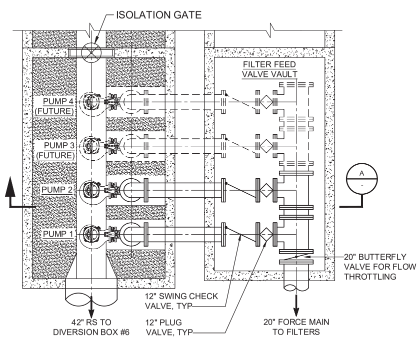
4.4.2 Preliminary Layout

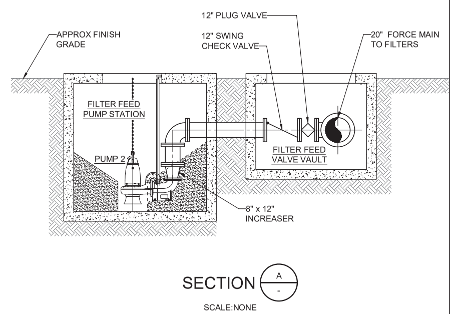
The Filter Feed Pump Station will be constructed integrally with the Wetland Supply Pump Station that is discussed in Section 8.1.3. The remainder of this section focuses on the Filter Feed Pump Station portion of the structure.

The wet well will be a trench-type wet well designed in accordance with the ANSI/HI 9.8 American National Standard for Rotodynamic Pumps for Pump Intake Design (ANSI/HI 9.8). The trench-type design will ensure that the flow of liquid into the pumps will be uniform, steady, and free from swirl and entrained air. Unsteady flow into the pump suction can adversely affect hydraulic performance, increase vibration, and reduce overall pump life.

A valve vault adjacent to the wet well will house the pump isolation valves, pump check valves, and other valves. Piping within the valve vault will be ductile iron. Outside of the vault, the force main will transition to PVC.

Figure 4-4 shows the preliminary layout for the Filter Feed Pump Station and valve vault.





NOT TO SCALE

KEALAKEHE WASTEWATER TREATMENT PLANT

FILTER FEED PUMP STATION PRELIMINARY LAYOUT

FIGURE 4-4

4.5 Chemical Addition and Flocculation Systems

The following chemical addition systems will be provided to supplement various R-1 treatment processes.

- Alum System – Used for coagulation of flow upstream of the filtration system. Alum will be injected into the rapid mix basin.
- Polymer System – Used for flocculation of flow upstream of the filtration system. Polymer will be injected into the flocculation basins.
- Sodium hypochlorite System – Used for maintenance purposes, including algae control in the filtration system. It will be possible to apply sodium hypochlorite both upstream of the filters and downstream of the UV disinfection process.

Table 4-3 presents a design summary for the chemical addition systems.

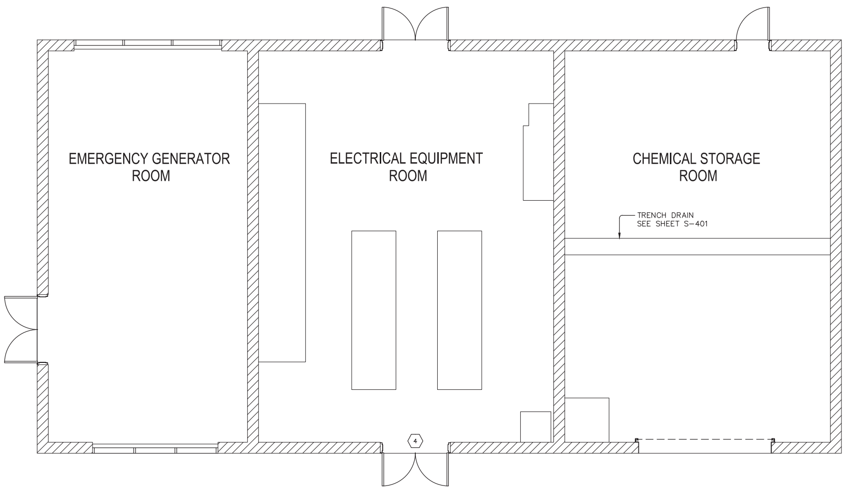
Table 4-3. Chemical Addition Systems Design Criteria Summary

Parameter	Value
General	
Chemical metering pump type	Solenoid-driven diaphragm
Pump turn down ratio	10:1
Piping type	CPVC, double-walled
Chemical delivery containers	275-gallon totes
Alum System	
Number of alum pumps	2 (1 duty, 1 standby)
Alum dose rate	4 - 8 mg/L
Polymer System	
Number of polymer pumps	2 (1 duty, 1 standby)
Polymer dose rate	4 - 8 mg/L
Hypochlorite System	
Number of hypochlorite pumps	2
Hypochlorite dose rate	As-needed maintenance purposes

Each chemical addition system will consist of delivery totes, metering pumps, carrier water pumps, piping, instrumentation, and supporting appurtenances. System components will be housed in an enclosed building with a secondary containment sump to collect any spills. Metering pumps will draw chemical from storage totes and inject the chemical into a carrier water line. Carrier water pumps will deliver the diluted chemical from the storage building to the injection points.

The hypochlorite dosing system will be controlled by chlorine residual analyzers that will be installed on the filter feed force main just upstream of the filters and the R-1 transfer force main just upstream of the R-1 storage tank.

Figure 4-5 is the preliminary floorplan for a new chemical and electrical building that will house the chemical additions systems, electrical and instrumentation systems, and an emergency diesel generator.



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KEALAKEHE WASTEWATER TREATMENT PLANT

PRELIMINARY EMERGENCY GENERATOR, ELECTRICAL ROOM,
AND CHEMICAL ADDITION AND STORAGE BUILDING LAYOUT

FIGURE
4-5

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4.6 Rapid Mixing and Flocculation

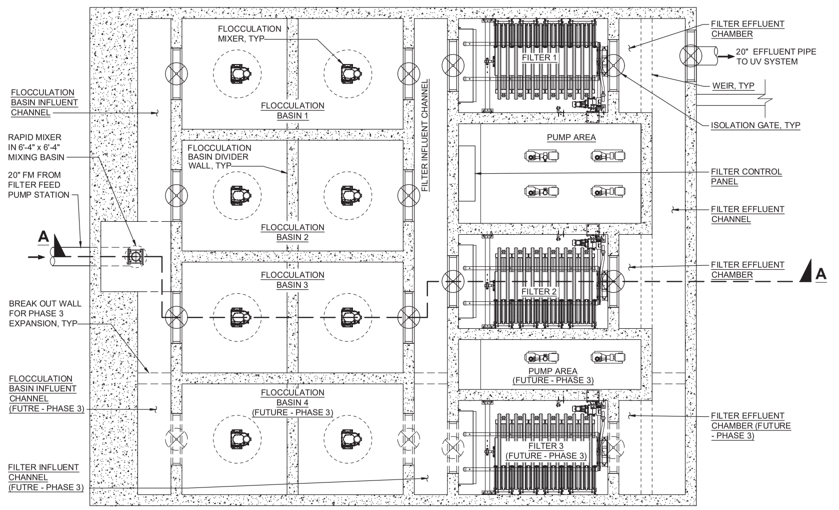
Rapid mixing and flocculation systems will be installed upstream of the filters to help enhance filtration performance. Table 4-4 presents a design criteria summary for the rapid mixing and flocculation systems.

Table 4-4. Rapid Mixing and Flocculation Systems Design Criteria Summary

Parameter	Value
Rapid Mixing System	
Detention time	30 - 60 seconds
Number of tanks	1
Velocity gradient G, maximum	500 sec^{-1}
Number of mixers per tank	1
Mixer horsepower	5 hp
Motor drive type	Variable-speed
Flocculation System	
Detention time, normal	20 minutes
Detention time, minimum	10 minutes
Number of trains, initial (Phase 1)	2
Number of trains, intermediate (Phase 2)	3
Number of trains, intermediate (Phase 3)	4
Number of tanks per train	2
Velocity gradient G, range	20 – 140 sec^{-1}
Number of mixers per tank	1
Mixer horsepower	1 hp
Motor drive type	Variable speed

The chemical addition system will convey chemicals to the rapid mixing and flocculation basins upstream of the filters. Chemical addition combined with mixing will facilitate the formation of floc particles from smaller solid particulates in the wastewater. The larger floc particles will be captured by the filters and enhance overall filtration performance that could not be achieved without chemical addition. Both rapid mixing and flocculation systems will be covered under a roof canopy structure to reduce algae growth, extend equipment life, and other operations and maintenance purposes.

Figure 4-6 shows the proposed preliminary layout of the rapid mixing and flocculation systems.



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KEALAKEHE WASTEWATER TREATMENT PLANT

FLOCCULATION BASINS AND FILTERS
PRELIMINARY LAYOUT

FIGURE
4-6

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4.7 Filtration

The filtration process is a key element of an R-1 treatment system and effluent turbidity is used to measure filtration performance. The DOH Reuse Guidelines require that an R-1 filtration system using sand, granular, cloth or other media has effluent turbidity that does not exceed any of the following:

- An average of 2 nephelometric turbidity units (NTU) within a 24-hour period.
- 5 NTU, more than 5 percent of the time within a 24-hour period (i.e. 72 minutes within a 24-hour period).
- 10 NTU at any time. Diversion of wastewater is required if turbidity exceeds 10 NTU.

The DOH Reuse Guidelines also require a turbidity meter be installed prior to filtration and after the filtration process but before disinfection. The turbidity meter must continuously log data and reports and be capable of retaining a two-year repository,

Although not explicitly required by the Reuse Guidelines, the DOH has historically relied on the State of California Department of Public Health (CDPH) guidance on filtration processes to produce R-1 water. Filtration systems that are approved to produce Title-22 recycled water in California are considered adequate to produce R-1 water in Hawaii. Thus, Title-22 approval will be a design requirement for this project.

The DOH Reuse Guidelines also require standby filtration units and adequate redundancy to provide treatment when units are taken out of service for maintenance, repair, or replacement. For purposes of this project, standby filtration is defined as a system capable of processing the peak flow at the approved filtration rate under the most stressful conditions. The most stressful conditions are defined as the peak flow with one or more filters in the backwash mode and one out of service.

4.7.1 Design Criteria

This section presents the preliminary design for the cloth disk filters and anticipated upstream chemical addition systems. Table 4-5 presents the design summary for the filters.

Table 4-5. Filter Design Criteria Summary

Parameter	Value
Filters	
Type	Cloth disk
Number of filters, initial (Phase 1)	2 (1 duty, 1 standby)
Number of filters, intermediate (Phase 2)	2 (1 duty, 1 standby)
Number of filters, ultimate (Phase 3)	3 (2 duty, 1 standby)
Maximum hydraulic loading rate	4.0 gpm/ft^2
Influent NTU, maximum	20 NTU
Influent TSS, maximum	30 mg/L
Backwash rate, maximum	20 percent
Backwash Pumps	
Type	Centrifugal, self-priming
Number of pumps per filter	2 (1 duty, 1 standby)
Pump horsepower	7.5 hp
Motor drive type	Variable speed
Flow meter type	Magnetic

4.7.2 Filters

The cloth disc filters will be installed in partially buried concrete basins. Additional filter discs and additional basins will be added at each build-out phase. Table 4-6 summarizes the proposed filter build-out to meet recycled water demand.

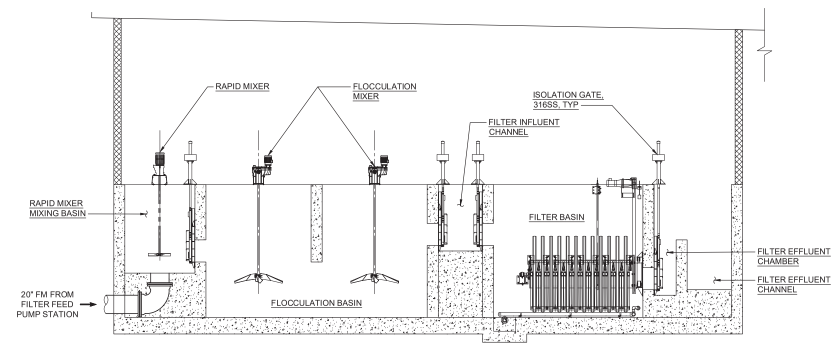
Table 4-6. Filter Build-Out Summary

Stage	No. of Filters	No. of Disks per Filter	Flow per Disk (mgd)	Total Flow per Filter (mgd)	Total System Capacity (mgd)[1]	Rated System Capacity (mgd)[2]
Initial (Phase 1)	2	6	0.33	1.98	3.96	1.98
Intermediate (Phase 2)	2	12	0.33	3.96	7.92	3.96
Ultimate (Phase 3)	3	12	0.33	3.96	11.88	7.92

1. *Capacity with all filters processing flow at maximum loading rate of 4.0 gpm/ft^2 with one disk in backwash mode.*
2. *Capacity with all filters processing flow at maximum loading rate of 4.0 gpm/ft^2 with one disk in backwash mode and one filter basin offline.*

Stairs will be provided from grade level to the filtration deck. All basins will be covered with removable grating. The entire filtration system will be covered with a canopy roof structure to minimize algae growth in the process. Growth of algae in the filter basins can prematurely foul media and result in the need for more frequent cleanings. Even with a roof shade, chlorine addition will be required for periodic filter maintenance. A chlorine line from the sodium hypochlorite system will be provided to each filter.

Figure 4-6 shows the proposed layout of the flocculation basins and filters, while Figure 4-7 shows a preliminary cross-section.



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KEALAKEHE WASTEWATER TREATMENT PLANT

FLOCCULATION BASINS AND FILTERS
PRELIMINARY CROSS SECTION

FIGURE 4-7

4.8 Disinfection

4.8.1 Design Considerations

In Hawaii, disinfection for R-1 recycled water production can be achieved through either chlorination or ultraviolet light (UV). UV disinfection will be used in the R-1 recycled water production system at the Kealakehe WWTP. Table 4-7 summarizes the applicable DOH Reuse Guidelines disinfection requirements. UV systems are also required to comply with NWRI UV Guidelines (NWRI, 2012).

Table 4-7. DOH Reuse Guidelines – Disinfection Requirements

General		
Maximum post-filtration turbidity*	2 NTU	24-hour average
	5 NTU	more than 5% of the time within a 24-hr period (72 minutes)
	10 NTU	at any time (diversion required if turbidity exceeds 10 NTU)
Turbidity meter	• Installed after filtration and prior to disinfection • Continuous turbidity monitoring and data logging with a two-year repository	
Inactivation of F-specific bacteriophage MS2 or poliovirus	99.999% removal	
Maximum effluent fecal coliform levels	2.2 CFU/100 mL	7-day median density
	23 CFU/100 mL	no more than a single sample in a 30-day period
	200 CFU/100 mL	at any time
Disinfection via UV*		
Minimum UV dose	100 mJ/cm^2 (based on max. daily flow)	
Minimum UV transmittance	55% at 254 nanometers	
UV system redundancy**	• Either a standby reactor per train or a standby reactor train or alternate disposal/storage • Standby power and looped power distribution system or alternate storage/disposal	
Monitoring**	• Continuous measurements for flow rate, UV transmittance, UV intensity, operational UV dose, turbidity • On/off status for each reactor and lamp, lamp age, reactor on/off cycles, power consumption and power set point, liquid level in reactor, GFI • Daily sampling for fecal coliform	
Alarms**	Lamp failure, low UV intensity, low UV transmittance, high turbidity, low operational UV dose, high and low water level, GFI	

** Guidelines for sand, granular, cloth or other media filtration*

*** NWRI Guidelines*

Continuous monitoring systems and alarms will be provided as required. The UV system will be covered by a canopy roof structure.

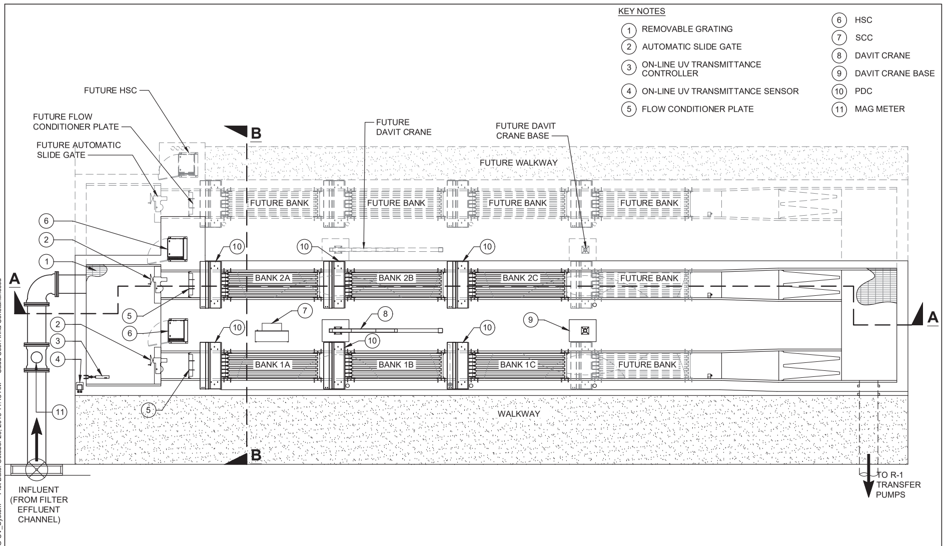
Table 4-8 summarizes design criteria for the UV disinfection system.

Table 4-8. UV Disinfection Design Criteria

Description	Value		
Filtered water UV transmittance	55 percent minimum [a]		
Minimum UV dose	100,000 µWs/cm^2		
Lamp type	Low pressure high output, in quartz sleeves		
End of lamp life factor	0.90		
Lamp fouling factor	0.90		
Lamp cleaning system	Automatic		
	Phase 1	Phase 2	Phase 3
Number of channels	1 duty and 1 redundant	2 duty	3 duty
Number of banks per channel	3 duty	2 duty and 1 redundant	2 duty and 1 redundant
Total number of banks	6	9	9
Number of lamps per bank	72	120	120
Total number of UV lamps	432	720	1,080
Lamp power draw	250 watts/lamp		
Maximum power draw	54 kW	120 kW	180 kW
Water level control	Fixed weirs		

4.8.2 Preliminary Layout

Figures 4-8 and 4-9 detail the UV system components and preliminary layout.



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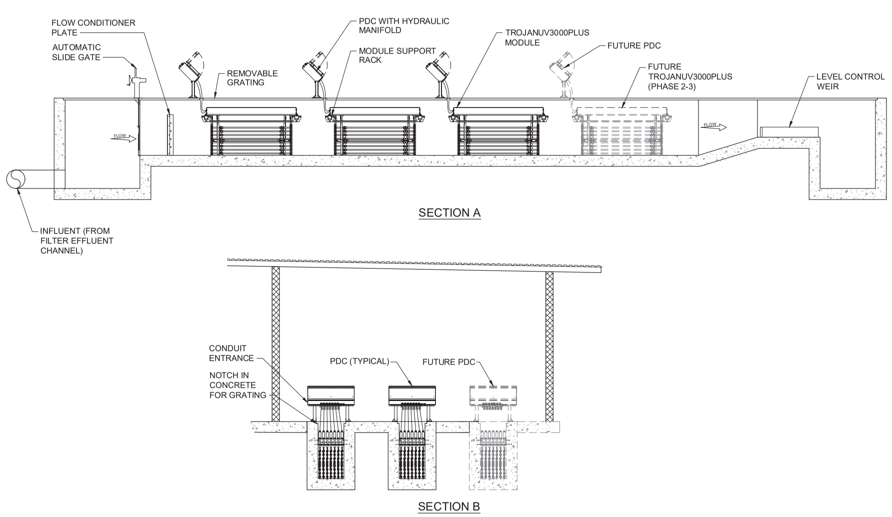
KEALAKEHE WASTEWATER TREATMENT PLANT

UV SYSTEM PRELIMINARY LAYOUT

FIGURE 4-8

Brown AND Caldwell



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KEALAKEHE WASTEWATER TREATMENT PLANT

UV SYSTEM PRELIMINARY SECTIONS

FIGURE 4-9

4.9 Transfer Pumping

The R-1 Transfer Pump Station will consist of pumps, a wet well, a discharge force main, and supporting appurtenances.

4.9.1 Design Criteria

Table 4-9 presents a summary of the design criteria for the R-1 Transfer Pump Station.

Table 4-9. R-1 Transfer Pump Station Design Criteria Summary

Parameter	Value
Pumps	
Type	Submersible, non-clog
Number of pumps, initial (Phase 1)	2 (1 duty, 1 standby)
Number of pumps, intermediate (Phase 2)	3 (2 duty, 1 standby)
Number of pumps, ultimate (Phase 3)	4 (3 duty, 1 standby)
Rated capacity, each	1.8 mgd / 1,250 gpm
Motor horsepower, each	30 hp
Motor drive type	Constant speed
Speed, maximum	1,800 rpm
Wet Well	
Type	Trench style
Material	Concrete
Force Main	
Material	PVC

4.9.2 Preliminary Layout

The R-1 Transfer Pump Station will be located downstream of UV treatment and serve to transport treated water to the nearby onsite storage tank.

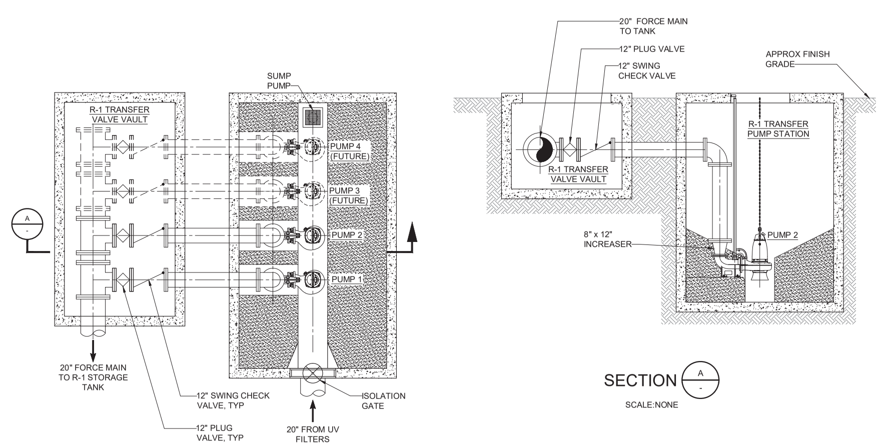
The wet well will be a trench-type wet well designed in accordance with the ANSI/HI 9.8 American National Standard for Rotodynamic Pumps for Pump Intake Design (ANSI/HI 9.8). The trench-type design will ensure that the flow of liquid into the pumps will be uniform, steady, and free from swirl and entrained air.

Using a minimum pump cycle time of 15 minutes, the Phase 3 minimum wetwell size is 1,867 ft^3, which will be achieved utilizing a combination of wetwell, pipe storage, and UV effluent chamber volumes.

An overflow pipe will be installed that will allow R-1 water to be sent to the wetland supply pump station for nutrient removal prior to disposal. Further discussion on the wetland system is provided in Section 8.1.

A valve vault adjacent to the wet well will house the pump isolation valves and pump check valves. Piping within the valve vault will be ductile iron. Outside of the vault, the force main will transition to PVC.

Figure 4-10 shows the preliminary layout for the R-1 Transfer Feed Pump Station and valve vault.



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R-1 TRANSFER PUMP STATION PRELIMINARY LAYOUT

FIGURE 4-10

4.10 Emergency Generator

A diesel-fueled emergency generator will be provided to provide electricity to power the R-1 systems when Hawaii Electric Light Company (HELCO) power is not available. The emergency generator will be located in the chemical and electrical building, as shown in Figure 4-5. Diesel fuel will be stored in an above-ground double-walled tank located adjacent to the building.

Section 5

Recycled Water Transmission System

5.1 R-1 Storage Tank

A 500,000-gallon R-1 storage tank will be constructed as indicated on the site layout presented in Figure 4-3. The tank will provide:

- onsite storage;
- supply and suction head for the constant speed transmission pumps that will transport R-1 water north to the Hina Lani tank; and
- supply and suction head for the constant-speed transmission pumps and hydropneumatics tank system that will supply the plant water system, buffer lands irrigation water system and users to the south including the Queen Liliuokalani Trust lands and the Old Kona Airport Park.

Table 5-1 lists design criteria for the onsite R-1 storage tank.

Table 5-1. Onsite R-1 Storage Tank Design Criteria

Description	Value
Nominal capacity	500,000 gallons
Inside diameter	56 feet
Working depth	30 feet
Materials of construction	Prestressed concrete

Provisions will be made to allow for potable water to enter the tank through an air gap for initial tank fill at startup, maintenance needs, and to supplement R-1 water supply to customers if R-1 production is reduced or curtailed for operational reasons.

A tank drain line will be provided to empty the reservoir. A tank overflow line will also be provided to prevent over-filling the tank. The drain and overflow lines will discharge to Lagoon 6.

Figure 5-1 shows prestressed concrete storage tank during construction.

Figure 5-1. Prestressed Concrete Tank Construction

5.1.1 Future Elevated Storage Tanks

Elevated storage tanks will be added in future expansion projects. The two 2.0 Mgal elevated tanks will provide diurnal storage capacity to balance recycled water production with demand, while also providing constant water pressure to the recycled water users. The tanks will be located at approximately elevation 290 feet MSL, within the QLT mauka development area, as shown in Figure 3-1.

5.2 R-1 Pumping Systems

Three pump stations will be needed to convey R-1 water from the on-site R-1 storage tank.

- North User System: pumping system designed to deliver R-1 recycled water to the Hina Lani Tank for use by Kohanaiki Golf and Ocean Club and the SAT site.
- South User System: pumping system designed to deliver R-1 recycled water at working pressure to onsite WWTP uses, buffer parcel, Makalapua Project, Old Kona Airport Park, and future QLT makai users.
- Future High-Head System: pumping system designed to deliver R-1 recycled water to future elevated storage tanks.

Figure 5-2 illustrates the transmission concept schematically, and the proposed location of the on-site storage tank and pump stations is shown on Figure 4-3.

According to the Reuse Guidelines (Volume 2) Transmission Lines fall under the jurisdiction of the recycled water purveyor and refer to the piping from the treatment facility to the approved use area, terminating after the service meter box for each approved use area. Design of new transmission systems shall conform to the "Water System Standards" (State of Hawaii, 2002) and other applicable requirements.

Cross-Connection and Backflow Provisions of the HAR Chapter 11-21 and Backflow Prevention Devices, Water System Standards, Volume I apply to the recycled water transmission and distribution systems.

5.2.1 North Users Pumping System

R-1 water will be pumped from KWWTP to the existing 1.0 MG storage tank at Hina Lani Street and service customers north of KWWTP. The transmission system will consist of vertical turbine pumps installed in cans and a pipeline network.

Design criteria are listed in Table 5-2.

Table 5-2. North Users Pumping System Design Criteria

Description	Value
Number of high-head transmission pumps	2 (1 duty, 1 standby)
Pump type	Vertical turbine in pump cans
Pumping rate	868 gpm (1.25 mgd)
Motor sizes	20 hp
Motor drives	Constant speed

5.2.2 South Users Pumping System

A pump station equipped with a hydropneumatic tank system will supply R-1 recycled water at working sprinkler irrigation pressure (minimum 70 psi) to the following users:

- WWTP internal uses.
- Buffer parcel (see Section 6).
- Old Kona Airport Park (see Section 7).
- Makalapua Project.
- Future QLT makai development.

Table 5-3 outlines the design criterial for the South Users Pumping System.

Table 5-3 South Users Pumping System Design Criteria

Description	Value
Number of transmission pumps	4 (3 duty, 1 standby)
Pump type	Vertical turbine in pump cans
Maximum pumping capacity	1,100 gpm
Motor sizes	25 hp
Motor drives	Constant speed
Hydropneumatic tank system	Three, 2,600-gallon bladder tanks (7,800-gallon total volume)

The distribution pumps will energize/de-energize in response to system pressure and flow. A pressure regulator downstream of the hydropneumatic tank will maintain steady water pressure in the distribution systems for the users.

5.2.3 Future High-Head Pumping System

In future phases, two new 2,000,000-gallon R-1 storage tanks will be constructed at approximately 290 feet elevation, at a location 1.2 approximately miles mauka of the KWWTP. The high-head pumping system will be designed to deliver R-1 recycled water to the tanks. After transmission piping changes are completed, the storage tanks will be used to provide constant pressure to all the R-1 users. Table 5-4 shows a summary of the high head pumping system design criteria.

Table 5-4. Future High-Head System Design Criteria

Description	Value
Number of transmission pumps	3 (2 duty, 1 standby)
Pump type	Vertical turbine in pump cans
Maximum pumping capacity	3,750 gpm (5.4 mgd)
Motor sizes	150 hp
Motor drives	Constant speed

When the high-head pumping system and elevated storage tanks are implemented the north users pumping system, south users pumping system, and Hina Lani tank will no longer be required, because the elevated storage tanks will provide pressure to the entire recycled water distribution system.

5.3 R-1 Pipelines

The R-1 recycled water transmission system will include:

1. **South Users System:** One new 16-inch diameter pipeline that will provide R-1 water to the Old Kona Airport Park and Queen Liliuokalani Trust (QLT) properties. This pipeline will be constructed within the existing force main easement and will terminate at the Kealakehe Sewage Pump Station (SPS).

A redundant 24-inch forcemain from the Kealakehe SPS to the WWTP will be installed within the easement along with the R-1 pipeline.

2. **North Users System:** Three new pipeline segments that will convey R-1 water north from the WWTP to the existing Hina Lani tank.
   a. Segment 1 – this 20-inch pipeline will connect the WWTP to the existing 20-inch recycled water main which currently terminates in the southwest corner of the Queen Kaahumanu Highway and Kealakehe Parkway intersection.
   b. Segment 2 – this 16-inch pipeline will connect the existing 16-inch lateral branching off the 20-inch recycled water main on the northeast corner of the intersection of Queen Kaahumanu Highway and Hina Lani Street to the existing storage tank located on Hina Lani Street.
   c. Segment 3 – this 12-inch pipeline that will provide R-1 water to the SAT site for irrigation of perimeter plantings and partial supply for the future Kealakehe Regional Park. The pipeline will extend from the southeast corner of the intersection of Kealakehe Parkway and Queen Kaahumanu Hwy along Kealakehe Parkway to the top of the SAT system.
3. A future phase 20" pipeline from the intersection of the WWTP entrance road to future phase elevated storage tanks located within the QLT mauka development area.

Figure 5-2 illustrates the proposed R-1 transmission system.

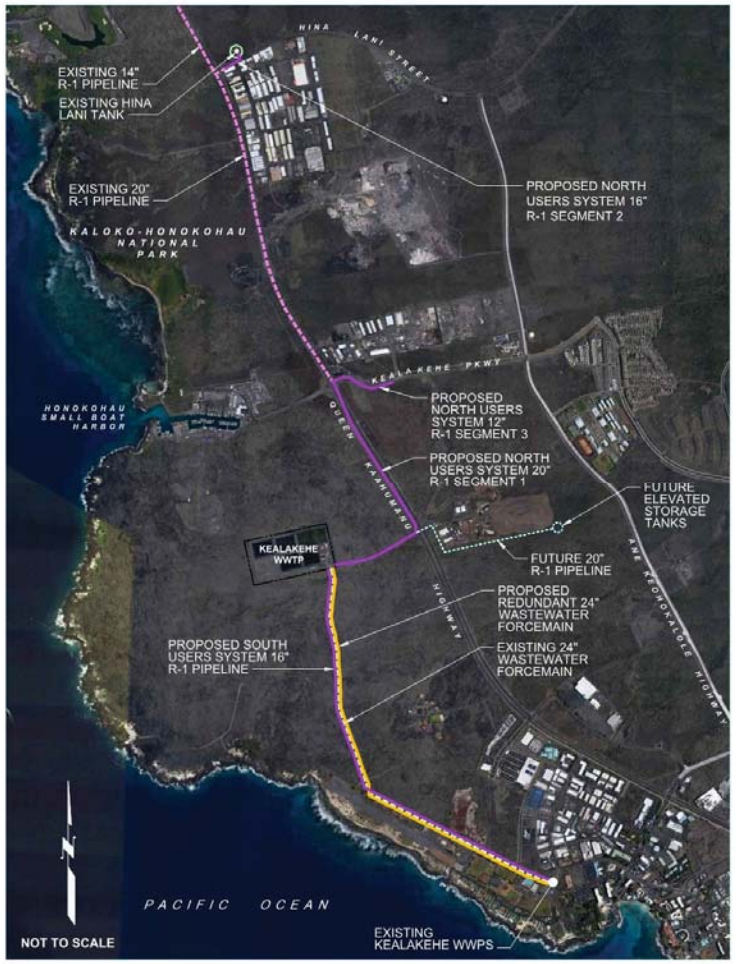


Figure 5-2. Proposed R-1 Distribution System

5.4 Future Elevated Storage Tanks

As mentioned previously, two 2.0 million-gallon R-1 storage tanks will be implemented at approximately the 290-foot elevation on the QLT mauka parcel as part of future phases. The tanks will provide diurnal storage to meet user demands as well as provide constant pressure to all users. When the elevated storage tanks are implemented the following modifications will be required:

- The south users piping system and north users piping systems will be interconnected.
- The Hina Lani tank will be disconnected.
- The north users and south users pumping systems will be disconnected.

The future high-head pumping system will then be capable of delivering recycled water to all of the users.

Section 6

Buffer Parcel Improvements

Recycled water will be to irrigate a landscaped buffer parcel that surrounds the WWTP. This section describes the improvements required to support this use.

6.1 Overview

The 40.458-acre buffer parcel (TMK (3) 7-4-008:073) surrounds the WWTP. The surface is currently comprised of irregular tuff with sparse grass and shrub vegetation. The buffer parcel area will be graded and soil will be imported to provide gently sloping land suitable for irrigation of salt tolerant landscape vegetation. The primary water quality objective will be to provide plant uptake of nutrients. The irrigated buffer parcel is also intended to add green space around the WWTP, providing a visual buffer when surrounding properties are developed.

6.2 Plantings

Recycled water applied to the buffer parcel will be mostly consumed by the plants. The conceptual design assumes vegetation for the buffer parcel will be primarily seashore paspalum grass. Seashore paspalum is native to the southeastern continental U.S. seaboard from Texas to North Carolina. It has also been used for golf course turf and erosion protection planting in Hawaii. Additional accent plantings may be included along the WWTP entrance road. An example of salt-tolerant grass and accent plantings irrigated with recycled water along the entrance road to Kohanaiki is shown in Figure 6-1.

Figure 6-1. Example of Salt-Tolerant Grass and Entrance Road Plantings Irrigated with Recycled Water at Kohanaiki

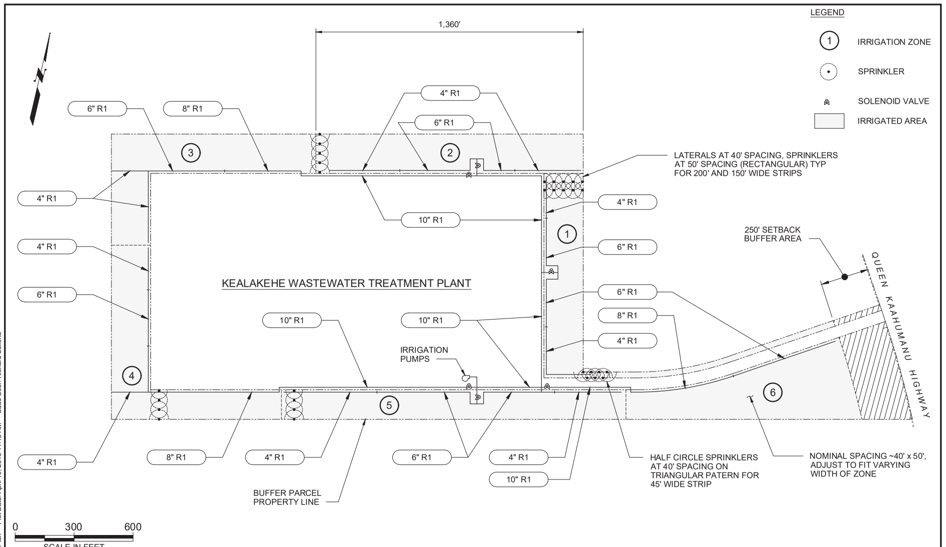
6.3 Irrigation System

Design criteria for the buffer parcel irrigation system are summarized in Table 6-1.

Table 6-1. Buffer Parcel Irrigation System Design Criteria

Description	Value
Total irrigated area	37.4 acres
Main planting	Seashore Paspalum
Peak month demand	348,000 gpd
Irrigation hours per day	8 hours maximum
Irrigation method	Pop-up solid set sprinklers
Pop-up height	6 inches
Sprinkler spacing	40 feet by 50 feet
Average application rate	0.29 inches/hour
Number of irrigation zones	5
Queen Kaahumanu Highway buffer strip	250' wide
Soil type	Loam fill over graded tuff
Soil depth	12 inches
Harvest methods	Mowing
Height before mowing	4 inches
Height after mowing	1.5 inches
Irrigation zone control	Automatic timer, electric valves
Irrigation uniformity	Moderate

An irrigation system preliminary design was developed based on the criteria listed. The layout is shown in Figure 6-2.



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Brown AND Caldwell

SCALE: 1" = 300'

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BUFFER PARCEL PRELIMINARY IRRIGATION PLAN

FIGURE 6-2

The irrigation system flow rate capacity would need to be sized to meet the maximum month demand in an average of 8 hours of irrigation per day. The 348,000 gallons per day maximum month flow rate over 37.4 acres translates to 0.34 inches per day depth of application, or 1.19 hours per day for each zone applying water at 0.29 inches/hr. For an 8-hour maximum run time, the theoretical number of zones would be 6.74, which would be rounded down to 6 actual zones. Additional zone details are provided in Table 6-2.

Table 6-2. Irrigation Zone Design Parameters

Design Parameter	Value
Depth Applied	0.34 inches per day
Number of Zones	6
Typical Zone Size (zones 1-5)	6.23 ac
Average Flow	783 gpm
Average Full Circle Equivalent Sprinklers per Zone	130

The layout shown in Figure 6-2 fits the irrigation zone design parameters as closely as possible, with the exception of zone 6, which would be only 5.6 acres and have a flow requirement of approximately 705 gpm. The values in Table 6-3 are only preliminary and could change slightly depending upon actual sprinkler and nozzle selections.

6.3.1.1 Irrigation for Accent Plantings

Accent plantings along the entrance road could be irrigated with drip irrigation and/or microsprinklers, depending upon the plants selected. One accent planting irrigation zone would be designed on each side of the entrance road. Small parallel irrigation mainlines would be constructed towards buffer land zones 6 and 1 to supply accent planting zone. Each accent planting zone would need approximately 75 to 125 gpm, depending upon irrigation equipment selected. Having separate supply lines would allow the accent plantings to be irrigated independently of the general buffer parcel system, which could be a desirable feature depending upon the recycled water demand from offsite users. Normally the accent areas would probably be irrigated at the same time as other buffer parcel zones. Area set aside for the accent plantings could slightly reduce the areas and irrigation flow rates for zones 1 and 6.

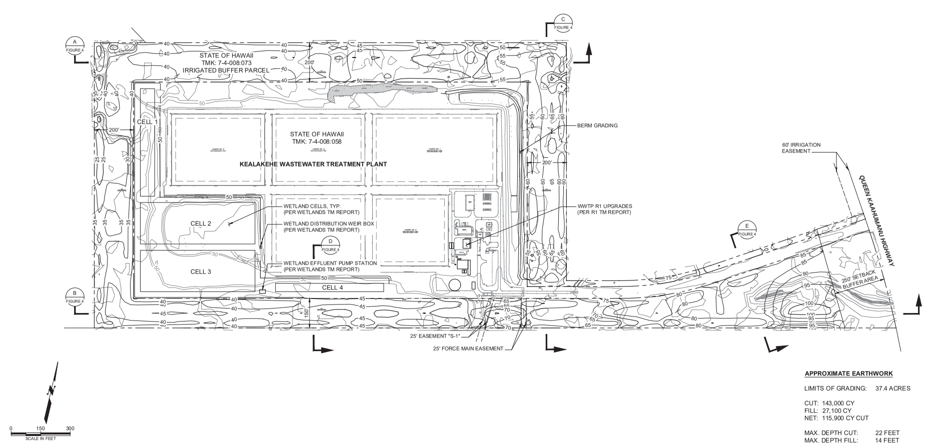
6.3.2 Nutrient Management

A Hawaii supplier for seashore paspalum recommends up to 12 lbs. of N per 1,000 square feet per year, or 522 lbs./acre/year (Southern Turf Hawaii, 2018). References for phosphorus (P) needs of seashore paspalum were not as definitive, with some saying it has relatively high phosphorous needs and others stating the opposite. The saltier the irrigation water, the more likely it will need greater amounts of phosphorus, potassium, and possibly calcium.

The average concentrations of nitrogen and phosphorus from the irrigation water are expected to be 15 mg/L, and 6 mg/L, respectively. For the average annual irrigation demand of 8,167 gpd per acre, these would correspond to loading rates of 373 and 149 lbs./acre/year gross loading rate, respectively. Approximately 15 percent of the applied nitrogen would be likely be lost in denitrification (USEPA, 2006). Therefore, the amount of nitrogen applied via recycled water will be less than the crop uptake. Furthermore, any excess phosphorous will be readily adsorbed by the soil.

6.4 Storm Water Management

Any storm water runoff from the buffer parcel will be captured and retained on site. The buffer parcel site will be graded to provide gentle swales that will convey surface runoff towards retention areas. Figure 6-3 shows the buffer parcel existing elevations and preliminary site grading plan.


STATE OF HAWAII
TMK: 7-4-008:073
IRRIGATED BUFFER PARCEL
STATE OF HAWAII
TMK: 7-4-008:058
KEALAKEHE WASTEWATER TREATMENT PLANT
CELL 1
CELL 2
CELL 3
CELL 4
WETLAND CELLS, TYP.
(PER WETLANDS TM REPORT)
WETLAND DISTRIBUTION WEIR BOX
(PER WETLANDS TM REPORT)
WETLAND EFFLUENT PUMP STATION
(PER WETLANDS TM REPORT)
BERM GRADING
WWTP R1 UPGRADES
(PER R1 TM REPORT)
60' IRRIGATION
EASEMENT
QUEEN KAAHUMANU HIGHWAY
25' EASEMENT "S-1"
25' FORCE MAIN EASEMENT
SCALE IN FEET
APPROXIMATE EARTHWORK
LIMITS OF GRADING: 37.4 ACRES
CUT: 143,000 CY
FILL: 27,100 CY
NET: 115,900 CY CUT
MAX. DEPTH CUT: 22 FEET
MAX. DEPTH FILL: 14 FEET

SCALE: 1" = 300'

KEALAKEHE WASTEWATER TREATMENT PLANT

BUFFER PARCEL EXISTING ELEVATIONS AND PRELIMINARY SITE GRADING PLAN

FIGURE 6-3

Section 7

Old Kona Airport (Kailua Park) Improvements

This section summarizes proposed irrigation improvements at the Kailua Park Complex, including the Old Kona Airport Park Recreational Area, located in Kailua-Kona, in the North Kona District of Hawaii island. The park complex will use R-1 recycled water for irrigation and other approved uses.

The Kailua Park Complex is owned and managed by the DPR and is currently irrigated by potable water from the County of Hawaii Department of Water Supply (DWS). To conserve potable water, reduce irrigation costs to DPR, and reduce waste of a potential recycled water source, DPR and the County of Hawaii Department of Environmental Management, Wastewater Division (DEM) have collaborated to use R-1 recycled water produced at the Kealakehe WWTP to irrigate the Kailua Park Complex. The future Kealakehe WWTP recycled water treatment plant and force main transmission line from the WWTP to the Kailua Park Complex are being designed and built by DEM. It is proposed that DEM will build the irrigation system improvements at the Kailua Park Complex; and, upon completion, DPR will own and operate the system. DEM will also seek site approval from DOH for the use of recycled water at the complex.

7.1 R-1 Irrigation Improvements

The irrigation improvements will include the following:

- Two connection points to the new R-1 force main transmission line from the Kealakehe WWTP to the Kailua Park Complex. The connection points will each require the installation of a R-1 water meter to track the park's irrigation use in an underground concrete vault, accessible for service and monitoring. See Figures 7-1 and 7-3 for the approximate locations of the two connection points.
- New piping, sprinkler and control systems appropriate for R-1 use to each of the existing irrigated areas.
- Replanting areas that will receive recycled water with suitable salt-tolerant plants or turf, as needed.

Figures 7-1 through 7-3 show the proposed areas of irrigation and the approximate associated acreage for each area.

Brown AND Caldwell	SCALE: AS SHOWN JO NO: 149607 DATE: Feruary 2, 2018	Kealakehe WWTP R-1 Irrigation - Kailua Park Comple Puapuaa, North Kona, Hawaii	FIGURE 7-1

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SCALE: AS SHOWN
JO□ NO: 149607
DATE: Fe□ruary 2, 2018

Kealakehe WWTP R-1 Irrigation - Kailua Park Comple□

Puapuaa, North Kona, Hawaii

FIGURE 7-2


6" R-1 Irrigation Main
Approximate location of R-1 Water Meter and Vault
R-1 Force Main (FM) from Kealakehe WWTP (County Easement)
Approximate Property Line
Approximate County Easement Line
2" R-1 Irrigation Lateral
MATCHLINE - SEE FIGURE 2-2
BALLFIELD E (APPROX. 5.7 ACRES)
D FIELD (APPROX. 4.3 ACRES)
NW: 0.062 AC.
N: 0.25 AC.
E: 0.074 AC.
AQUATIC CENTER TOTAL (APPROX. 0.38 ACRES)
BASKETBALL COURTS (APPROX. 0.30 ACRES)
2" R-1 Irrigation Lateral
HORSESHOE FIELD (APPROX. 0.28 ACRES)
BALLFIELD C (APPROX. 2.9 ACRES)
6" R-1 Irrigation Main
B FIELD (APPROX. 2.4 ACRES)
BALLFIELD A (APPROX. 2.9 ACRES)
2" R-1 Irrigation Lateral
Approximate Property Line
2" R-1 Irrigation Lateral
Legend:
Approximate Areas of Irrigation
R-1 FM from Kealakehe WWTP
6" R-1 Mainline
2" R-1 Lateral
Google earth

Brown AND Caldwell

SCALE: AS SHOWN
JOB NO: 149607
DATE: February 2, 2018

Kealakehe WWTP R-1 Irrigation - Kailua Park Complex

Puapuaa, North Kona, Hawaii

FIGURE 7-3

7.2 Proposed Irrigated Areas

The existing areas of the Kailua Park Complex proposed to be irrigated by R-1 water (as shown in Figures 7-1 through 7-3) are summarized in Table 7-1. The table also includes the estimated peak irrigation demands.

Table 7-1. Irrigated Area Size and Peak Irrigation Demand

Proposed Irrigated Area	Approx. Irrigated Acreage	Peak Irrigation Demand[1] (gpd)
Maka'eo Walking and Jogging Park	1.5	14,000
Event Center–East	0.80	7,600
Event Center–West	0.21	2,000
In-line Hockey Rink	0.24	2,300
Ballfield E	5.7	54,000
Horseshoe Field	0.28	2,700
D Field	4.3	41,000
Ballfield C	2.9	28,000
Aquatic Center	0.38	3,700
B Field	2.4	23,000
Ballfield A	2.9	28,000
Basketball Courts	0.30	2,900
Total	**21.9**	**209,000**

[1] *Based on peak irrigation demand of 9,500 gpd per acre*

The Kailua Park Complex R-1 irrigation system will have the capacity to deliver the R-1 flow required to meet R-1 irrigation water demands across the entire complex during a daily 4-hour irrigation period (11:00 p.m. to 3:00 a.m.). The design irrigation demands are based on a peak irrigation demand of 9,500 gpd per acre. Table 7-1, based on area acreage, shows the peak irrigation demand of each area identified to have R-1 irrigation improvements.

The total R-1 peak demand for the complex is 209,000 gpd, but to deliver this peak flow over 4 hours will require a flow rate of 870 gallons per minute (gpm).

7.3 Irrigation Systems

The recycled irrigation systems will be designed and operated to comply with the DOH 2016 Reuse Guidelines.

Section 8

Effluent Disposal System

The Kealakehe WWTP recycled water system will be designed to reuse most of the tertiary-treated recycled water that will be generated. Excess water that is not recycled will be polished in constructed wetlands and then applied to the soil aquifer treatment (SAT) system for further treatment and disposal.

8.1 Constructed Wetlands

The WWTP's existing aerated lagoon system currently converts ammonia that is present in the wastewater into nitrate via a process called nitrification. However, there is no mechanism to remove nitrate from the wastewater, so nitrogen is discharged to the environment with the treated effluent in the form of nitrate.

A subsurface flow constructed wetland is proposed to provide additional treatment at the facility. The wetlands will remove nitrogen from the wastewater via a process called denitrification. In addition, other treatment benefits will be realized in the natural treatment system.

Subsurface flow wetlands consist of shallow, lined basins that are filled with gravel media and planted with emergent wetland vegetation. Water is introduced to the gravel media layer and flows horizontally through the basin. The water level in the wetland is maintained below the gravel surface at all times. Treatment occurs through physical, chemical, and biological mechanisms as the water flows horizontally through the gravel media bed. Figure 8-1 is an illustration of the concept.

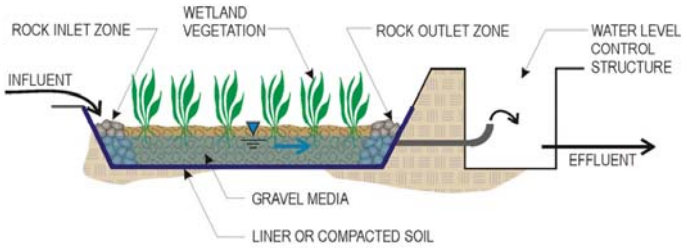


Figure 8-1. Subsurface Flow Constructed Wetland Concept

8.1.1 Denitrification in Subsurface Flow Constructed Wetlands

The Kealakehe WWTP subsurface flow constructed wetland is being designed to provide denitrification treatment to remove nitrate from the aerated lagoon effluent prior to disposal. Denitrification is a biological process whereby nitrate molecules are transformed into nitrogen gas

molecules by naturally-occurring bacteria. The denitrifying bacteria require five conditions for the process to occur:

- A place to grow.
- A source of nitrate.
- An anoxic (low-oxygen) environment.
- A source of carbon.
- Adequate water temperature.

Subsurface flow constructed wetlands provide an excellent environment for the denitrification process to occur, as presented in Table 8-1.

Table 8-1. Denitrification in Subsurface Flow Constructed Wetlands

Condition for Denitrification	Subsurface Flow Constructed Wetland
A place for denitrifying bacteria to grow	The gravel media provides ample surface area for the bacteria to attach and grow.
A source of nitrate	Treated wastewater contains nitrate.
An anoxic (low oxygen) environment	The gravel media in subsurface flow constructed wetlands is an anoxic environment.
A source of carbon	Carbon is introduced into the subsurface flow wetlands via degradable carbon that is present in the treated wastewater and from decaying wetland vegetation.
Adequate water temperature	Treated wastewater is generally warmer than the surrounding environment.

As shown in Table 2-1, subsurface flow constructed wetlands can provide excellent conditions for denitrification of treated wastewater. The equation used to predict denitrification in subsurface flow constructed wetlands is shown below (Crites, et.al., 2014).

$$\frac{C_e}{C_o} = \exp(-K_T t)$$

where:

C_e = effluent nitrate-nitrogen concentration (mg/L)

C_o = influent nitrate-nitrogen concentration (mg/L)

K_T = temperature-dependent rate constant = $1.00(1.15)^{(T-20)}$ days^{-1} when T>1 °C

t = hydraulic residence time (days)

8.1.2 Additional Treatment Benefits

The proposed Kealakehe WWTP subsurface flow constructed wetlands are primarily designed to provide a means to denitrify effluent to reduce the total nitrogen concentration in the wastewater prior to disposal. However, additional polishing treatment benefits will be realized including BOD_5 and TSS reduction, a small amount of phosphorus removal, and reduction in metals, trace organic compounds, and pathogens.

The additional treatment benefits are not primary design parameters for the Kealakehe system but are presented below to document the additional polishing treatment benefits that may be realized.

8.1.2.1 Organic Carbon Removal

Organic carbon is measured in wastewater using the 5-day biochemical oxygen demand (BOD_5) test. Subsurface flow constructed wetlands remove settleable BOD_5 material by deposition in the

quiescent conditions and by filtration within the media. The settled BOD_5 undergoes aerobic or anaerobic decomposition, depending on the oxygen status at the point of deposition. Colloidal and dissolved BOD_5 is removed via contact with the microbial growth that is attached to the gravel media. BOD_5 removal observed in subsurface flow wetland system has ranged from 65 to 88 percent (Crites, et.al., 2014).

8.1.2.2 Suspended Solids Removal

Suspended solids are measured in wastewater using the total suspended solids (TSS) test. The mechanisms for TSS removal in subsurface flow wetlands include sedimentation and filtration. TSS removal in subsurface flow constructed wetlands has ranged from 23 to 93 percent (Crites, et.al., 2014).

8.1.2.3 Phosphorus Removal

A limited amount of phosphorus removal occurs in subsurface flow constructed wetlands via adsorption and a small amount of plant uptake. Phosphorus removal in subsurface flow constructed wetlands has ranged from 10 to 40 percent (Crites, et.al., 2014).

8.1.2.4 Metals Removal

Subsurface flow constructed wetlands can remove metals from applied water via adsorption, sedimentation, precipitation, and plant uptake. Data from operational systems indicate greater than 80 percent removal of copper, zinc, and cadmium is possible (Crites, et.al., 2014).

8.1.2.5 Trace Organics Removal

Constructed wetlands systems remove trace organic compounds via volatilization or adsorption and biodegradation. Table 8-2 provides a summary of removals at a pilot scale constructed wetland with a 24-hour hydraulic retention time (HRT) (Crites, et.al., 2014).

Table 8-2. Removal of Organic Priority Pollutants in Constructed Wetlands

Compound	Initial Concentration (µg/L)	Removal in 24 Hours (%)
Benzene	721	81
Biphenyl	821	96
Chlorobenzene	531	81
Dimethyl phthalate	1033	81
Ethylbenzene	430	88
Naphthalene	707	90
p-Nitrotoluene	986	99
Toluene	591	88
p-Xylene	398	82
Bromoform	641	93
Chloroform	838	69
1,2-Dichloroethane	822	49
Tetrachloroethlyene	457	75
1,1,1-Trichloroethane	756	68

Source: Reed, et.al., 1995.

8.1.2.6 Pathogen Removal

Greater than 90 percent removal of bacteria and virus has been documented in subsurface flow constructed wetland systems. The removal mechanisms include adsorption and filtration (Crites, et.al., 2014).

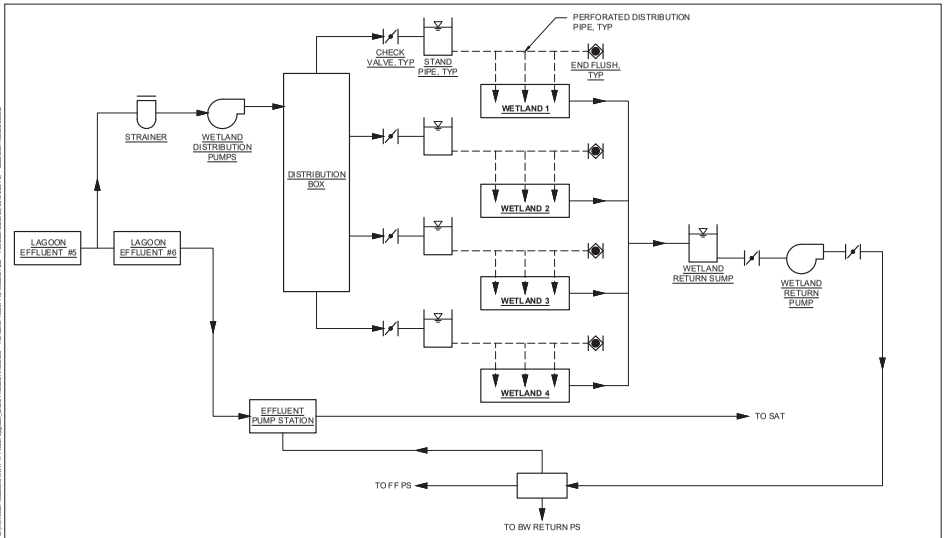
8.1.3 Preliminary Design

This section summarizes the preliminary design of the Kealakehe WWTP subsurface flow constructed wetland system. The system includes:

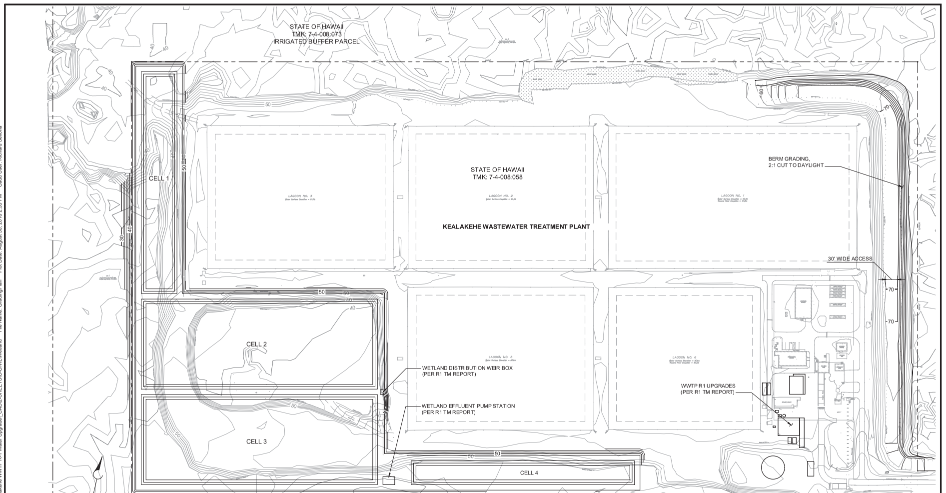
- Wetland supply pump station
- Wetland distribution system
- Wetland cells
- Wetland collection network
- Wetland return pump station
- Supplemental carbon system

Figure 8-2 is a schematic diagram of the proposed system. Figure 8-3 is a site plan showing the various system components.

Wetland feed water will be drawn from the diversion box located between Lagoons 5 and 6. The wetland feed pump station will operate continuously to provide constant feed to the wetland system. The wetland distribution system will divide the flows between the wetland cells in proportion to their surface area. The water will be treated as it flows through the wetland cells. A collection network will transport the treated water to the wetland return pump station that will send flow to a valve vault. Valves will be used to partition the wetland return flow between the effluent pump station, the filter feed pump station, and the backwash return pump station. A supplemental carbon system will be included to enhance treatment as the wetland vegetation is established.



Brown AND Caldwell	SCALE: NONE	KEALAKEHE WASTEWATER TREATMENT PLANT SUBSURFACE CONSTRUCTED WETLAND PROCESS SCHEMATIC	FIGURE 8-2



CELL #	BOTTOM ELEVATION	TOP ELEVATION	BOTTOM AREA	TOP AREA
CELL 1	43'	48'	0.75 ACRES	1.18 ACRES
CELL 2	43'	48'	2.61 ACRES	3.16 ACRES
CELL 3	43'	48'	2.61 ACRES	3.16 ACRES
CELL 4	43'	48'	0.38 ACRES	0.79 ACRES
TOTAL			6.35 ACRES	8.29 ACRES

Brown AND Caldwell

SCALE: 1" = 150'

KEALAKEHE WASTEWATER TREATMENT PLANT

SUBSURFACE CONSTRUCTED WETLAND SITE PLAN

FIGURE 8-3

Path: P:\Projects\Hawaii, County Of (HI)\149607 Kealakehe WWTP R-1 Water Upgrade_CAD\2-SHEETS\C-CIVIL\Wetland File Name: GradingPlan Plot Date: August 30, 2018 2:35 PM Cadd User: Richard Sellona

8.1.3.1 Wetland Supply Pump Station

The wetland supply pump station will be located adjacent to the filter feed pump station. The pump station will be constructed over the existing 42-inch diameter Lagoon 6 bypass line. The normal configuration will be to have the bypass line open so that the wetland feed pump station draws water from the distribution box located between Lagoons 5 and 6. Normal operation will be to have two pumps operating continuously. Flow to the wetland can be reduced by operating only one pump. A 16-inch diameter PVC force main will be used to convey wetland supply flow to the wetland distribution system.

Table 8-3 provides preliminary design criteria for the wetland supply pump station. The pump starters and controls will be located in the new electrical and chemical feed building.

Table 8-3. Wetland Supply Pump Station Design Criteria Summary

Parameter	Value
Pumps	
Type	Submersible, non-clog
Number of pumps	3 (2 duty, 1 standby)
Capacity, each	1.65 mgd / 1,150 gpm
Motor horsepower, each	7.5 hp
Motor drive type	Constant speed
Wet Well	
Style	Trench
Material	Concrete

8.1.3.2 Wetland Distribution System

The wetland distribution system will include the following elements:

- **Strainer:** An automatic strainer will be provided to remove debris from the wetland supply flow.
- **Distribution box:** the wetland supply flow will be divided in a concrete weir box. The flow to each wetland cell will be proportional to its surface area. The weir box will be covered with aluminum checker plate, with hinged observation hatches.
- **Gated distribution pipe:** Water will be distributed evenly within the wetland cells using at-grade gated pipe. The adjustable gates are evenly spaced along the length of the pipe. Figure 8-4 is a photo of gated pipe in operation at an agricultural site.

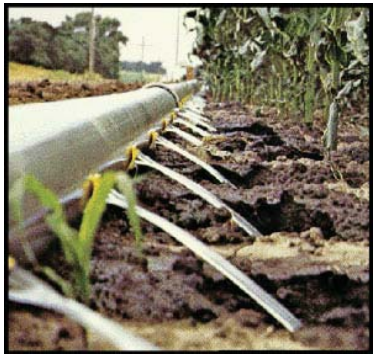


Figure 8-4. Gated Pipe

8.1.3.3 Wetland Cells

There will be four wetland cells. Figure 8-5 is a typical cross section.

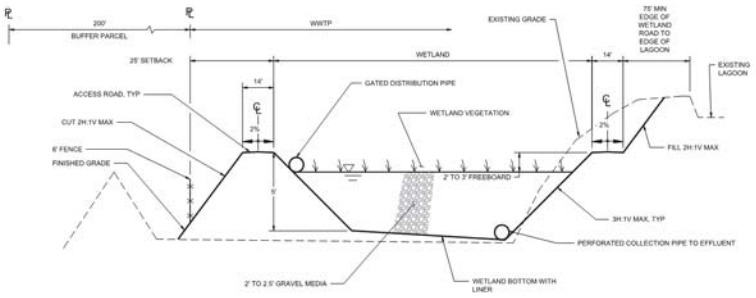


Figure 8-5. Typical Wetland Section

8.1.3.4 Basin and Liner

The basin berms will be constructed of native pahoehoe lava rock that has been crushed. Berm side slopes will be 3 (horizontal) to 1 (vertical). The top width of the berms will serve as roads for wetland access.

The wetland cells will be lined with 60 mil high density polyethylene (HDPE). 60 mil HDPE is commonly used to line sanitary landfills and is expected to provide a long (greater than 50 years) service life when protected from sunlight. A quality assurance/quality control testing program will be used to ensure liner integrity prior to backfilling.

8.1.3.5 Inlet Zone

Water will be introduced into the wetland via an inlet zone consisting of large (3 to 6 inches) rock. The inlet zone will help distribute flow into the gravel media and will prevent wetland vegetation growth at the distribution pipe.

8.1.3.6 Wetland Hydraulics

For effective treatment, the flow through the wetland must be below the surface of the gravel media at all times. Flow through the gravel media is governed by Darcy's law:

$$Q = KSA_c$$

where:

Q = average flow through system, ft^3/day

K = hydraulic conductivity of the media, ft/day

S = hydraulic gradient

A_c = hydraulic cross section, ft^2

The Kealakehe WWTP wetland cells are designed with a small length to width ratio. Doing so provides a large hydraulic cross-sectional area to minimize the hydraulic gradient through the bed and distribute flow over a large area of the wetland cell. The large cross-sectional area also provides a large safety factor against media clogging with solids to provide a long media life.

8.1.3.7 Media

The selected media is crushed blue basalt drain rock that is available from local quarries. The drain rock, also referred to as 2.5-inch clean rock, is incompressible crushed rock ranging from 0.375 to 2.5" rock, with no fines. Table 8-4 provides preliminary design criteria for the wetland cells.

Table 8-4. Wetland Cells Design Criteria Summary

Parameter	Value
Basins	
Side slopes	3H:1V, maximum
Width to length ratio	4:1, minimum
Liner	60-mil HDPE
Berm top width	14 feet, minimum
Total constructed wetland surface area	6 acres
Media depth (flow depth)	2.5 feet
Media type	Medium gravel, D_{10} = 1.25 inches
Media porosity	38%
Portion of hydraulic gradient used	20%
Hydraulic conductivity	33,000 ft/day
Average HRT	2 days
Water temperature	82°F to 86°F (28°C and 30°C respectively)
Portion of hydraulic gradient used	20%
Flow path length	150 feet

8.1.3.8 Vegetation

Roth Ecological Design International prepared a Technical Memorandum that describes the plants selected for the wetlands. The plants were selected based on their characteristics, size, and tolerance for brackish water. Table 8-5 provides a summary of the selected species. All but one are native species.

Table 8-5. Selected Wetland Vegetation

Botanical Name	Common Name	Hawaiian Name
Heliconia psittacorum	Golden Torch	Heliconia
Cyperus javonicus	Java Sedge	`Ahu`awa
Bolboschoenus maritimus	Saltmarsh Bulrush	Kaluha
Schoenoplectus tabernaemontani	Giant Sedge	Akaakai
Bacopa monnieri	Water Hyssop	`Ae`ae
Sesuvium portulacastrum	Sea Purslane	Akulikuli

8.1.4 Wetland Collection Network

8.1.4.1 Effluent Structures

Each wetland cell will have an effluent structure with a downward-opening slide gate to act as an adjustable weir. Figure 8-6 is an example of a similar structure at another County facility. The

structure will allow the operators to vary the depth of water in the gravel media. The typical operating depth will be just below the gravel surface. However, during the initial plant establishment period it will be necessary to slowly lower the water elevation to encourage deeper plant roots. The effluent structures will be designed to allow the wetland cells to be completely drained for maintenance purposes.

Figure 8-6. Typical Effluent Structure

Collection Pipe Network

Water will be collected from the wetland via a collection pipe network for conveyance to the wetland return pump station. Perforated PVC pipe will be installed in the wetland cells to collect treated water from the gravel media to the effluent structures. Solid PVC pipe will be installed to convey water from the effluent structures to the wetland return pump station.

8.1.4.2 Wetland Return Pump Station

Table 8-6 provides preliminary design criteria for the wetland return pump station.

Table 8-6. Wetland Return Pump Station Design Criteria Summary

Parameter	Value
Pumps	
Type	Submersible, non-clog
Number of pumps	2 (1 duty, 1 standby)
Capacity, each	3.5 mgd / 2500 gpm
Motor horsepower, each	10 hp
Motor drive type	Constant speed
Wet Well	
Style	Trench
Material	Concrete

8.1.4.3 Supplemental Carbon System

Wetlands are large carbon reservoirs because the plants in them grow, die, and decay. The plant biomass provides a carbon source to promote microbial growth and reproduction that is critical for the denitrification process. A supplemental carbon addition system will be included in the project to mitigate the anticipated carbon shortfall that will occur during the period of wetland vegetation establishment. One tote per day of either MicroC (a commercial product) or glycerin, which can potentially be supplied locally by Pacific Biodiesel, is the anticipated supplemental carbon demand.

8.1.5 Wetland Monitoring

The Kealakehe subsurface flow constructed wetland's primary purpose is to provide nitrogen removal via denitrification. A wetland monitoring schedule will be developed as part of the facility's operation and maintenance manual. Wetland operational performance monitoring will likely consist of periodic grab samples that will be tested for ammonia, nitrite, nitrate, BOD_5, and TSS.

8.2 Soil Aquifer Treatment System

Soil aquifer treatment (SAT) is a process in which wastewater is treated by passing it through permeable soil or sand. It has been known by many names over its existence including infiltration-percolation and rapid infiltration. SAT systems have been operating for many, many years achieving long-term effective removal of a wide range of constituents. Lake George, New York has an SAT system that has operated successfully since the 1930s.

The concept is to intermittently apply wastewater to permeable soils or sands. As the applied water percolates through the sand or soil particles, it is treated by physical filtration and by biological mechanisms. After an application period or wetting period, the surface can dry and oxygen can enter the soil matrix, which aids aerobic biological treatment. This frequent wetting and drying also maintains the infiltration rate through the soil surface and minimizes soil clogging.

8.2.1 Anticipated Treatment Benefits

Soil aquifer treatment is an effective process for BOD_5, TSS, trace organics, endocrine disruptors, and pathogen removal. Removal of phosphorus and metals is excellent. Nitrogen removal can be significant when systems are managed for that objective.

8.2.1.1 BOD_5 and TSS Removal

BOD_5 levels are typically less than 2 mg/L in SAT percolate. Suspended solids are typically 1 to 2 mg/L in the percolate from SAT systems because of filtration through the soil profile.

8.2.1.2 Nitrogen Removal

Nitrification/denitrification is the principal mechanism for removal of ammonia and nitrate from the wastewater in SAT systems. Ammonia adsorption also plays an important role in retaining ammonia in the soil long enough for biological conversion. Nitrification and denitrification are affected by low temperatures and proceed slowly at temperatures of 36 to 41°F (3.6 to 5°C). In addition, denitrification requires an adequate carbon source and the absence of available oxygen. The relatively high average annual temperatures at Kealakehe will have no negative effect on the nitrification process, but the treated effluent that is applied to the SAT will be low in carbon, so denitrification in the SAT will be limited.

The Anammox (anaerobic ammonia oxidation) process of ammonia and nitrate reduction was found to be occurring in SAT systems at Tahoe-Truckee, CA (Woods, et al., 1999) and at Mesa, AZ (Gable and Fox, 2000). The process appears to be continuing through the saturated soil.

Experience with nitrification has been that rates of up to 60 lbs./acre/day can be achieved under favorable moisture and temperature conditions. Total nitrogen loadings should be checked to verify that they are not more than the 50 to 60 lbs./acre/day range. The anticipated total nitrogen loading to the Kealakehe SAT will be 2 lbs./acre/day, due to the subsurface wetlands treatment previously described.

Nitrogen removal is a function of detention time, BOD_5: N ratio (adequate carbon source) and anoxic conditions. Detention time is related to hydraulic loading rate through the soil profile. For effective nitrogen removal (80 percent or more) the loading rate should not exceed 6 in/d (Lance, et al., 1976). The BOD_5: N ratio needs to be 3:1 or more to ensure adequate carbon to drive the denitrification reaction. Secondary effluent will have a BOD_5: N ratio of about 1:1 while primary effluent usually has a BOD_5: N ratio of 3:1. To overcome the low BOD: N ratio in secondary effluent a longer application period (7 to 9 days) is necessary (Bouwer, et al., 1980). Typical removals of total nitrogen and percolate concentration of nitrate nitrogen and total nitrogen are presented in Table 8-7.

Table 8-7. Nitrogen Removal for Soil Aquifer Treatment Systems

Location	Applied Total Nitrogen (lbs./acre/day)	Applied Total Nitrogen (mg/L)	Percolate Nitrate Nitrogen (mg/L)	Percolate Total Nitrogen (mg/L)	Total Nitrogen Removal (%)
Calumet, Michigan	20.7	24.4	3.4	7.1	71
Dan Region, Israel	28.9	13.0	6.5	7.2	45
Ft. Devens, Massachusetts	37.0	50.0	13.6	19.6	61
Hollister, California	14.9	40.2	0.9	2.8	93
Lake George, New York	12.5	12.0	7.0	7.5	38
Phoenix, Arizona	40.0	18.0	5.3	5.5	69
W. Yellowstone, Montana	115.6	28.4	4.4	14.1	50

Source: *Crites, R.W., in Artificial Recharge of Groundwater, Asano, T., Ed., Butterworth Publishers, Stoneham, MA, 1985, 579–608. With permission.*

The Kealakehe aerated lagoons will nitrify the wastewater, and the proposed constructed wetland's primary objective will be denitrification. Therefore, nitrogen loading to the SAT is expected to be low and nitrogen removal will not be a primary design consideration or system management objective.

8.2.1.3 Phosphorus Removal

Phosphorus removal will be the primary design objective of the Kealakehe SAT system. Phosphorus removal in SAT is accomplished by adsorption and chemical precipitation. The adsorption occurs quickly and the slower-occurring chemical precipitation replenishes the adsorption capacity of the soil. Typical phosphorus removals for SAT are presented in Table 8-8 including travel distances through the soil.

Table 8-8. Phosphorus Removal for Soil Aquifer Treatment Systems

Location	Applied Phosphorus[3] (mg/L)	Vertical Travel Distance (feet)	Horizontal Travel Distance (feet)	Percolate Concentration (mg/L)	Removal (%)
Boulder, Colorado	6.2	8–10	0	0.2–1.5	40–97
Brookings, South Dakota	3.0[b]	2.6	0	0.45	85
Calumet, Michigan	3.5	10–30	0–400	0.1–0.4	89–97
	3.5	30[c]	5,580[c]	0.03	99
Ft. Devens, Massachusetts	9.0[b]	50	100	0.1	99
Hollister, California	10.5	22	0	7.4	29
Lake George, New York	2.1[b]	10	0	<1	>52
	2.1[b]	10[c]	1,970[c]	0.014	99
Phoenix, Arizona	8–11	30	0	2–5	40–80
	7.9	20	100	0.51	94
Vineland, New Jersey	4.8[b]	6.5–60	0	1.54	68
	4.8[b]	13–52	850–1,700	0.27	94

Source: *USEPA, Process Design Manual for Land Treatment of Municipal Wastewater, EPA 625/1-81-013, U.S. Environmental Protection Agency, Cincinnati, OH, 1981.*

a. Total phosphate measured, except as noted.

b. Soluble phosphate measured.

c. Seepage.

8.2.1.3.1 Phosphorus Adsorption Testing

Where phosphorus removal is critical, a phosphorus adsorption test using the specific site soil can be conducted (Reed and Crites, 1984). To conduct an adsorption test, samples of soil are placed in containers containing known concentrations of phosphorus in solution. After intermittent shaking over a period of 5 days, the solution is decanted and analyzed for phosphorus. The difference in concentrations between the initial concentration and the remaining concentration in the liquid is attributed to adsorption onto the soil particles. Actual phosphorus retention at a SAT site (long term) will be 2 to 5 times greater than the values obtained in the 5-day phosphorus adsorption test (U.S.EPA, 1981). The reason the actual long-term retention is larger than the results of the 5-day test is because of the chemical precipitation that occurs, which renews the adsorption sites over time for more phosphorus adsorption to occur.

8.2.1.3.2 Phosphorus Removal Results

Phosphorus adsorption testing was conducted on six locally-available sandy materials. The materials are listed in Table 8-9. The results of the phosphorus adsorption testing are presented in Table 8-10 and in Figures 8-7 through 8-11. The results for material number 6 were not included because the sample had a lot of fine material making the results inconsistent with the other samples.

Table 8-9. Media Tested for Phosphorus/Adsorption	
Sample Number	Description
1	Crushed onsite a`a lava
2	Blue basalt sand from Waimea
3	3/8 red cinder from Waimea
4	Red cinder sand from Waimea
5	Red cinder sand from Pahoa
6	Brown basalt sand from Waimea

Table 8-10. Phosphorus Testing Adsorption Results and Expected Lifetime		
Sample Number	Adsorption Capacity (g P/g soil) [a]	Lifetime (Years) [b]
Soil 1	0.0046526	42.1
Soil 2	0.0046743	42.3
Soil 3	0.0046368	41.9
Soil 4	0.0046374	41.9
Soil 5	0.0046268	41.8

a. *Based on empirical tests of soil adsorption at varying concentrations of solute.*

b. *Estimated lifetime of the soil based on a basin size of 8.5 usable acres, an average flowrate of 1 mgd an influent P concentration of 5.7 mg/L, and media depth of 4.25 ft.*

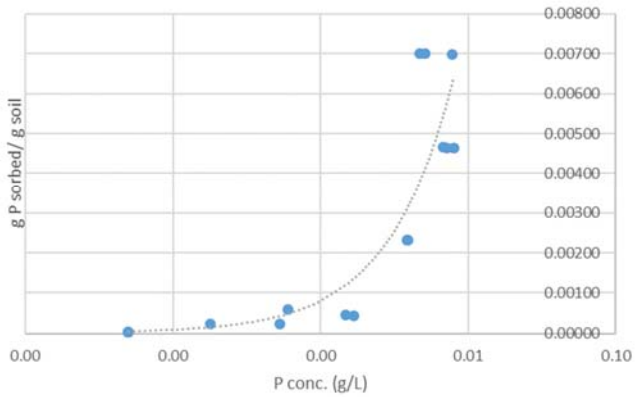


Figure 8-7. Soil Sample 1: Adsorption Isotherm

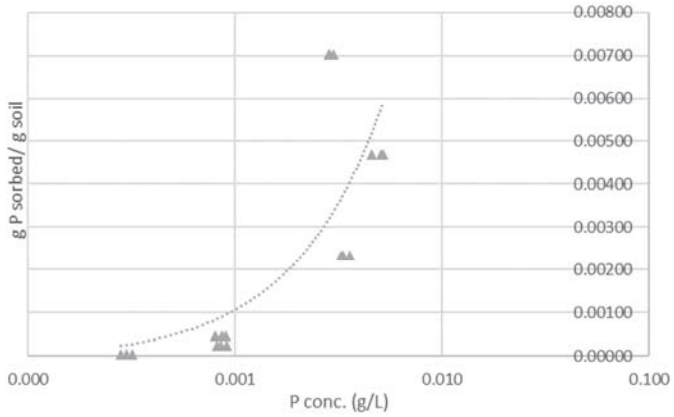


Figure 8-8. Soil Sample 2: Adsorption Isotherm

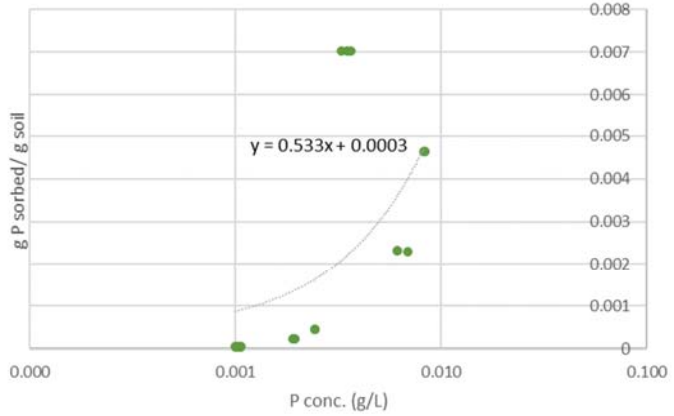


Figure 8-9. Soil Sample 3: Adsorption Isotherm

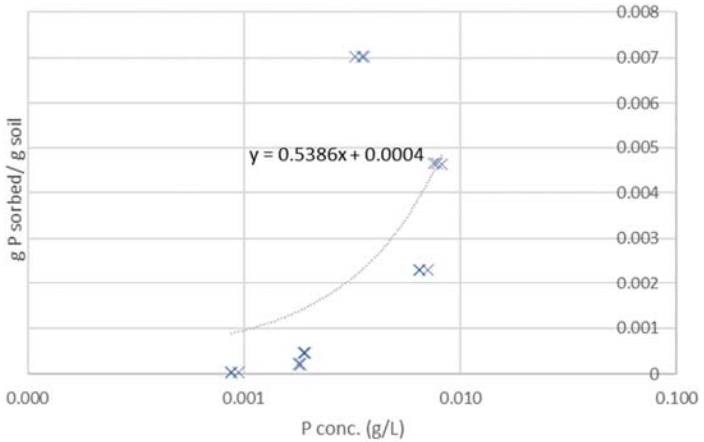


Figure 8-10. Soil Sample 4: Adsorption Isotherm

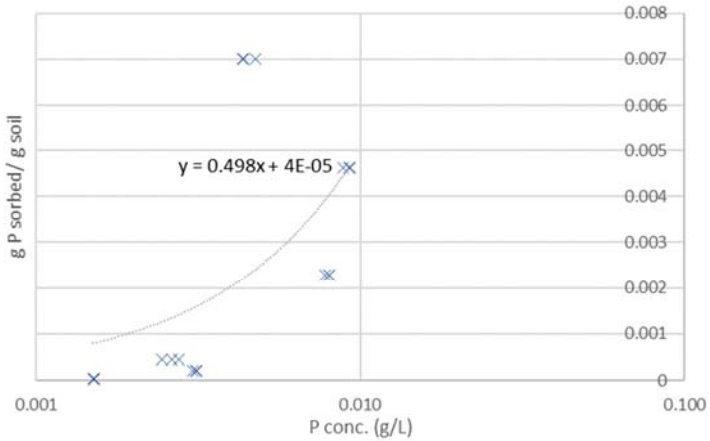


Figure 8-11. Soil Sample 5: Adsorption Isotherm

Figure 8-12 shows the six material samples. From left to right, samples 1 through 3 are in the top row, and the samples 4 through 6 are in the bottom row. Based on the test results the crushed onsite a`a lava and blue basalt sand (top row left and center) will be used, as they will be the lowest cost media and provide the best performance.

Figure 8-12. Soil Samples

8.2.1.4 Heavy Metals Removal

Heavy metals removal, using the mechanisms of precipitation, adsorption and complexation, will range from 50 to 90 percent for SAT. Metals applied at very low concentrations (below drinking water standards) may not be affected by passage through sand (Crites, 1985a).

Metals removal at a SAT in Boulder, Colorado was studied over a six-week period. The results of the applied influent and the effluent percolate are presented in Table 8-11. The soil was a loamy to clay sand and the depth of the underdrains was 8 to 10 feet (Smith et al., 1979)

At a SAT on Cape Cod the accumulation of metals was measured by depth from the surface down to a depth of 1.7 feet. The distribution of the metals retained is shown in Table 8-12. For all five metals, between 76 and 88 percent of the metals detected were found in the top 1.5 inches (0-0.13 feet). When 33 years of loading was compared to the total metals detected in the top 1.7 feet of the SAT sandy soils, the amounts retained ranged from 49 to 129 percent of the amounts applied over 33 years (US EPA 1981).

Table 8-11. Heavy Metal Removal by SAT at Boulder, Colorado

Metal	Total Metals		
	Applied, ppb	Percolate, ppb	Removal %
Cadmium	2.47	0.78	68
Copper	54.02	18.75	65
Chromium	25.93	14.60	47
Nickel	13.86	8.94	36
Lead	10.15	1.75	83
Zinc	60.28	7.94	87

Note: Adapted *from Smith, et al. (1979)*

Table 8-12. Heavy Metal Retention by Depth at SAT on Cape Cod, Massachusetts, %

Depth, ft	Cadmium	Chromium	Copper	Lead	Zinc
0 – 0.13	84	87	76	88	82
0.13 – 0.19	12	10	23	12	13
0.46 – 0.52	1	0	0.4	0	1
0.79 – 0.85	1	2	0.4	0	2
0.95 – 1.02	1	0	0.1	0	0.8
1.44 – 1.50	0.5	1	0.1	0	1.2
1.64 - 170	0.5	0	0	0	0
TOTAL	100	100	100	100	100
Percent retention of 33-year loading	113	62	85	129	49

Note: *Adapted USEPA (1981).*

Heavy metals removal is not a design objective for the Kealakehe SAT, but nevertheless there will be removal benefits realized when compared to the status quo.

8.2.1.5 Trace Organics

Trace organics are removed in SAT systems by volatilization, sorption, and degradation. Removal levels depend on the constituent, the applied concentration, the loading rate, and the presence of easily degradable organics to serve as a primary substrate (Crites, 1985b). Removals have been studied at Phoenix, AZ; Ft. Devens, MA; and Whittier Narrows, CA; and have ranged from 10 to 96 percent.

Trace organics removal is not a design objective for the Kealakehe SAT, but nevertheless there will be removal benefits realized when compared to the status quo.

8.2.1.6 Endocrine Disruptors

SAT systems have been utilized for the removal of endocrine disrupting chemicals found in municipal wastewaters (Conroy, et al., 2001; Quanrad, et al., 2002). Endocrine disruptors originate from industrial, agricultural, and domestic sources. These include a combination of natural hormones, pharmaceutical products, and industrial chemicals such as polychlorinated biphenyls,

organochlorine pesticides, phenoxyacid herbicides, phthalates and tirazines. Following conventional secondary treatment, percolation through approximately 120 ft (36 m) of unconsolidated sediments to the local aquifer reduced residual estrogenic activity by greater than 95 percent, as illustrated in Table 8-13 (Quanrud, et al., 2002). The fate of micropollutants originating from pharmaceuticals and active ingredients in personal care products have been studied at two groundwater recharge facilities in Arizona (Drewes, et al., 2001). Preliminary studies indicate that groundwater recharge offers a high potential to remove acidic drugs such as lipid regulators and analgesics. Other compounds such as antiepileptic drugs and X-ray contrast agents showed no clear indication of removal during travel times of more than 6 years.

Table 8-13. Fractional Attenuation of Estrogenic Activity (Relative to Primary Effluent) During Secondary Treatment and Soil Aquifer Treatment

Sample Location	Fractional Removal
Primary	0.00
Secondary unchlorinated	0.62
Secondary chlorinated	0.65
Secondary dechlorinated	0.65
Storage pond	0.68
0.8 m (2.5 ft)	0.77
3.1 m (10 ft)	0.83
5.2 m (17 ft)	0.83
18.3 m (60 ft)	0.93
36.6 m (120 ft)	0.99

Source: *USEPA, Process Design Manual for Land Treatment of Municipal and Industrial Wastewater. Center for Environmental Research Information (CERI), U.S. Environmental Protection Agency, Cincinnati, OH, 2006.*

Additional studies of long-term SAT at field sites in Mesa, AZ., indicate that substantial removal of effluent organic matter can occur. Identified trace organics were efficiently removed as a function of travel time to very low concentrations or below detection limits. Based on the characterization techniques used, the character of bulk organics that are present in final SAT water resembled the character of natural organic matter present in drinking water (Drewes, et al., 2001).

Endocrine disruptor removal is not a design objective for the Kealakehe SAT, but nevertheless there will be removal benefits realized when compared to the status quo.

8.2.1.7 Pathogens

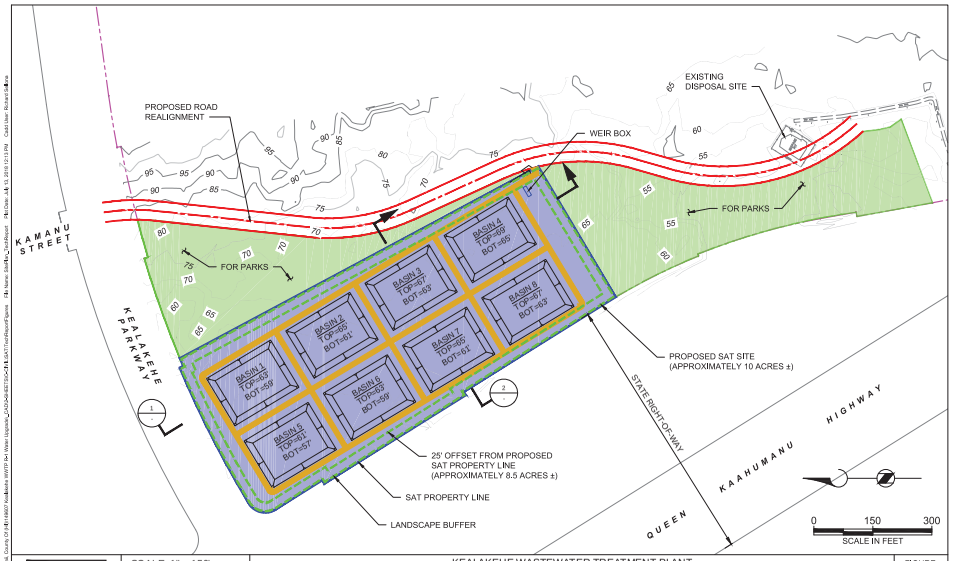
Pathogens are filtered out by the soil and adsorbed onto clay particles and organic matter. Fecal coliform is removed by 2 to 4 orders of magnitude in many SAT systems (U.S.EPA, 1981). At the SAT site in Phoenix, AZ, 99.99 percent virus removal was achieved after travel through 30 ft (10 m) of sand at a loading rate of 300 feet/year (Crites, 1985b). A summary of virus removal through soil at different SAT sites is presented in Table 8-14.

Table 8-14. Virus Removal through Soil at SAT System (USEPA, 1976)

Location	Sampling distance, m	Virus concentration, PFU/L	
		At source	At sample point
Phoenix, Arizona (Jan-Dec 1974)	3-9	8	0
		27	0
		24	0
		2	0
		75	0
		11	0
Gainesville, Florida (Apr-Sep 1974)	7	0.14 (average over study period)	0.005
		0.14 (average over study period)	0
		0.14 (average over study period)	0
		0.14 (average over study period)	0
		0.14 (average over study period)	0
		0.14 (average over study period)	0
		0.14 (average over study period)	0
Santee, California (1966)	61	Concentrated type 3 polio	0
Ft. Devens, Massachusetts (1974)	17	Indigenous virus, 276 (average) F_2 bacteriophage seed, 2.2×10^5	8.3 (average) 1.3×10^5
Medford, New York (Nov 1976-Oct 1977)	0.75-8.34	Indigenous virus, 1.1-81.0	17 samples negative; 6 positive, at 0.47 average; range 0.14-0.66
	0.75	Polio virus seed, 7×10^4 (6 cm/h infiltration rate)	Range 0-25.5
	0.75	1.84×10^5 (100 cm/h infiltration rate)	Range 0.03×10^4 to 97.5×10^4
Vineland, New Jersey (Aug 1976-May 1977)	0.6-16.8	13 (average over study period)	9 of 10 positive, 1.62 average
		13 (average over study period)	7 of 10 positive
		13 (average over study period)	2 of 10 positive, 1.95 average
		13 (average over study period)	0 of 10 positive, 0.48 average

8.2.2 Preliminary design

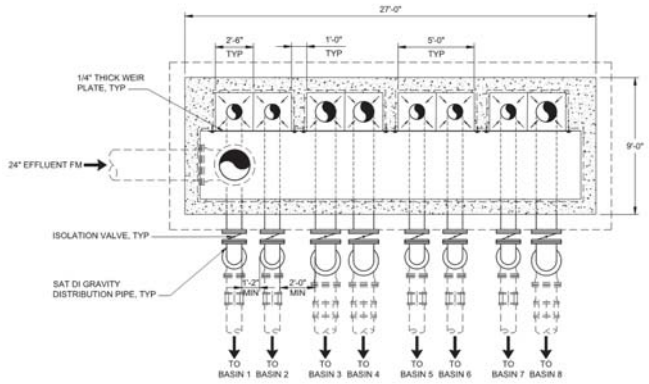
The SAT site consists of a gross area of approximately 10 acres inclusive of 8 basins of approximately equal area, a flow distribution box, and distribution piping. Figure 8-13 presents the conceptual SAT site plan.



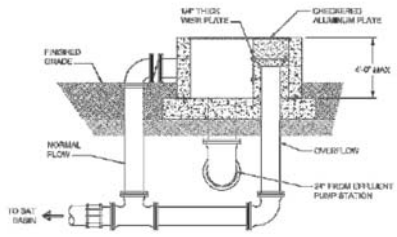
Brown and Caldwell	SCALE: 1" = 150'	KEALAKEHE WASTEWATER TREATMENT PLANT SAT CONCEPTUAL SITE PLAN	FIGURE 8-13

8.2.2.1 Flow Distribution Box

A flow distribution box will be located at the SAT site to normalize and divert influent flow from the existing WWTP 24-inch effluent pipeline. The solid PVC gravity distribution mains will include isolation valves adjacent to the distribution box so that flow can be directed and rotated to standpipe reservoirs at specific basins, thus allowing cyclical wetting and drying of basins. In high flow conditions the water will flow over weirs to all of the basins, providing peak wet weather capacity. Figure 8-14 is a plan view and section cut of the flow distribution box.



Plan View



Cross Section

Figure 8-14. SAT Flow Distribution Box

8.2.2.2 Perforated Distribution Pipe

The distribution system will consist of low pressure perforated distribution piping near the surface of the SAT basin. Low pressure distribution will apply effluent uniformly over the entire absorption area,

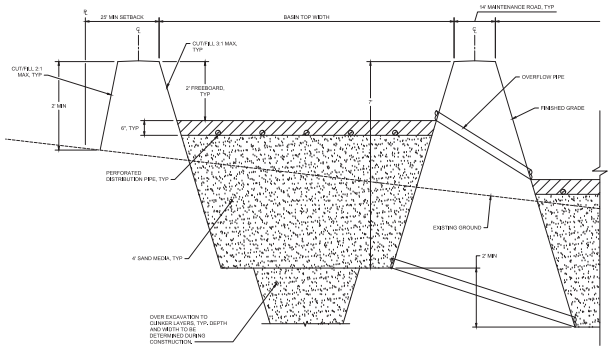
optimizing SAT performance. The rate of application will be less than the saturated hydraulic conductivity of the soil/media, ensuring ponding does not occur.

The perforated pipe orifices will be oriented up and covered with orifice shields to prevent clogging from the gravel backfill. Perforated distribution lines will be spaced approximately 5 feet on center with orifice openings every 2 feet. Figure 8-15 represents pressure dosed systems before and after covering with gravel. Figure 8-16 is a typical section of the basin and schematically shows the perforated distribution pipe.

Exposed piping

Piping covered with gravel

Figure 8-15. SAT Pressure Dosed Application Systems



Brown and Caldwell	SCALE: NONE	KEALAKEHE WASTEWATER TREATMENT PLANT SAT BASIN TYPICAL SECTION	FIGURE 8-16

8.2.3 SAT Site Improvements

Site requirements for an SAT system include basin footprint and layout, side slopes, berms, and maintenance roads as reflected in the conceptual site plan seen in Figure 8-13.

8.2.3.1 Location

The proposed SAT site is mauka of the Kealakehe WWTP along the Queen Kaahumanu Highway at the intersection of Kealakehe Parkway. The site currently contains the existing WWTP effluent disposal seepage pit. Other than the existing disposal system, which includes the buried effluent pipeline, the site is currently undeveloped, but there is a master plan to develop portions of the site for a regional park. The terrain consists of A'a lava with nearly no vegetation and generally slopes from east to west.

8.2.3.2 Basins

The SAT system will be comprised of eight basins of roughly the same footprint area with a total effective basin area of 6.3 acres. The native A`a lava, which will be crushed and then graded into basin berms, will also be placed as backfill over the pressurized distribution pipes. Effluent will enter a different basin each day of the week so that basins are rested for seven days and then rotated in again the next week.

The performance and size of the SAT is dependent on the hydraulic characteristics of the soil. Specifically, the required footprint area for the basins is defined by the hydraulic loading rate of the soils as governed by the following equation:

$$A = CQ(365\frac{d}{yr})/L_w$$

where:

A = field area (acre)

C = conversion factor (3.07 ac ft/mgd)

Q = flow (mgd)

L_w = hydraulic loading rate (ft/yr)

Final basin layout will occur after the site is surveyed and the geotechnical investigation is complete, but based on current site information, the basins are anticipated to be. The basins will be filled with imported sand media. The media depth will be approximately 4 feet of imported sand. Figure 8-20 are site sections that depicted the existing and finished grade of the site.

8.2.3.3 Hydraulic Pathways

The geology below the SAT site is complex, containing veins of highly-permeable clinker and impermeable basalt. Portions of the basin bottoms will be over-excavated to suitable clinker layers and backfilled with native material to create hydraulic pathways below the basins. The over-excavated areas will be wider than they are deep.

8.2.3.4 Access Roads

Temporary access to the SAT site will be provided by connection to Kealakehe Parkway until the regional park is built-out when access will be provided from the park roadway frontage. Within the site, an internal roadway network for operations and maintenance will be provided around the

basins. Figure 8-19 is a typical section reflecting the conceptual layout of the basins and maintenance roads.

8.2.3.5 Stormwater Management

The terrain consists of A'a lava with nearly no vegetation and generally slopes from east to west. The existing elevations range between 75 to 55 feet above mean sea level (MSL) and slopes in the westerly direction at an average rate of 2 to 10 percent. The soils in the area are described as A'a lava; these soils are considered well drained with low runoff and slight erosion hazard. Although most of the site sheet flows in a westerly direction, there is at least one watercourse that runs across the site to the adjacent highway shoulder and is conveyed makai through a large box culvert. All low points and watercourses will be mitigated such that no flooding occurs within the SAT site. Furthermore, all basins will be sized to include freeboard to accommodate the 100-year, 24-hour storm event in addition to the peak effluent flow.

8.2.3.6 Perimeter Fencing

A 6-foot high perimeter fence with signs will be installed to control access to the SAT site. Gates to the SAT facility will be locked except when County personnel are present.

8.2.4 Regulatory Framework

The Kealakehe SAT system will be the first in the State of Hawaii. DOH has indicated that the Kealakehe SAT system would be regulated as land disposal via the requirements contained in HAR 11-62. The HAR 11-62 regulations require secondary treatment (BOD_5 and TSS less than 30 mg/L) prior to land disposal and establishes minimum monitoring, record-keeping and reporting requirements. The proposed system will exceed the minimum requirements. The director of the DOH can establish more stringent requirements for systems if needed on a case-by-case basis.

8.2.5 SAT Monitoring

The DOH has indicated that they may require additional (i.e., beyond HAR 11-62 minimum requirements) monitoring for the Kealakehe SAT system due to it being the first system of its kind in Hawaii. Groundwater monitoring is commonly required at SAT and other forms of land treatment systems to allow assessment of the groundwater impacts and system efficacy. Typical groundwater monitoring systems consist of three wells; one located upgradient and two located downgradient of the SAT system. The Kealakehe upgradient well would be located mauka of the basins, and the two downgradient wells would be located makai. A groundwater monitoring program will be developed in consultation with DOH during development of the facility operation and maintenance manual. Groundwater monitoring will likely consist of semi-annual testing for nutrients (nitrogen and phosphorus), salts, and other parameters developed in consultation with DOH.

A pan lysimeter will be installed in each SAT basin. The pan lysimeters will allow collection of percolate grab samples from below the SAT basins for analysis. A pan lysimeter monitoring program will be developed in consultation with DOH during development of the facility operation and maintenance manual. Pan lysimeter monitoring will likely consist of semi-annual testing for nutrients (nitrogen and phosphorus), salts, and other parameters developed in consultation with DOH.

8.3 Existing Disposal System Closure

The existing disposal basin will be closed as part of the project. Closure will occur after the SAT system is operational. DOH will be consulted during detailed design of the closure requirements.

Section 9

Nutrient Reduction Benefits

The nutrient reduction benefits that will be realized by the project are presented below.

9.1 Current Condition

Currently, all wastewater entering the WWTP is treated in the aerated lagoons prior to discharge to the off-site infiltration basin. Naturally-occurring microbes in the aerated lagoons oxidize organic matter in the wastewater. In addition, nitrogen in the form of ammonia is converted first to nitrite and then to nitrate via a process called nitrification. The aeration system is used to maintain aerobic conditions within the water column to facilitate the treatment process and prevent nuisance odors.

Table 9-1 summarizes the existing effluent characteristics. As shown in the table, most of the nitrogen is in the form of nitrate, and most of the phosphorus is in the form of orthophosphate.

Table 9-1. Existing Effluent Nutrient Characteristics

Parameter	Typical Concentration [a]
Ammonia as N	0.35 mg/L
Nitrite as N	0.57 mg/L
Nitrate as N	21.7 mg/L
Total N (calculated)	22.6 mg/L
Total phosphorus as P	7.01 mg/L
Orthophosphate as P	6.30 mg/L
Organic P (calculated)	0.71 mg/L

[a] *Average of values from six weeks of testing December 2012 – January 2013*

Table 9-2 summarizes the existing mass loads of nutrients released to the environment via the existing infiltration basins, based on the characteristics shown in the table above.

Table 9-2. Existing Mass Load of Nutrients to the Environment via the Existing Infiltration Basins

Description	Value
Average flow rate	1.7 mgd
Nitrogen mass load to the environment	320 lbs./day
Phosphorus mass load to the environment	99 lbs./day

9.2 Future Nutrient Management

The proposed project will allow the County to direct nutrients from the service area community to appropriate locations. In general,

- Water with higher nutrient content will be treated to create R-1 recycled water.
- Water that is not recycled will be polished to remove nutrients via the subsurface flow constructed wetland and SAT, so that water that is released to the environment as percolate from the SAT system has low nutrient content.

The project includes provisions to allow the County to reduce the nutrient content of the recycled water, if needed, by adding low nutrient water to the R-1 feed flow. Another provision will allow excess R-1 production (and off-spec water) to be routed through the constructed wetland for polishing prior to disposal.

The three nutrient pathways are discussed below.

9.2.1 Water Recycling

The proposed recycled water program will allow a portion of the WWTP effluent to be put to beneficial use. Nutrients present in the recycled water will be distributed over the areas that are irrigated with the recycled water. The applied nutrients are then taken up by the vegetation as fertilizer or immobilized in the soil. Over-application of nitrogen via recycled water application represents a risk to the environment, therefore the amount of nitrogen applied via recycled water should not exceed the needs of the vegetation it is applied to. Applied phosphorus is generally taken up by the crop or is adsorbed to soil particles and represents less environmental risk so long as recycled water is applied at appropriate rates so that run off to surface water does not occur.

As mentioned above, the proposed project will allow the County to control the nutrient content of the recycled water by blending a portion of the polished effluent from the subsurface flow constructed wetland with the lagoon effluent that is directed to the R-1 treatment processes. A 15 mg/L maximum total nitrogen concentration has been established as a target for the recycled water, based on the information shown in Table 9-3. Areas that receive recycled water are assumed to be primarily planted with salt-tolerant turf grass (e.g., parks, buffer parcel, golf course). As shown in the table, the recycled water will provide most or all of the nutrient requirements of the anticipated crop, and no supplemental fertilization will be required.

Table 9-3. Nutrient Application via Recycled Water	
Description	Value
Average annual irrigation demand	8,167 gallons per day per acre
Average annual irrigation application	2.98 Mgal/acre/year
R-1 total nitrogen concentration	15 mg/L
Annual total nitrogen application	373 lbs./acre/year
Estimated denitrification losses in soil	15% [a]
Net nitrogen available for crop	317 lbs./acre/year
Typical salt-tolerant turf grass nitrogen needs	
Seashore paspalum	348 lbs./acre/year [b]
Bermuda grass	523 lbs./acre/year [c]
Excess nitrogen application	0 lb./acre/year
R-1 total phosphorus concentration	6 mg/L
Annual phosphorus application	149 lbs./acre/year
Typical salt-tolerant turf grass phosphorus uptake	
Bermuda grass	30 – 40 lbs./acre/year [d]

[a] *USEPA, September 2006.*
[b] *University of Hawaii CTAHR, Feb 2008.*
[c] *University of Hawaii CTAHR, Jan 2008.*
[d] *Crites, et.al., 2000*

9.2.2 Subsurface Flow Constructed Wetlands

As presented in Section 8, aerated lagoon effluent will be continuously circulated through the subsurface flow constructed wetland to remove nitrogen via denitrification and provide additional polishing treatment benefits. The return flow from the wetlands will be stored in Lagoon 6, so that water directed to the SAT via the effluent pump station contains lows concentrations of nitrogen.

The Kealakehe subsurface flow wetlands are expected to remove approximately 81 percent of the applied total nitrogen, based on modeling discussed below. A small amount of phosphorus removal is also expected, on the order of 10 percent.

9.2.3 SAT

As presented in Section 8, the SAT sand media will adsorb phosphorus from the applied water, so that water released to the environment from the bottom of the SAT will have low phosphorus concentrations. Phosphorus adsorption in the SAT is expected to be excellent, on the order of 80 percent. A small amount of nitrogen removal may occur, on the order of 10 percent.

9.3 Nutrient Reduction Benefits

A spreadsheet model was developed to assess the nutrient reduction benefits that are expected to be realized by the proposed project. The model incorporates the effects of continuous recirculation flow through the constructed wetlands. The model was used to evaluate five scenarios for comparison to the status quo, as summarized in Table 9-4. As shown in the table, three influent flow scenarios were modeled: the initial flow condition, the projected flow in 20 years, and the ultimate WWTP capacity. The scenarios also assess two future conditions with respect to expansion of the recycled water program; expansion of the recycled water program as the community grows, and no expansion beyond the initial R-1 production capacity (1.8 mgd).

Table 9-4. Nutrient Reduction Scenarios				
Scenario	WWTP Influent Flow (mgd)	Average Annual Recycled Water Use (mgd)	Average Annual Flow to SAT (mgd)	Notes
0	1.7	0	1.7	Status quo
1	1.7	0.8	0.9	Initial condition
2	3.2	2.4	0.8	20-year flow condition, water recycling program is expanded as the community grows
3	3.2	1.8	1.4	20-year flow condition, water recycling capacity is not expanded beyond 1.8 mgd
4	5.3	4.5	0.8	Ultimate flow condition, water recycling program is expanded as the community grows
5	5.3	1.8	3.5	Ultimate condition, water recycling capacity is not expanded beyond 1.8 mgd

The results of the nutrient reduction modeling are summarized in Table 9-5. The results are shown graphically in Figure 9-1. The assessments are included as Appendix A.

Table 9-5. Nutrient Model Results				
	Nutrient Disposal Mass (ppd) [a]		Nutrient Disposal Reduction [b]	
Scenario	Nitrogen	Phosphorus	Nitrogen	Phosphorus
0	319	99	Not applicable	Not applicable
1	14	8	>90%	>90%
2	16	8	>90%	>90%
3	32	14	90%	86%
4	21	8	>90%	>90%
5	281	38	12%	61%

[a] *ppd = pounds per day.*
[b] *As compared to the status quo condition (scenario 0).*

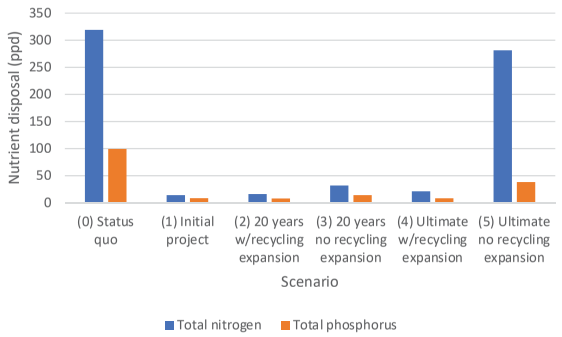


Figure 9-1. Nutrient Disposal Mass – Comparison of Scenarios

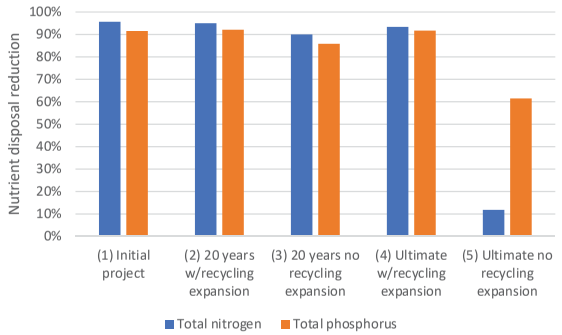


Figure 9-2. Nutrient Disposal Reduction – Comparison of Scenarios to Status Quo

The following conclusions can be drawn from the table and corresponding figures:

- Implementation of the project will significantly reduce the mass of nutrients that are disposed, with nitrogen and phosphorus reductions expected to exceed 90 percent of the current status quo condition.
- If the water recycling program is expanded as the community grows then the mass of nutrients disposed can be maintained at low levels, with nitrogen and phosphorus reductions expected to continue to exceed 90 percent of the current status quo.
- If the water recycling program is not expanded beyond the capacity of the initial project (1.8 mgd) then the mass of nutrients disposed will increase as WWTP flows increase. However,

even at the ultimate WWTP flow capacity (5.3 mgd) the mass of nutrients disposed is expected to be below current levels.

Section 10

Other Options Considered

This section provides a summary of other options that were considered and evaluated during the development of the proposed project, including other effluent management alternatives, different water recycling program structures, and other forms of treatment.

10.1 Effluent Management Alternatives

The proposed project will manage WWTP effluent via water recycling and disposal via SAT. Other effluent management alternatives that were considered are presented below.

10.1.1 Surface Water Discharge

Discharging treated wastewater to surface waters (i.e. creeks, streams, rivers, or lakes) is a common practice throughout the United States. The receiving water dilutes the effluent and natural biological, physical and chemical actions within the water course further attenuate the remaining pollutants in the discharge. Surface water discharges are regulated via the National Pollutant Discharge Elimination System (NPDES).

There are no lakes, rivers or streams in the area of the WWTP due to the highly porous nature of the surrounding land and dry climate. This discharge method was eliminated as a possible effluent management strategy.

10.1.2 Ocean Discharge

Discharge to ocean waters is a common practice for coastal WWTPs. Treated effluent can be conveyed via an ocean outfall a distance off shore for discharge into the ocean. Outfall systems are designed to provide dilution and dispersion of effluent and are sited to ensure currents carry the treated wastewater away from the shoreline. Natural biological, physical and chemical processes within the ocean water column attenuate the remaining pollutants in the discharge. Ocean discharge is regulated via the NPDES program.

Discharge to the ocean as an effluent management strategy was explored as part of the original environmental assessment for the WWTP in the 1980s, but was rejected in lieu of other strategies (County of Hawaii, Department of Public Works, July 1981). The conditions favoring other methods remain today, and the ocean outfall option was eliminated from further consideration.

10.1.3 Injection wells

Injection wells are a common way of disposing of treated effluent in Hawaii because there are often impermeable basalt layers in the subsurface geology that limit percolation of surface-applied water to the basal groundwater lens. In addition, injection wells require very little land area to implement. Injection wells are defined by the State of Hawaii as shafts or holes in the ground that are deeper than they are wide. Although the regulatory definition includes systems that don't extend all the way to the basal groundwater lens, for purposes of analysis it is assumed that injection wells for the Kealakehe WWTP would extend below sea level.

Treated wastewater that is discharged to an injection well is diluted by the groundwater flow. Additional degradation of wastewater constituents can occur as the groundwater and treated wastewater moves through the aquifer towards the ocean.

Injection wells are regulated in Hawaii as part of the Underground Injection Control (UIC) program which seeks to limit their use over potable water aquifers. The DOH has defined UIC lines for each island that defines the boundary of the potable water aquifer for the island. The Kealakehe WWTP is located makai of the UIC line. However, Act 131 (18), signed into law on July 5, 2018, prohibits DOH from issuing permits "for the construction of sewage wastewater injection wells unless alternative wastewater disposal options are not available, feasible, or practical." Therefore, injection wells are not a feasible alternative at Kealakehe WWTP.

10.1.4 Evaporation

Evaporation is a zero-discharge approach, meaning that no treated effluent makes contact with surface water, ocean water or ground water. Wastewater can be disposed by pumping it into shallow impermeable basins where the water is allowed to evaporate. In order to manage the effluent in this manner would require numerous large impermeable basins. Discharge to the basins would be rotated to allow the effluent to evaporate prior to re-flooding. The sediment left behind would need to be disposed of in a landfill.

A large area would be required to implement evaporation disposal; estimates based on Kona climate data are that approximately 185 acres of land would be required for each mgd of wastewater flow. A net 980 acres of evaporation ponds would be required to accommodate the full 5.3 mgd treatment capacity. The large land area requirement makes this option not feasible. In addition, the Federal Aviation Administration strongly discourages the development of open-water features that could attract birds within 10,000 feet of an aircraft operating zone (e.g. Kona International Airport).

Water can also be evaporated by thermal means. However, it takes 1,500 British Thermal Units (BTU) of energy to evaporate a pound of water. A gallon of diesel fuel contains 129,000 BTU of energy. It would take 97,000 gallons of diesel fuel to evaporate a million gallons of effluent. At current flows (1.7 mgd), it would require 60 million gallons of diesel fuel evaporate the effluent annually. Therefore, thermal evaporation was removed from consideration due to high cost and on sustainability grounds.

10.1.5 Slow Rate Land Treatment

Slow rate land treatment consists of irrigation of land and vegetation with effluent. Significant treatment is provided as the water percolates through the soil. The vegetation uses the nutrients in the effluent as fertilizer and transpires a portion of the applied water. Water is applied in excess of the crop requirement, resulting in a significant percolation component. Figure 10-1 illustrates the process. Figure 10-2 is an example image of a slow rate system.

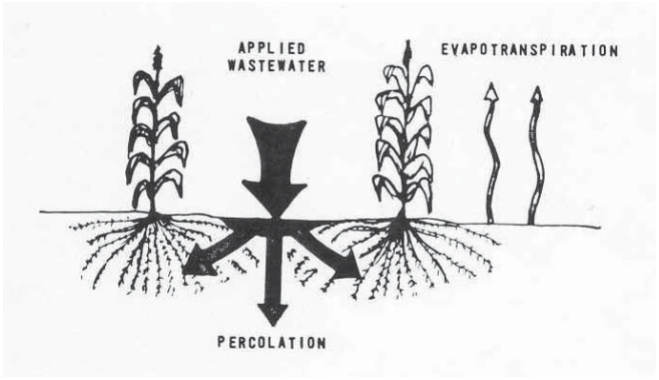


Figure 10-1. Slow Rate Land Treatment Process

Figure 10-2. Example of SR System Utilizing Sprinkler Irrigation

A slow rate land treatment system would require significantly more area than the proposed SAT system, and would require suitable soils to grow vegetation. Significant quantities of soil would need to be imported to the site, because the lava fields in the vicinity of the WWTP will not support suitable vegetation. Slow rate land treatment was removed from consideration due to the large land area requirement and the lack of suitable soil in the area.

10.1.6 Continue to Use Existing Percolation Basin

The existing percolation basin could continue to be used for effluent disposal purposes. The 10,000-square foot percolation basin area is significantly smaller than the proposed SAT, and does not contain a sand media that can support land treatment functions. The hydraulic loading rate to the percolation basin is very high due to its small area. Table 10-1 compares the HLR to the percolation

basin and the proposed SAT at current flows (1.7 mgd). As shown in the table the HLR to the percolation basin is 22 times greater than the hydraulic loading rate to the proposed SAT. The high HLR precludes much, if any, treatment occurring as the water percolates.

Table 10-1. Comparison of Existing Percolation Basin to Proposed SAT

Description	Existing Percolation Basin	Proposed SAT
Net surface area	0.25 acre	6.3 acres
HLR at current flow (1.7 mgd)	7,616 feet/year	302 feet/year

The hydraulic capacity of the existing percolation basin is unknown. If the proposed SAT system is not constructed it is likely the existing percolation basin system will require expansion to meet the community's future effluent management needs.

Due to the controversial nature of the existing percolation basin, continued use of the system was removed from consideration.

10.2 Water Recycling Program Alternatives

Options considered to the proposed water recycling program include a seasonal storage reservoir and supplemental water addition, as described below.

10.2.1 Seasonal Storage Reservoir

Implementation of a seasonal storage reservoir would make it possible to recycle 100 percent of the effluent produced by the WWTP in a typical year. The seasonal storage reservoir would make it possible to save recycled water produced during the wet season for use during the dry season. An annual water balance was prepared to assess the seasonal storage reservoir needs for the WWTP. Figure 10-3 provides a summary of the evaluation, and shows recycled water supply, use, and storage throughout a typical year, based on the 5.3 mgd WWTP capacity. As shown in the graph, peak storage of approximately 254 acre-feet (83 million gallons) would occur during June, and by November the storage reservoir would be dry and ready for another wet season. Under this scenario it would be possible to irrigate approximately 643 acres of golf courses, parks, schools and other areas accessible to the public. The lined, 20-foot-deep storage reservoir would have a water surface area of approximately 15 acres.

Storage of recycled water is not without its challenges. Recycled water contains nutrients that allow algae to grow. The algae can cause odors if stagnant water conditions are allowed to develop. Recycled water that is stored in open reservoirs must often be re-treated to improve the water quality characteristics. Recycled water reservoirs can be equipped with mixers to prevent stagnant water conditions, and/or be equipped with floating covers to block the sunlight that fosters algal growth.

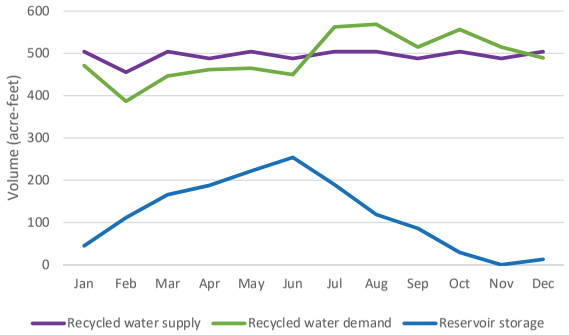


Figure 10-3. Seasonal Storage Reservoir Analysis

Implementation of a seasonal storage reservoir and recycling program would not eliminate the need for the proposed SAT system, as described previously. HAR 11-62 requires a disposal system for all recycled water systems, to provide a means for disposal of water that does not meet R-1 standards or disposal of excess water should the seasonal storage reservoir capacity be exceeded during an exceptionally wet year.

A seasonal storage reservoir is not included in the proposed project for the following reasons:

- **Limited recycled water users:** Initially, there are few potential users of recycled water in the area. Due to the lack of soil in the area adding additional users will be expensive. It appears that recycled water supply will outstrip demand in the foreseeable future, making a seasonal storage reservoir a poor investment.
- **Cost:** A 254-acre-foot seasonal storage reservoir can be expected to cost on the order of $10 million to construct, excluding the cost of land.
- **Space:** There is insufficient space at the WWTP for a seasonal storage reservoir. Additional property would need to be procured.

When the recycled water program has matured, and demand exceeds supply the County can consider implementing a seasonal storage reservoir to maximize reuse.

10.2.2 Supplemental Water Addition

Another way to make it possible to recycle virtually all of the effluent produced by the WWTP during a typical year is the use of supplemental water to match supply and demand. To achieve nearly 100 percent reuse it is necessary to a large land base that allows the lowest demand month to be equal to the recycled water supply. Figure 10-4 presents the results of a supplemental water analysis, based on the 5.3 mgd WWTP capacity and area climate. The analysis shows that a land base of 757 acres would be required to use 5.3 mgd of R-1 water during the month of February. Irrigation demands during the remaining months would be met by a combination of recycled water and supplemental water. The analysis shows that a supplemental water source capable of providing up to 166 acre-feet of water per month (1.7 mgd) would be required to meet the irrigation demand. The supplemental water source could be water pumped from a groundwater well or from the potable supply system.

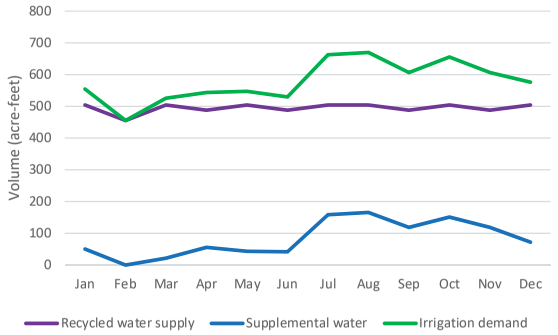


Figure 10-4. Supplemental Water Analysis

The use of supplemental water to increase recycled water use at the facility was not included in the proposed project for the following reasons:

- **Limited recycled water users:** Initially, there are few potential users of recycled water in the area. Due to the lack of soil in the area adding additional users will be expensive. It appears that recycled water supply will outstrip demand in the foreseeable future, making water supplementation unnecessary.
- **Lack of supplemental water source:** Potable supplies are limited in the area, and potable water is relatively expensive. The groundwater underneath the WWTP is brackish due to the proximity to the ocean shoreline, and its use for supplemental water would potentially worsen the recycled water salinity.

When the recycled water program has matured, and demand exceeds supply the County can consider implementing water supplementation to maximize reuse. A well located inland to tap a low-chloride aquifer would be recommended to serve as the supplemental water source.

10.3 Treatment Alternatives

The proposed project relies on the existing aerated lagoon treatment system to provide secondary treatment. Other treatment alternatives that were considered are discussed below.

10.3.1 Activated Sludge Treatment Plant

Converting the WWTP from aerated lagoons to conventional activated sludge treatment processes was considered. Lagoons 5 and 6 would be filled to provide space for the new process tankage, that would incorporate biological nutrient removal (BNR) to remove nitrogen and phosphorus. Lagoons 1, 2, and 3 would be retained for emergency and effluent storage purposes. The improvements would include:

- Aeration tanks with anoxic and anaerobic zones for BNR
- Circular secondary clarifiers
- Return and waste activated sludge pumping

- Filtration
- Disinfection
- Sludge thickening
- Sludge digestion
- Sludge dewatering

An activated sludge process with BNR can reliably produce an effluent containing less than 10 mg/L total N and less than 3 mg/L total P. The County would have to also construct the infrastructure to deliver recycled water to users and the SAT to provide an effluent disposal system as required by DOH.

Table 10-2 provides a comparison of an activated sludge approach with the proposed project. As shown in the table, the proposed project incurs significantly lower capital, O&M, and life-cycle costs. The proposed project is expected to result in less nitrogen mass disposal compared to the BNR WWTP approach. Phosphorus mass disposal for the two approaches are similar. The results of the analysis confirm that making full use of the existing secondary treatment infrastructure is cost-effective. In addition, using "natural treatment system" subsurface flow constructed wetland is a cost-effective approach in a remote island location with available land and high electricity costs.

Table 10-2. Comparison of Activated Sludge with BNR to Proposed Project

Description	Activated Sludge with BNR WWTP	Proposed Project
Capital cost	$167 million	$67 million
Annual O&M cost	$4.3 million	$2.9 million
Life-cycle cost	$239 million	$116 million
Nitrogen mass to disposal	47 lbs./day	14 lbs./day
Phosphorus mass to disposal	8 lbs./day	8 lbs./day
Life-cycle cost per pound of nutrients (N+P) removed	$360/lb.	$174/lb.

10.3.2 Advanced Nutrient Removal

The option of providing advanced nutrient removal was also considered. The advanced nutrient removal option consists of additional processes to the activated sludge with BNR option described above to provide the limit of available treatment technology that is currently available. The additional processes include:

- The use of denitrification filters to remove nitrate. This process requires addition of a supplemental chemical carbon source (typically methanol) prior to the denitrification filters to act as a carbon source for naturally-occurring denitrifying bacteria in the filters that convert nitrate into nitrogen gas.
- Addition of aluminum sulfate (alum) or ferric chloride to precipitate phosphorus.

Table 10-3 provides a comparison of the advanced nutrient removal WWTP with the proposed project. As shown in the table, the advanced nutrient removal approach incurs significantly higher capital, O&M and life-cycle costs. Nitrogen disposal is anticipated to be slightly lower with the proposed project, but less phosphorus would be disposed with the advanced nutrient removal WWTP approach.

Table 10-3. Comparison of Advanced Nutrient Removal to Proposed Project

Description	Advanced Nutrient Removal WWTP	Proposed Project
Capital cost	$178 million	$67 million
Annual O&M cost	$5.3 million	$2.9 million
Life-cycle cost	$267 million	$116 million
Nitrogen mass to environment	20 lbs./day	14 lbs./day
Phosphorus mass to environment	1 lb./day	8 lbs./day
Life-cycle cost per pound of nutrients (N+P) removed	$371/lb.	$174/lb.

10.3.3 Desalination

The recycled water that will be produced by the proposed project will be brackish due to elevated chloride concentrations in the service area's drinking water plus infiltration of brackish groundwater into the wastewater collection system. Desalination to reduce the recycled water salinity was considered to create a recycled water product that could be used on vegetation that is not salt-tolerant. Desalination is accomplished using reverse osmosis (RO). RO is an energy-intensive process that typically requires microfiltration or ultrafiltration using membrane technology as a pretreatment. An example where desalination of recycled water is occurring is at the Honouliuli Wastewater Treatment Plant on Oahu, where recycled water is desalinated to create high quality water for industrial use.

RO is not a treatment process per se, but rather a concentration process. The RO process separates the salts that are present in the water into a brine (concentrate) that requires disposal. The brine production rate is typically 15 to 20 percent of the flow and contains high concentrations of dissolved solids. Brine is most-commonly managed by marine discharge via ocean outfalls. Deep injection wells are used where an ocean outfall is not available. Evaporation in large shallow lined ponds with landfill disposal of the resulting solids is another option. Per earlier discussion, an ocean outfall or injection wells are not considered to be regulatorily feasible options for the Kealakehe WWTP, leaving evaporation ponds as the potential brine management solution. Desalination of the full 5.3 mgd design flow of the WWTP would create approximately 4.3 mgd of recycled water and 1 mgd of brine requiring disposal. An evaporation pond system encompassing approximately 200 net acres would be required to evaporate the brine, based on local climate data. The large land area required for brine management, coupled with high energy requirements for the RO process, make desalination not practical or feasible at the WWTP.

Section 11

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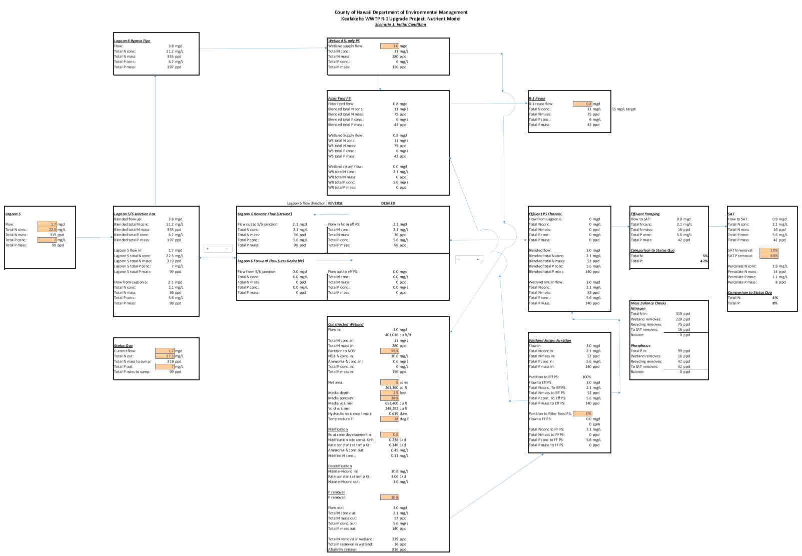
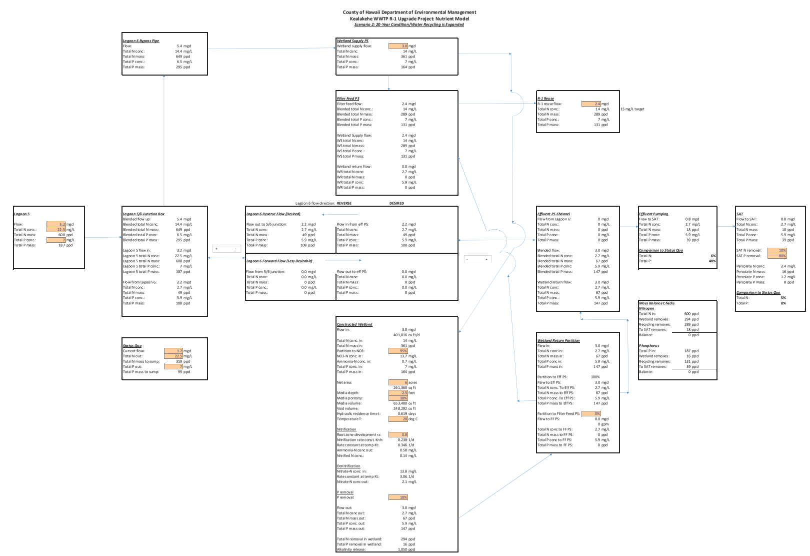
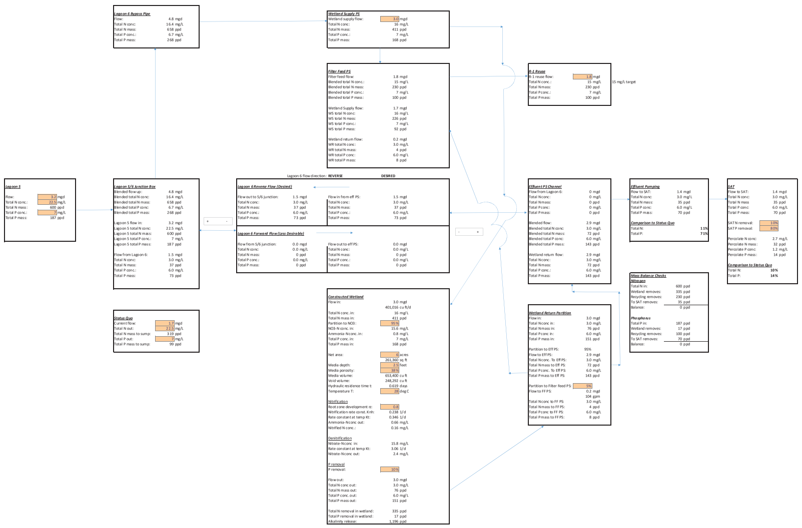
Appendix A: Nutrient Balance

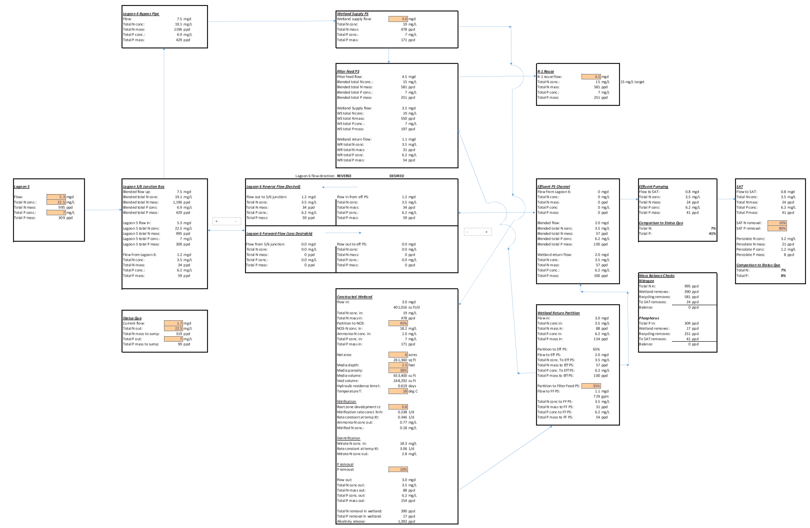

County of Hawaii Department of Environmental Management
Kealakehe WWTP R-1 Upgrade Project: Nutrient Model
Scenario 1: Initial Condition
Wetland Supply PS
Wetland supply flow: 3.0 mgd
Total N conc.: 11 mg/L
Total N mass: 280 ppd
Total P conc.: 6 mg/L
Total P mass: 156 ppd
Filter Feed PS
Filter feed flow: 0.8 mgd
R-1 Reuse
R-1 reuse flow: 0.8 mgd
15 mg/L target


County of Hawaii Department of Environmental Management
Kealakehe WWTP R-1 Upgrade Project: Nutrient Model
Scenario 2: 20-Year Condition/Water Recycling is Expanded
Wetland Supply PS
Wetland supply flow: 3.0 mgd
Total N conc: 14 mg/L
Total N mass: 361 ppd
Total P conc.: 7 mg/L
Total P mass: 164 ppd
Filter Feed PS
Filter feed flow: 2.4 mgd
R-1 Reuse
R-1 reuse flow: 2.4 mgd
15 mg/L target

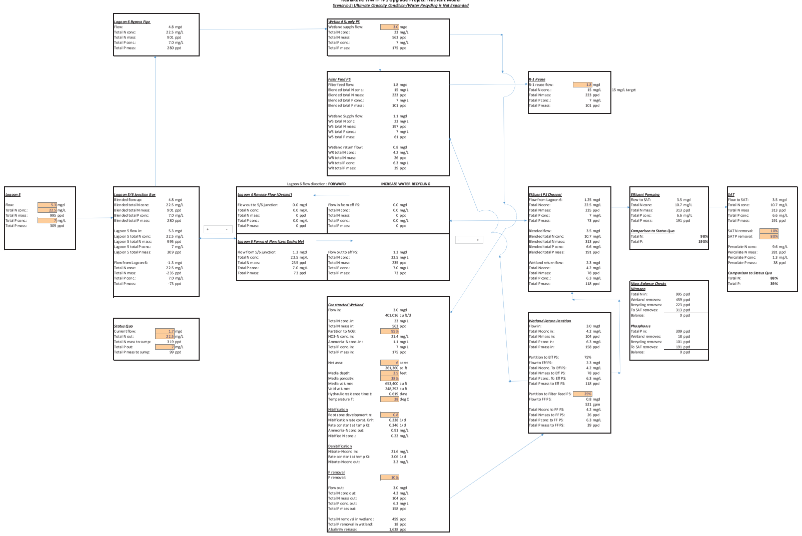
County of Hawaii Department of Environmental Management
Kealakehe WWTP R-1 Upgrade Project: Nutrient Model
Scenario 3: 20-Year Condition/Water Recycling is Not Expanded

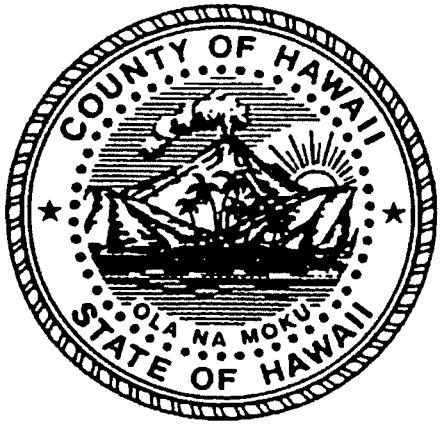


County of Hawaii Department of Environmental Management
Kealakehe WWTP R-1 Upgrade Project: Nutrient Model
Scenario 4: Ultimate Capacity Condition/Water Recycling is Expanded



County of Hawaii Department of Environmental Management
Kealakehe WWTP R-1 Upgrade Project: Nutrient Model
Scenario 5: Ultimate Capacity Condition/Water Recycling is Not Expanded





APPENDIX C

10079-01 10/19/18

Biological surveys for the Kealakehe WWTP R-1 upgrade North Kona, Island of Hawai'i [1]

cc: DOH BC

March 21, 2018 **DRAFT** *AECOS* No. 1498B

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Introduction

The County of Hawai'i, Department of Environmental Management (DEM) is proposing to make improvements to the Kealakehe Waste Water Treatment Plant (WWTP) and construct various distribution and storage facilities for production of R-1 (reusable) water ("Project"). Treated effluent in excess of demand for R-1 water, will be further treated at an onsite subsurface flow "wetland" and then piped to an offsite soil aquifer treatment (SAT) facility for further treatment and disposal.

The R-1 water produced will be used to irrigate a landscape buffer parcel surrounding the WWTP and distributed via underground pipes to properties that plan to use the recycled water in landscaping, notably the Queen Lili'uokalani Trust (QLT) Children's Center, the Old Kona Airport Park, Kohanaiki Golf and Ocean Club, and presumably others as the system becomes fully functional. In this and future phases, storage reservoirs with connecting transmission lines will be established.

The part of North Kona District, where the project is located, is low sloping ground covered by lava flows from Hualālai ranging in age from 1,600 to 11,000 ybp (years before present), forming a coastal plain of sorts. The land surface starts to rise on the *mauka* (inland) side of the main highway: Queen

[1] This report was prepared for the County of Hawai'i under a contract through Wilson Okamoto Corp. to assist in the preparation of an Environmental Impact Statement (EIS) for the subject Project, and will become part of the public record. This version ("B") is an updated version from the original dated December 29, 2017 to incorporate additional avian survey work conducted in March 2018.

Ka'ahumanu Highway. However, even the low-sloping ground is not flat or without significant topography. The numerous separate lava flows create an undulating surface and can add 3 to 8 m of relief over older flows. Because the geology is one of relatively recent flows, the predominant substratum is lava rock (mostly pāhoehoe; see Figure 1).

E. Guinther

Figure 1. Typical vegetation on pāhoehoe flow, Kealakehe WWTP parcel.

Methods

Botanical Survey

In as much as the project involved several transmission corridors and delimited broad parcels of land, separate surveys were conducted in each of six areas (see Figure 2): 1) existing Kealakehe WWTP outside the security fence to the property line, 2) pipeline routes from the WWTP to old Kona Airport Park and Queen Lili'uokalani Trust (QLT) Children's Center, 3) a pipeline route to a future storage tank site beside the old County landfill, 4) along Queen Ka'ahumanu Highway from the WWTP property to a connecting point being constructed along the highway expansion project, 5) the SAT site parcel, and 6) the existing

Figure 2. Kealakehe WWTP R-1 upgrade project survey areas outlined in yellow. Thin, white dotted lines are the recorded tracks of the botanists.

DWS Hina Lani Reservoir site (not shown in Figure 2; located further north on Hina Lani Street just *mauka* of Queen Kaahumanu Highway). The connection pipe between the end of our survey along Queen Ka'ahumanu Highway and the existing Hina Lani reservoir is being installed as part of the Queen Kaahumanu Hwy Improvement Project.

AECOS botanists, Eric Guinther and David Miranda, conducted the plant surveys on September 20-21, 2017 covering an area estimated at 117 ac of open land and approximately 3.65 miles of transmission pipes. Areas were surveyed on foot, the botanists noting each plant species as it was encountered. Each botanist carried a Trimble 6000 Series GNSS unit (GeoXH and GeoXT 6000 Series) to record progress tracks shown in Fig. 2), providing real-time feedback on location and adequacy of coverage during the surveys as well as the capability to mark the position of any feature or plant of special interest or concern. Given the open nature of the terrain nearly everywhere, these pedestrian transects were spaced to assure that plants (such as native endemics) could be reasonably expected to be discovered if present.

R.David

Figure 3. R-1 pipelines between Old Kona Airport Park, QLT Children's Center, and the WWTP would follow existing unimproved roads.

Delimited areas were surveyed in 1) and 5). For the others, the proposed transmission line route was surveyed within a reasonable distance to either side to account for potential construction (installation) impacts. Area 2), the section from Kealakehe WWTP to Old Kona Airport Park and QLT Children's Canter, followed an existing road and buried force main (see Figure 3, above).

Within each survey area, notes on the abundance of species were kept for reporting a rough qualitative sense of each species. Although the botanical survey was conducted in the dry season, conditions with respect to plant health were not seriously adverse; plants were readily identifiable by fruits and flowers and recent rains had promoted growth of new tissue and germination of seedlings in some areas.

Plant names used herein follow *Manual of the Flowering Plants of Hawai'i* (Wagner, Herbst, & Sohmer, 1990; Wagner & Herbst, 1999) for native and naturalized flowering plants, *A Tropical Garden Flora* (Staples & Herbst, 2005) for ornamental plants, and *Hawai'i's Ferns and Fern Allies* (Palmer, 2003) for ferns and fern allies. More recent name changes for naturalized plant species follow Imada (2012).

Avian Survey

Twenty avian count-stations were sited roughly equidistant from each other within the survey sites and along the various linear waterline features included in the proposed Project. Count stations were sited approximately 300 m apart from each other. A single six-minute avian point count was made at each of the 20 count-stations. Field observations were made with the aid of Leica 8 X 42 binoculars and by listening for vocalizations. The avian counts were conducted in the early morning hours. Time not spent counting at point-count stations was used to search the area and pipeline alignments for species not detected during the point-counts. Weather conditions were excellent with unlimited visibility and winds of between 1 and 15 kilometers per hour. Fieldwork was conducted between September 20 and 22, 2017.

Following the drafting of the initial flora and fauna survey report, the County made a decision to expand the scope of project to include work in Lagoon 5 and 6 at the WWTP, involving draining and replacing the liners in both lagoons and removal of sludge from Lagoon 6. As the interior of the fenced enclosure is not vegetated (and vegetation present along or close to the security fence was identified in the September survey by the botanical team), no additional botanical survey was required. A supplemental waterbird survey was conducted within the fenced wastewater treatment plant on March 9, 2018. All five lagoons at the WWTP that currently have water in them were counted. Count

methodology was to set-up at a location beside each pond where all of the waterbirds in the lagoon could be seen at one time. These birds were then counted by species three times and the highest number obtained taken as the result. All five pond counts were then combined to arrive at a total number of waterbirds counted within the facility during the count period.

The avian phylogenetic order and nomenclature used in this report follows the *AOU Check-List of North American Birds* (American Ornithologists' Union, 1998), and the 42nd through the 56th supplements to the Check-List (American Ornithologists' Union, 2000; Banks et al., 2002, 2003, 2004, 2005, 2006, 2007, 2008; Chesser et al., 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017).

Mammalian Survey

With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of Hawai'i are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all terrestrial mammalian species detected within the Project areas. Mammal scientific names follow (Wilson and Reeder, 2005).

Results

Vegetation

A substantial portion of the survey area consists of 'a'ā or pāhoehoe lava flows of various ages that support a generally sparse vegetation of widely scattered shrubs and fountain grass (*Cenchrus setaceus*). Throughout each of the survey areas, disturbed to highly disturbed land is present, either as roadways and bulldozed tracks or fill land (Figure 4). In most cases, these disturbed environments support a sparse to dense growth of ruderal weeds.

Flora

The flora of an area is the listing of species of plants that are growing there. The results of our surveys are expressed in Tables 1a and 1b as such a list. The list presents qualitative assessments of abundance by survey area (A through D) as defined in Table 2. Table 1 is divided into two parts: Table 1a lists non-native plants (naturalized and ornamental plants) encountered and Table 1b lists native plants encountered plus early Polynesian introductions of potential

Table 1. Flora for various survey areas for the proposed R-1 system at Kealakehe WWTP and associated areas in North Kona, Island of Hawai'i.

1a. Non-native (ornamentals and naturalized) plants

Family Species	Common name	Status	Plant abundance (by area)						Notes
			A	**B**	**C 1**	**C 2**	**C 3**	**D**	
FERNS AND FERN ALLIES									
NEPHROLEPIDACEAE									
Nephrolepis multiflora (Roxb.) F.M. Jarrett ex C.V. Morton	---	Nat	--	--	O	--	--	--	
FLOWERING PLANTS DICOTYLEDONS									
AMARANTHACEAE									
Amaranthus spinosus L.	spiny amaranth	Nat	--	--	R	--	--	--	
ANACARDIACEAE									
Schinus terebinthifolius Raddi	Christmas berry	Nat	O	C	O	--	O	--	
APOCYNACEAE									
Nerium oleander L.	oleander	Orn	--	--	--	--	R	U	
Cascabella thevitia (L.) Lippold	be-still tree	Nat	--	--	--	--	R	--	
Catharanthus roseus (L.) G. Don	Madagascar periwinkle	Nat	R	--	--	--	--	--	
ASCLEPIADACEAE									
Stapelia gigantea N. E. Brown	giant toad plant	Nat	--	--	--	O	--	--	
ASTERACEAE									
Pluchea carolinensis (Jacq.) G. Don	sourbush	Nat	Ru	Uu	Uc	--	O	--	
Senecio madagascariensis Poir.	---	Nat	--	--	--	--	R	--	
Tridax procumbens L.	coat buttons	Nat	O	U	Uu	--	O	Uc	

Table 1 (continued).

Family Species	Common name	Status	Plant abundance (by area)						Notes
			A	**B**	**C 1**	**C 2**	**C 3**	**D**	
BUDDLEIACEAE									
Buddleia asiatica Lour.	dogtail	Nat	R	--	--	--	--	--	
CACTACEAE									
Opuntia ficus-indica (L.) Mill.	*panini*	Nat	--	--	R	--	R	--	
CAPPARACEAE									
Cleome gynandra L.	*honohina*, wild spider flower	Nat	--	--	--	--	R	--	
CARICACEAE									
Carica papaya L.	papaya	Nat	R	--	--	--	--	--	
CONVOLVULACEAE									
Ipomoea obscura (L.) Ker-Gawl.	---	Nat	R	--	--	--	--	--	
Ipomoea triloba L.	little bell	Nat	--	--	--	--	R	--	
CUCURBITACEAE									
Coccinea grandis (L.) Voigt	scarlet-fruited gourd	Nat	R	--	Rc	--	--	--	
Momordica charantia L.	wild bitter melon	Nat	--	--	--	--	--	R	
EUPHORBIACEAE									
Euphorbia hirta L.	garden spurge	Nat	Oc	R	--	U	C	U	
FABACEAE									
Acacia farnesiana (L.) Willd.	*klu*	Nat	O	C	--	--	O	--	
Chamaecrista nictitans (L.) Moench	partridge pea, *lauki*	Nat	Oc	C	--	--	O	O	
Crotalaria retusa L.	rattlepod	Nat	--	--	--	--	R	--	
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	Nat	--	--	R	--	O	Uc	
Indigofera hendecaphyla Jacq.	creeping indigo	Nat	--	--	--	--	R	--	
Indigofera suffruticosa Mill.	indigo	Nat	U	O	--	--	O	--	
Leucaena leucocephala (Lam.) deWit	*koa haole*	Nat	Ac	A	Aa	A	C	AA	
Macroptilium atropurpureum (DC.) Urb.	---	Nat	R	--	--	--	--	--	
Macroptilium lathyroides (L.) Urb.	cow pea	Nat	R	--	O	--	O	U	

Table 1 (continued).

Family Species	Common name	Status	Plant abundance (by area) A	B	C 1	C 2	C 3	D	Notes
FABACEAE (continued)									
Pithecellobium dulce (Roxb.) Benth.	*ʻopiuma*	Nat	--	--	--	R	--	--	
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	*kiawe*	Nat	O	R	R	O	R	--	
LAMIACEAE									
Hyptis pectinata (L.) Poir.	comb hyptis	Nat	Ru	--	--	--	--	--	
MALVACEAE									
Sida ciliaris L.	---	Nat	--	--	R	--	--	U	
Sida rhombifolia L.	Cuba jute	Nat	--	--	--	--	R	--	
Sida spinosa L.	prickly sida	Nat	--	--	--	--	O	--	
MORACEAE									
Ficus microcarpa L. f.	Chinese banyan, juv.	Nat	R	--	--	--	--	--	
NYCTAGINACEAE									
Boerhavia coccinea Mill.	false *alena*	Nat	--	R	R	C	R	R	
PORTULACACEAE									
Portulaca oleracea L.	pig weed	Nat	R	R	R	--	--	R	
Portulaca pilosa L.	*ʻihi*	Nat	Uu	R	Rc	R	O	R	
Talinum fruticosum (L.) Juss.	---	Nat	Ca	C	Ca	U	C	Ca	
SOLANACEAE									
Nicotiana glauca R.C. Graham	tree tobacco	Nat	--	--	--	--	R	--	
VERBENACEAE									
Lantana camara L.	lantana	Nat	O	U	R	R	R	--	
MONOCOTYLEDONS									
AGAVACEAE									
Agave sisalana Perrine	sisal hemp	Nat	--	--	--	--	--		

Table 1 (continued).

Family Species	Common name	Status	Plant abundance (by area) A	B	C 1	C 2	C 3	D	Notes
POACEAE (GRAMINEAE)									
Cenchrus ciliaris L.	buffelgrass	Nat	Ra	--	R	Oa	--	Uu	
Cenchrus echinatus L.	common sandbur	Nat	--	--	--	Oc	--	--	
Cenchrus setaceus (Forssk.) Morrone	fountain grass	Nat	AA	AA	AA	AA	AA	AA	
Cenchrus purpureus (Schumach.) Morrone	Napier grass	Nat	--	--	R	--	--	--	
Chloris barbata (L.) Sw.	swollen fingergrass	Nat	Uc	U	Rc	--	R	--	
Digitaria ciliaris (Retz.) Koeler	Henry's crabgrass	Nat	--	--	R	--	--	--	
Melinis repens (Willd.) Zizka	Natal redtop	Nat	Oc	U	Oc	--	C	Oa	
TOTAL SPECIES			26	17	23	12	29	16	

Table 1b. Native (and early Polynesian introduced) Plants

Family Species	Common name	Status	Relative abundance (by area) A	B	C 1	C2	C3	D	Notes
FERNS AND FERN ALLIES									
PSILOTACEAE									
Psilotum nudum (L.) P. Beauv.	*moa*	**Ind**	R	R	--	--	--	--	
FLOWERING PLANTS DICOTYLEDONS									
CAPPARACEAE									
Capparis sandwichiana DC.	*maiapilo*	**End**	O	U	Uu	--	R	--	
MALVACEAE									
Sida fallax Walp.	*ʻilima*	**Ind**	R	--	--	--	R	--	
Waltheria indica L.	*ʻuhaloa*	**Ind?**	Ca	A	A	R	C	A	

Table 1 (continued).

Family Species	Common name	Status	Plant abundance (by area) A	B	C 1	C 2	C 3	D	Notes
MYOPORACEAE									
Myoporum sandwicense A. Gray	*naiʻo*	**Ind**	--	--	R	--	--	--	
RUBIACEAE									
Morinda citrifolia Hillbr.	*noni*	Pol	O	C	R	--	R	R	
Psydrax odorata (Forst. f.) A.C. Smith & S. Darwin	*alahe'e*	**Ind**	R	U	U	--	R	--	
SAPINDACEAE									
Dodonaea viscosa Jacq.	*ʻaʻaliʻi*	**Ind**	R	--	--	--	--	--	
MONOCOTYLEDONS									
COMMELINACEAE									
Commelina diffusa N.L. Burm.	*honohono*	Pol	--	--	R	--	--	--	
TOTAL SPECIES			7	5	6	1	5	2	
native/total ratio (%)			*27*	*28*	*26*	*8*	*17*	*12*	

Legend to Table 1:

Status = distributional status
End = endemic; native to Hawai'i and found naturally nowhere else.
Ind = indigenous; native to Hawai'i, but not unique to the Hawaiian Islands.
Nat = naturalized, exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.
Abundance = occurrence ratings for plants on parcels in August 2013.
R – Rare - only one or two plants seen.
U - Uncommon - several to a dozen plants observed.
O - Occasional - found regularly, but not abundant anywhere.
C - Common - considered an important part of the vegetation and observed numerous times.
A - Abundant - found in large numbers; may be locally dominant.
AA - Abundant - very abundant and dominant; defining vegetation type.

Lowercase letters (as in Ru) offset occurrence ratings (u – several plants; c – many plants; a – abundant in a limited area) in cases where distribution across the survey area may be limited, but individuals seen are more than indicated by the occurrence rating alone.

Table 2. Survey areas key for Table 1.

Survey Area – corresponds to:

A – Kealakehe WWTP buffer zone (TMK: 7-4-008: 058 & 073). Surrounding existing Kealakehe WWTP, excluding all active areas within the security fence.
B – Proposed R-1 pipeline connecting Kealakehe WWTP to QLCC & Old Kona Airport Park.
C1 – SAT site parcel (see Figure 5).
C2 – Proposed R-1 transmission line *mauka* of Queen Kaʻahumanu Highway to a proposed (Phase II) reservoir site south of the County landfill.
C3 – Proposed R-1 transmission line along *makai* side of Queen Kaʻahumanu Highway to R-1 line being placed in highway r-o-w by ongoing highway improvement project.
D – Existing reservoir site on Hina Lani Street, including highway verge from Queen Kaʻahumanu to tank site.

E. Guinther

Figure 4. Example of a highly disturbed site: soil and boulders pushed over the original lava surface (portion of site C2).

R. David

Figure 5. A large portion of the SAT parcel is an 'a'ā flow; however, much of the flow has been graded over, so untouched areas such as this are somewhat limited in extent.

cultural value. The total number of species recorded for the entire survey was 32, and 26 of these (81%) are in Table 1a (that is, non-natives). Plants in Table 1a are of no consequence in terms of any potential adverse impacts on flora resulting from the project and no listed species occur in this table.

Of the 6 native and early Polynesian species listed in Table 1b, one is a native endemic species (*maiapilo*; *Capparis sandwichiana*), four are native indigenous species, and one is a Polynesian introduction. The most ubiquitous indigenous native in the project area is *'uhaloa* (*Waltheria indica*), a common plant that is abundant over most of the Project area, and occurs in both disturbed and undisturbed areas. *Noni* (*Morinda citrifolia*), a Polynesian introduced shrub or small tree, is fairly ubiquitous throughout the survey areas. The other indigenous species are rare or uncommon in these locations. Endemics may be of particular concern as these are natives that do not occur naturally outside the Hawaiian Islands). The single endemic, *maiapilo* (see Figure 6), is uncommon at most sites, although characterized as occasional on the Kealakehe WWTP property along the north side of the existing developed area.

R. David

Figure 6. Large *maiapilo* plant along the Kealakehe WWTP entrance roadway flowering profusely, as were all the *maiapilo* encountered during the September survey.

Fauna

A total of 926 individual birds of 32 species, representing 17 separate families, were recorded during station counts (Table 3). Four of the species recorded are native resident species, two of which, Hawaiian Coot (*Fulica alai*) and the endemic sub-species of the Black-necked Stilt (*Himantopus mexicanus knudseni*) are listed as endangered species under both the federal and State of Hawai'i endangered species statutes. One species, Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*) is an indigenous resident water obligate species, and Least Tern (*Sterna antillarum*), is a recently established breeding seabird species. Additionally, six other species recorded are migratory indigenous shorebird or waterbird species. The remaining 21 species are established alien species.

Avian diversity and densities were very high in and adjacent to the WWTP, but low in all others areas surveyed away from the WWTP, in keeping with the

highly disturbed native dominated grassland present across the bulk of the area surveyed. Five species, African Silverbill (*Euodice cantans*), Black-Crowned Night-Heron (*Nycticorax nycticorax hoactli*), Hawaiian Coot (*Fulica alai*), Hawaiian Stilt (*Himantopus mexicanus knudseni*), and Zebra Dove (*Geopelia striata*) accounted for 47% of all birds recorded during station counts. The most frequently recorded species was African Silverbill , which accounted for 14% of the total number of individual birds recorded during station point-counts.

Table 3. Avian species detected during point-counts for the Kealakehe WWTP R1 Upgrade Project.

Common Name	Scientific Name	ST	RA
	ANSERIFORMES		
	ANATIDAE - Ducks, Geese & Swans		
	Anserinae - Geese & Swans		
Cackling Goose	*Branta hutchinsii*	IM	0.05
	Anatinae - Ducks		
Mallard hybrid	*Anas platyrhynchos x* sp?	A	0.10
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	0.10
Black Francolin	*Francolinus francolinus*	A	0.05
Domestic Chicken	*Gallus* sp.	A	0.50
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	1.25
Zebra Dove	*Geopelia striata*	A	3.70
	GRUIFORMES		
	RALLIDAE - Rails, Gallinules and Coots		
Hawaiian Coot	*Fulica alai*	**EE**	4.05
	CHARADRIIFORMES		
	RECURVIROSTRIDAE - Stilts & Avocets		
Black-necked Stilt	*Himantopus mexicanus knudseni*	**EE**	3.60
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	2.35
	SCOLOPACIDAE - Sandpipers		
	Arenariinae - Turnstones		
Ruddy Turnstone	*Arenaria interpres*	IM	2.50
	Calidrdinae - Calidridine Sandpipers		
Sanderling	*Calidris alba*	IM	0.55

Table 3 (continued).

Common Name	Scientific Name	ST	RA
	Tringinae – Tringinae Sandpipers		
Wandering Tattler	*Tringa incana*	IM	0.35
	LARIDAE - Gulls, Terns & Skimmers		
	Sterninae - Terns		
Least Tern	*Sternula antillarum*	IB	0.95
	PELECANIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	1.95
Black-crowned Night-Heron	*Nycticorax nycticorax hoactli*	IB	4.10
	THRESKIORNITHIDAE - Ibises & Spoonbills		
	Threskiornithinae - Ibises		
White-faced Ibis	*Plegadis chihi*	IM	0.05
	PSITTACIFORMES		
	PSITTACIDAE - African and New World Parrots		
	Arinae - New World Parakeets, Macaws & Parrots		
Red-masked Parakeet	*Psittacara erythrogenys*	A	0.60
	PASSERIFORMES		
	ZOSTEROPIDAE - White-eyes		
Japanese White-eye	*Zosterops japonicus*	A	1.60
	MIMIDAE - Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	A	0.05
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	3.50
	FRINGILLIDAE - Fringilline and Carduline Finches & Allies		
	Carduelinae - Carduline Finches and Hawaiian Honeycreepers		
House Finch	*Haemorhous mexicanus*	A	0.60
Yellow-fronted Canary	*Ceithagra mozambica*	A	0.15
	PASSERIDAE - Old World Sparrows		
House Sparrow	Passer domesticus	A	1.15
	CARDINALIDAE - Cardinals & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	0.40
	THRAUPIDAE - Tanagers		
	Thraupinae - Core Tanagers		
Yellow-billed Cardinal	*Paroaria capitata*	A	0.55
Saffron Finch	*Sicalis flaveola*	A	0.10
	ESTRILDIDAE - Estrildid Finches		
Common Waxbill	*Estrilda astrild*	A	1.10
African Silverbill	*Euodice cantans*	A	6.35
Java Sparrow	*Lonchura oryzivora*	A	0.35
Scaly-breasted Munia	*Lonchura punctulata*	A	1.00

Table 3 (continued).

Legend to Table 3

ST	Status
A	Alien – Introduced to the Hawaiian Islands by humans
EE	Endangered Endemic – native and unique to the Hawaiian Islands, listed as an endangered species
IM	Indigenous migratory – native migratory species not unique to the Hawaiian Islands does not breed in the state
IB	Indigenous - native not unique to the Hawaiian Islands that does breed in the state
RA	Relative Abundance – Number of birds detected divided by the number of count stations ~ (20)

Waterbird Counts — Fifteen waterbird and migratoy shorebirds were recorded with in the existing WWTP. The individual species totals presented in Table 4 are total high count for the entire facility. Two of the species counted, Hawaiian Coot (*Fulica Alai*), and Hawaiian Stilt (*Himantopus mexicanus knudseni*), are listed as endangered under both federal and state of Hawai'i endangered species statutes.

Table 4. Waterbird counts for the Kealakehe WWTP R1 Upgrade Project.

Common Name	Scientific Name	*ST*	Count
	ANSERIFORMES		
	ANATIDAE - Ducks, Geese & Swans		
	Anserinae - Geese & Swans		
Cackling Goose	*Branta hutchinsii*	IM	1
	Anatinae - Ducks		
Northern Shoveler	*Spatula clypeata*	IM	52
Eurasian Wigeon	*Mareca penelope*	IM	1
American Wigeon	*Mareca americana*	IM	18
Muscovy hybrid	*Cairina moschata x* sp?	D	2
Northern Pintail	*Anas acuta*	IM	13
Lesser Scaup	*Aythya affinis*	IM	9
	GRUIFORMES		
	RALLIDAE - Rails, Gallinules and Coots		
Hawaiian Coot	*Fulica alai*	**EE**	67
	CHARADRIIFORMES		
	RECURVIROSTRIDAE - Stilts & Avocets		
Black-necked Stilt	*Himantopus mexicanus knudseni*	**EE**	30

Table 4 (continued).

Common Name	Scientific Name	*ST*	Count
	PELECANIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	1
Black-crowned Night-Heron	*Nycticorax nycticorax hoactli*	A	22
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	55
	SCOLOPACIDAE - Sandpipers		
	Arenariinae - Turnstones		
Ruddy Turnstone	*Arenaria interpres*	IM	36
	Calidrdinae - Calidridine Sandpipers		
Sanderling	*Calidris alba*	IM	10
	Tringinae – Tringinae Sandpipers		
Wandering Tattler	*Tringa incana*		
	THRESKIORNITHIDAE - Ibises & Spoonbills		
	Threskiornithinae - Ibises		
White-faced Ibis	*Plegadis chihi*	IM	4

Legend to Table 4

ST	Status
A	Alien – Introduced to the Hawaiian Islands by humans
EE	Endangered Endemic – native and unique to the Hawaiian Islands, listed as an endangered species
IM	Indigenous migratory – native migratory species not unique to the Hawaiian Islands does not breed in the Hawaiian Islands

Eight terrestrial mammalian species were detected on the sites or along the pipeline routes during the course of this survey. In Table 4 the type of detection is shown for each species. All of the mammalian species recorded are alien to the Hawaiian Islands are deleterious to native species. No mammalian species currently proposed for listing or listed under either the federal or State of Hawai'i endangered species statutes was recorded on this site (DLNR 1998; USFWS, 2016).

Table 5. Mammalian species detected during faunal surveys for the Kealakehe WWTP R1 Upgrade Project.

Common name	Scientific name	ST	DT
	RODENTIA - Gnawers		
	Muridae - Old World Rats & Mice		
Rat sp.	*Rattus* sp.	A	V, Car
European house mouse	*Mus musculus domesticus*	A	V
	CARNIVORA- Flesh Eaters		
	Canidae - Wolves, Jackals & Allies		
Domestic dog	*Canis familiaris*	A	V, A, Sc, Tr
	VIVERRIDAE - Civets & Allies		
Small Indian mongoose	*Herpestes auropunctatus*	A	V, A, Sc
	FELIDAE- Cats		
House cat	*Felis catus*	A	V, Sc, Tr
	ATRIODACTYLA - EVEN-TOED UNGULATES		
	SUICIDAE - Old World Swine		
Pig	*Sus scrofa*	A	V, A, Sc, Tr, Si, Car
	CERVIDAE - Antlered Ruminants		
	Bovidae- Hollow-horned Ruminants		
Domestic goat	*Capra hircus*	A	V, A, Sc, Sci
Domestic sheep	*Ovis aries*	A	V, A, Sc

Legend to Table 4

ST	Status
DT	Detection type
A	Alien – Introduced to the Hawaiian Islands by humans
V	Visual – an animal seen
Car	Carcass – an animal identified by the presence of a carcass
A	Audio – an animal heard
Sc	Scat – an animal detected by fecal droppings
Tr	Tracks -an animal detected by the presence of tracks
Si	Sign – an animal detected by sign, i.e., tunnels, beds, tree scrapping etc.

Discussion

Botanical Resources

The Project areas for the Kealakehe WWTP R-1 Upgrade are a mix of undisturbed, slightly disturbed, but mostly greatly disturbed lava flows and roadways. Remnants of the native plant community exist throughout the area, but these are either common species (such as *'uhaloa* and *noni*, the latter a Polynesian introduction) or are rare across the sites. The only plant of concern is *maiapilo* (see Figure 6), a plant with a wide but essentially coastal distribution in the Hawaiian Islands (and found nowhere else), but with a population that appears to be in slow decline. The species is regarded as "vulnerable" by IUCN because lowland environments face threats from development on all of the islands (IUCN, 2003). *Maiapilo* is not listed as threatened or endangered by USFWS or the State of Hawaii (USFWS, 2017; DLNR, 1998). It is misnamed on the USFWS website as "*pus pilo*" (should be *pilo*, *pua pilo, or maiapilo*).

Because of the sparse distribution of *maiapilo* in the Project area, it is likely no or but a very few plants will be impacted. Within the survey areas, the most *maiapilo* plants occur on the northern part of the Kealakehe WWTP buffer parcel and on the lava fields over which the R-1 lines to the QLT Children's Center and Old Kona Airport Park are planned. In the former case, no plants are located in areas designated for polishing wetlands (WOC, undated). In the latter case, *maiapilo* are not located close to the unimproved roads proposed as routes for installation of distribution lines.

Avian Resources

Point Counts — The findings of the avian survey in September are consistent with the location of the sites, and the habitats present along the various waterline routes surveyed. As previously mentioned, a total of 32 avian species were recorded during the point-counts conducted within the Project areas. Five of these species are native resident species, two of which, Hawaiian Coot and the endemic sub-species of the Black-necked Stilt, are listed as endangered species under both federal and State of Hawai'i endangered species statutes. One species, Black-crowned Night-Heron, is a resident breeding indigenous water obligate species widely distributed across the state wherever there is standing or running fresh to brackish water. The recording of seven Least Terns is notable in that this is a species which has recently colonized the Islands and are breeding in several locations here. Three of the terns recorded were hatch-year birds. Five indigenous migratory shorebird species: Pacific Golden-Plover

(*Pluvialis fulva*), Ruddy Turnstone (*Arenaria interpres*), Sanderling (*Calidris alba*), Wandering Tattler (*Tringa Incana*) and White-faced Ibis (*Plegadis chihi*), were recorded. The first four of these nest in the high Arctic during the late spring and summer months, returning to Hawai'i and the Tropical Pacific to spend the fall and winter months each year. They usually leave Hawai'i for the Arctic in late April or the very early part of May. All are widely distributed in the Hawaiian Islands during the winter months. A lone Cackling Goose (*Branta hutchinsii*) was recorded at the WWTP.

Waterbird Counts — Eight waterbird species were detected in March. Six of these—Cackling Goose (*Branta hutchinsii*), Northern Shoveler (*Spatula clypeata*), Eurasian Wigeon (*Mareca Penelope*), American Wigeon (*Mareca Americana*), Northern Pintail (Anas acuta), Lesser Scaup (*Aythya affinis*)—are indigenous migratory species. One species, Hawaiian Coot, is an endemic endangered species and one species, Muscovy hybrid (*Cairina moschata* x sp*?*), is a domestic feral species.

Although not detected during this survey, the endangered Hawaiian Petrel (*Pterodroma sandwichensis*) and the threatened endemic Newell's Shearwater (*Puffinus newelli*) have been recorded over-flying the general Project area between April and the end of November each year. The petrel is listed as endangered, and the shearwater as threatened under both federal and State of Hawai'i endangered species statutes. The primary cause of mortality in both Hawaiian Petrel and Newell's Shearwater is thought to be predation by alien mammalian species at the nesting colonies (USFWS, 1983; Simons and Hodges, 1998; Ainley et al., 2001). Collision with man-made structures is considered to be second-most significant cause of mortality of these seabirds in Hawai'i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds may collide with man-made structures and, if not killed outright, dazed or injured birds become prey to feral mammals (Hadley, 1961; Telfer, 1979; Sincock, 1981; Reed et al., 1985; Telfer et al., 1987; Cooper and Day, 1998; Podolsky et al., 1998; Ainley et al., 2001; Hue et al., 2001; Day et al., 2003). Neither nesting colonies nor appropriate nesting habitat for either of these listed seabird species occur within or close to the Project site.

Mammalian Resources

The findings of the mammalian survey are consistent with the location of the Project and the habitats currently present on the sites and along the pipeline routes. All of the introduced mammalian species recorded are deleterious to native ecosystems and the native faunal species dependent on them.

No Hawaiian hoary bats were detected during the course of this survey. Given the location of the site and the lack of trees it is not expected that bats roost within the general project area. Hawaiian hoary bats have been seen flying over the existing wastewater treatment plant and the coastal areas to the north and south of the area (David, 2017). It is not expected that the proposed actions will result in deleterious impacts to this listed endemic mammal.

Potential Impacts to Protected Species

Waterbirds

The principal potential impacts posed by the Project to endangered waterbirds are associated with disturbances of nesting birds during the nesting season within the small footprint of the proposed electrical and chemical buildings and a new underground waterline running parallel to the southern boundary fence, within the WWTP site. These activities, though of a short duration, could potentially disturb nearby nesting Hawaiian Stilts and Hawaiian Coots. Disturbance of this nature can result in birds abandoning their nest, eggs, and to a lesser degree, chicks.

Seabirds

Potential impact to protected seabirds posed by the Project is an increased threat to transiting birds disoriented by lights associated with the Project during the seabird nesting season between September 15 through December 15 each year. If, during construction, it is deemed expedient to conduct night-time construction activities, or if streetlights are installed as part of the proposed action, these must be shielded (Reed et al. 1985, Telfer et al. 1987). Shielding of lights would serve the dual purpose of minimizing disorientation and downing of petrels and shearwaters, and complying with Hawai'i County Code §14 – 50 et seq., which requires shielding of exterior lights to lower ambient glare reaching the astronomical observatories located on Mauna Kea.

Hawaiian hoary bat

As there are no suitable roosting trees anywhere close to any portion of the proposed action, and all fencing that will be installed will not have barbed wire strands topping them, it is not expected that the proposed action will result in deleterious impacts to this listed species.

Recommendations

- Any *maiapilo* plant noted to be close to construction associated with this Project (but that will not be removed) should be temporarily surrounded by construction fencing to prevent accidental damage.

- If night-time construction activity or equipment maintenance is proposed during the construction phases of the project, all associated lights should be shielded, and when large flood/work lights are used, they should be placed on poles high enough to allow the lights to be pointed directly at the ground.

- If streetlights or exterior facility lighting is installed in conjunction with the Project, the lights must be shielded to reduce the potential for interactions of nocturnally flying seabirds with external lights and man-made structures (Reed et al., 1985; Telfer et al., 1987).

- A sturdy silt fence or other suitable barrier system should be installed around the areas within the existing WWTP facility that will be excavated to install the new line along the southern and western fence line connecting the WWTP to the polishing fields to prevent ingress of listed waterbird species into areas subject to construction disturbances.

- Daily waterbird monitoring should continue until all work within the WWTP fenced facility is complete.

- In locations that fencing is installed as part of this action it is recommended that the fences not be topped with strands of barbed wire, as there have been records of Hawaiian hoary bats being impaled on barbed wire topping fences.

Protected Species and Environments

No federal or state listed endangered or threatened plants species (DLNR, 1998; USFWS 2017) were collected or observed during the course of this survey. Several endangered waterbird species were recorded in adjacent parcels and/or flying over portions of the action area, though none was recorded on the ground within any of the areas surveyed, which is to be expected since there is currently no suitable terrestrial habitat to support any of these species within the proposed disturbance footprint.

Critical Habitat

No federally delineated Critical Habitat overlays any portion of the survey area. No equivalent statute exists under State law.

Jurisdictional Waters

No federal jurisdictional waters occur in the survey area.

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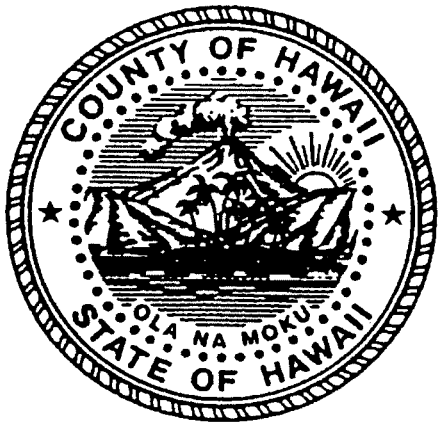

APPENDIX D

Draft
Archaeological Literature Review and Field Inspection Report for the Kealakehe Wastewater Treatment Plant Master Plan, Kaloko, Honokōhau, Kealakehe, and Keahuolū Ahupua‘a, North Kona District, Hawai‘i Island TMKs: [3] 7-3-009:027; 7-4-008:002, 058, 073; 7-4-020:007, 019, 021, 022; 7-5-005:007

Prepared for
Wilson Okomoto Corporation

Prepared by
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McKenzie Wildey, B.A.,
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Cultural Surveys Hawai‘i, Inc.
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Management Summary

Reference	Archaeological Literature Review and Field Inspection Report for the Kealakehe Wastewater Treatment Plant Master Plan, Kaloko, Honokōhau, Kealakehe, and Keahuolū Ahupua‘a, North Kona District, Hawai‘i Island, TMKs: [3] 7-3-009:027; 7-4-008:002, 058, 073; 7-4-020:007, 019, 021, 022; 7-5-005:007 (Bautista et al. 2018)
Date	April 2018
Project Number(s)	Cultural Surveys Hawai‘i, Inc. (CSH) Job Code: KEALAKEHE 4
Investigation Permit Number	CSH completed the fieldwork component of this study under archaeological fieldwork permit number 17-08, issued by the Hawai‘i State Historic Preservation Division (SHPD) per Hawai‘i Administrative Rules (HAR) §13-282.
Agencies	Unicted States Environmental Protection Agency (EPA); Hawai‘i State Department of Health (DOH); SHPD; County of Hawai‘i Department of Environmental Management (DEM)
Land Jurisdiction	State of Hawai‘i/County of Hawai‘i/Private (Queen Lili‘oukalani Trust)
Project Proponent	County of Hawai‘i DEM
Project Funding	Federal (EPA); State of Hawai‘i (revolving fund); County of Hawai‘i
Project Location	The project area is located on the leeward side of Hawai‘i Island just north of the town of Kailua-Kona. The project area straddles Queen Ka‘ahumanu Highway (Route 19) within Kaloko, Honokōhau, Kealakehe, and Keahuolū Ahupua‘a. The project area is depicted on a portion of the 1996 Keahole Point and Kailua U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle. Under this study for organizational purposes the project area has been broken into three geographical units: • The “Mauka Section” comprises portions of the Kealakehe Parkway and Queen Ka‘ahumanu Highway rights-of-way (ROWs) and TMKs: [3] 7-4-020:007, 019, 021, 022 located *mauka* (upslope) of the Queen Ka‘ahumanu Highway ROW; • The “Makai Section” comprises TMKs: [3] 7-4-008:002, 058, 073 and 7-5-005:007 located *makai* (seaward) of the Queen Ka‘ahumanu Highway ROW; and overlaps a Special Management Area (SMA); • The “Northern Section” comprises TMK: [3] 7-3-009:027 and portions of the Hina Lani Street and Queen Ka‘ahumanu Highway ROWs.
Project Description	The County of Hawai‘i DEM (“County”) intends to upgrade the Kealakehe Waste Water Plant (WWTP) to provide effluent treatment to produce R-1 recycled water. Facilities to be constructed as part of this project include water reuse, wastewater collection and treatment

	enhancements, and effluents disposal elements. Ground disturbance would include excavation for installation of new water and sewer lines and upgrades to existing subsurface lines and infrastructure.
Project Acreage	The overall project area is approximately 199 acres (81 hectares).
Area of Potential Effect (APE) and Inspection Area Acreage	The project APE has not yet been determined. For the purposes of this LRFI, the inspection area acreage is the same as the project acreage (approximately 199 acres).
Document Purpose	This investigation was designed—through detailed historical, cultural, and archaeological background research and a field inspection of the project area—to determine the likelihood that historic properties may be affected by the project and, based on findings, consider cultural resource management recommendations. This document is intended to facilitate the project's planning and support the project's historic preservation and environmental review compliance. This investigation does not fulfill the requirements of an archaeological inventory survey investigation, per HAR §13-13-276. Consequently, this report cannot be used to make formal recommendations for SHPD review and acceptance.
Fieldwork Effort	CSH archaeologists accomplished fieldwork on 25–26 September 2017 and 6 October 2017; archaeologists included Olivier M. Bautista B.A., McKenzie Wildey B.A., and Sarah Wilkinson, B.A., under the general supervision of Hallett Hammatt, Ph.D. This work required approximately 9 person-days to complete. The fieldwork focused on confirming sites located within or immediately adjacent to (within 5 m of) the project area bounds, and determining the potential presence of previously unrecorded features.
Consultation	National Historic Preservation Act (NHPA) Section 106 consultation with community members, agencies, and Native Hawaiian Organizations (NHOs) is being initiated by the project proponents. A cultural impact assessment (CIA) in accordance with HRS §343 is also ongoing for the project, and involves consultation with community members, agencies, and NHOs.
Results Summary	The project area lies within the southernmost extent of the Kekaha region, in which the uplands were used for residences and farming, and the coastal lands for residence, fishing, and aquaculture. The lands located between the coast and uplands settlements, in which the majority of the project area is situated, contained networks of trails along which shelter and water collection caves, quarries, and scattered agricultural sites were located. In the historic era the area was used widely for ranching.

	Background research indicated the presence of 119 previously identified archaeological sites/historic properties overlapping or within 100 m (330 feet [ft]) of the bounds of the project area. Most of these are pre-Contact sites associated with agriculture, habitation, transportation, resource procurement, ceremony, burial, artistic expression, and/or recreation. Historic era sites included trails (including but not limited to State Inventory of Historic Places [SIHP] # 50-10-27-00002, Māmalahoa Trail), habitation areas, a cemetery, and ranching-related features like boundary walls. The field inspection identified variable levels of prior disturbance throughout the project area. The Mauka Section contains the largest areas of undisturbed land. The field inspection confirmed 30 of 119 previously identified archaeological sites and possibly relocated portions of eight previously identified sites; these 38 sites are within or immediately adjacent to the project area. In addition, archaeologists documented 16 newly identified archaeological features/feature complexes within or directly adjacent to the project area.
Recommendations	In general, efforts to minimize potential effects on historic properties is recommended in the project design phase. Such efforts could include limiting ground disturbance within previously undisturbed areas as much as possible (e.g., propose installation of transmission lines within existing roadbeds or graded areas). Some portions of the project area are of potentially higher sensitivity given their known archaeological content: • A section of the Māmalahoa Trail (SIHP # 50-10-27-00002) runs parallel to Queen Ka‘ahumanu Highway within the Mauka Section in the vicinity of the proposed soil aquifer treatment (SAT) facility. A portion of this historic property within the project area has existing mitigations in place associated with the ongoing Queen Ka‘ahumanu Highway Widening Phase 2 project. Impact to the Māmalahoa Trail should be avoided if possible by routing pipelines or other infrastructure through existing breaches along the trail. • The portion of the Mauka Section relating to the future elevated storage tank has not been subjected to recent archaeological survey, and was found during the field inspection to contain several previously unrecorded archaeological features and lava tube openings. Lava tubes in this area commonly contain cultural modifications and/or deposits including but not limited to human burials. • The section of the Initial Phase R-1 Transmission Line approaching the Old Kona Airport Park (Kailua Park) within the

	Makai Section is in direct proximity to several extensive previously identified site complexes. While many of these features are likely located a safe distance from the current project area, some are directly adjacent and could potentially be impacted. Difficulties in correlating present findings with the previously recorded sites—and the discovery of previously unrecorded features—highlight potential concerns with the existing body of archaeological coverage in this area. Consultation with the SHPD is recommended regarding project historic preservation requirements. Given the high number of previously identified historic properties, the presence of newly documented archaeological features within and in the vicinity of the project area, and likelihood that the project would have an effect on some of these sites, SHPD may require an archaeological inventory survey (AIS) and/or other form(s) of mitigation.

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Section 1 Introduction

1.1 Project Background

At the request of Wilson Okomoto Corporation (WOC), Cultural Surveys Hawai‘i, Inc. (CSH) has prepared this literature review and field inspection report (LRFI) for the Kealakehe Wastewater Treatment Plant Master Plan, Kaloko, Honokōhau, Kealakehe, and Keahuolū Ahupua‘a, North Kona District, Hawai‘i Island, TMKs: [3] 7-3-009:027; 7-4-008:002, 058, 073; 7-4-020:007, 019, 021, 022; 7-5-005:007. The project area is located north of the town of Kailua-Kona and is bisected by Queen Ka‘ahumanu Highway (Route 19). It is depicted on a portion of the 1996 Keahole Point and Kailua U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle (Figure 1), tax map plats (Figure 2 and Figure 3), and a 2013 aerial photograph (Figure 4).

The Hawai‘i State Department of Health (DOH) advocates for the use of recycled water provided that public health and water resources are not compromised. Use of recycled water has become more significant due to the state’s growing population, limited potable water resources, and waste water disposal issues. The County of Hawai‘i, Department of Environmental Management (“County”) intends to upgrade the Kealakehe Waste Water Plant (WWTP) to provide effluent treatment to produce R-1 recycled water.

Facilities to be constructed as part of this project include water reuse, wastewater collection and treatment enhancements, and effluents disposal elements, illustrated on Figure 5. R-1 water produced at the Kealakehe WWTP will be initially stored on site in a 500,000-gallon above grade tank. The storage tank will also serve as a clear well for the buffer parcel irrigation pumps, provide pressure head for transmission of R-1 water to the Old Kona Airport Park (also known as Kailua Park) and Queen Lili‘uokalani Trust (QLT) lands, and feed the R-1 distribution system to the north. The extent of the site infrastructure for the initial and future R-1 storage and distribution system to the north will consist of new, repurposed, and recently installed components. Recycled water infrastructure, including the “purple pipe” required to differentiate recycled water from other pipelines, was installed in 2016 in conjunction with the Queen Kaūahumanu Highway Phase II Widening project from Kealakehe Parkway to the entrance of the Kohanaiki Golf and Ocean Club. A new pipeline will be constructed from Kealakehe WWTP to connect with the Queen Kaūahumanu Highway purple pipe at Kealakehe Parkway. R-1 water will be pumped from the WWTP to an existing, unused potable water storage tank on Hina Lani Street which will be permanently isolated from the potable water distribution system and recommissioned for R-1 service.

To the south, a new pipeline will be constructed to convey R-1 water to the Old Kona Airport Park, whose irrigation infrastructure will be modified to facilitate the use of R-1 water. A high head R-1 pump station will be constructed in the future to deliver water to a planned elevated tank located *mauka* (upslope) of the WWTP, expanding the system to provide storage and adequate pressure for additional uses. Potential future users include the proposed Kealakehe Regional Park, Honōkohau Harbor, industrial and commercial operations within the service area, QLT land development, and other projects (see Figure 5). Treated wastewater in excess of demand for reuse will be further treated through a proposed on-site subsurface flow wetlands and then conveyed to a proposed offsite soil aquifer treatment (SAT) facility for even further treatment and disposal.

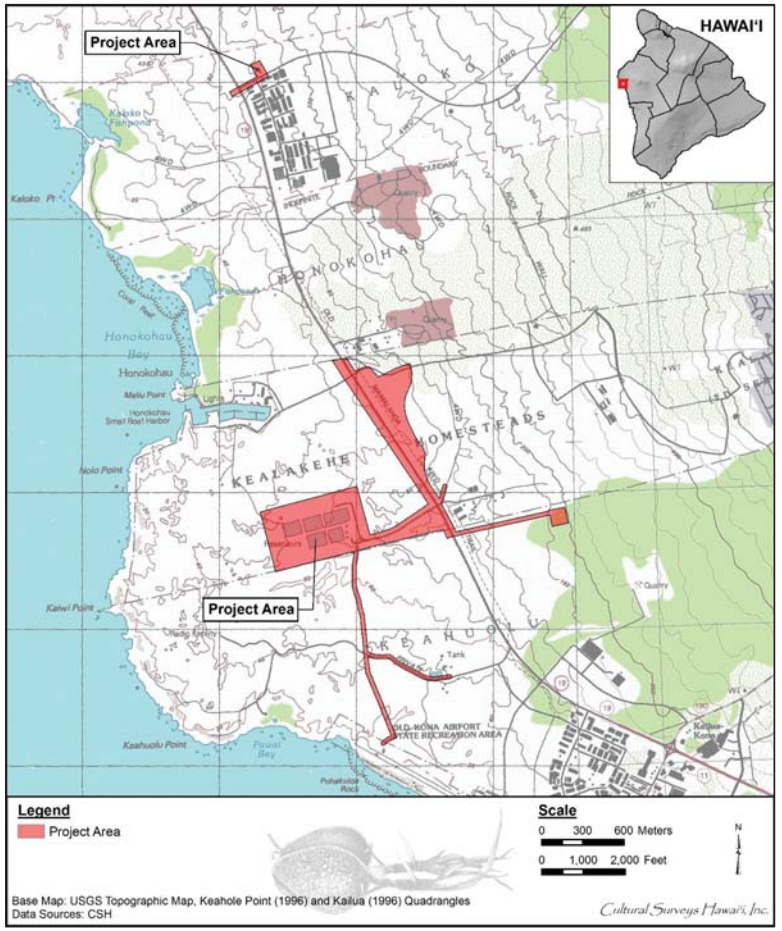

Figure 1. Portions of the 1996 Keahole Point and Kailua USGS 7.5-minute topographic quadrangles showing the location of the project area

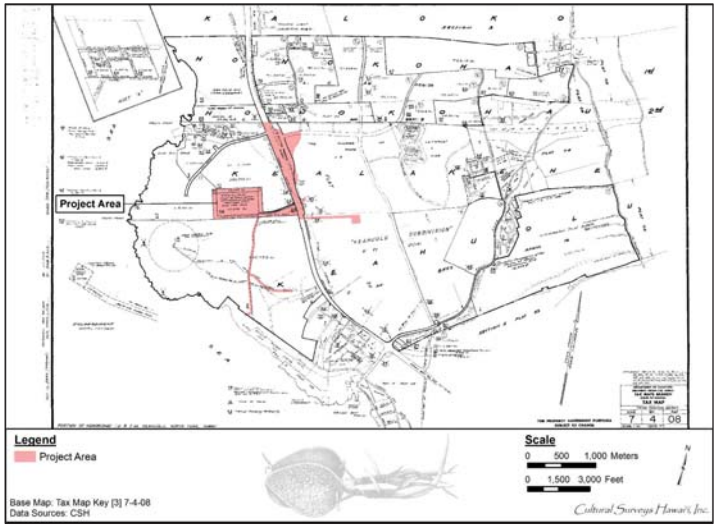

Figure 2. Tax Map Key (TMK) [3] 7-4-08 showing portions of the project area (Hawai'i TMK Service 2014)

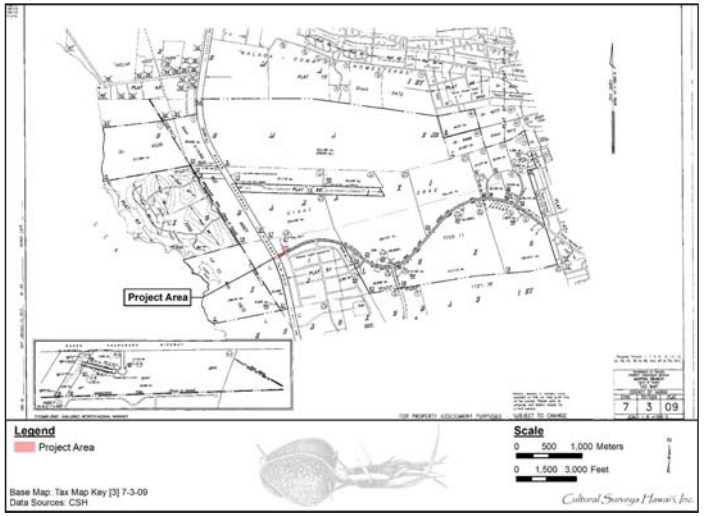

Figure 3. TMK: [3] 7-3-09 showing a portion of the project area (Hawai'i TMK Service 2014)

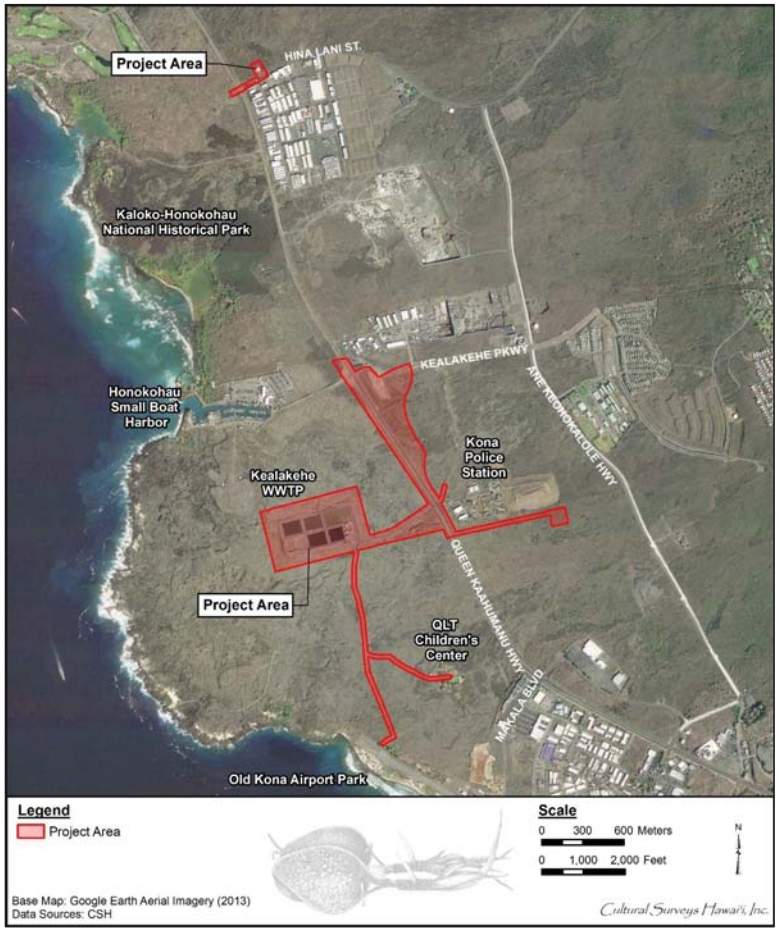

Figure 4. Aerial photograph showing the location of the project area (Google Earth 2013)

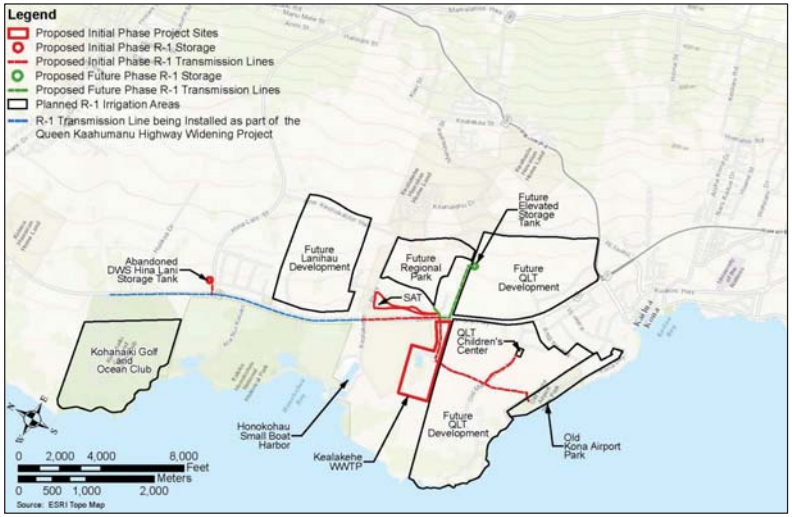

Figure 5. R-1 use concept plan from environmental impact statement public notice (courtesy of client)

The project Area of Potential Effect (APE) has not yet been determined. For the purposes of this LRFI, the inspection area acreage is the same as the overall project acreage (approximately 199 acres or 81 hectares). Under this study for organizational purposes the project area has been broken into three geographical units, illustrated on Figure 6:

- The “Mauka Section” comprises portions of the Queen Ka‘ahumanu Highway, Kealakehe Parkway, and Hale Māka‘i Place rights-of-way (ROWs) and TMKs: [3] 7-4-020:007, 019, 021, 022 located *mauka* (inland) of the Queen Ka‘ahumanu Highway ROW;
- The “Makai Section” comprises TMKs: [3] 7-4-008:002, 058, 073 and 7-5-005:007 located *makai* (seaward) of the Queen Ka‘ahumanu Highway ROW; and overlaps a Special Management Area (SMA);
- The “Northern Section” comprises TMK: [3] 7-3-009:027 and portions of the Hina Lani Street and Queen Ka‘ahumanu Highway ROWs.

1.2 Document Purpose

This investigation was designed—through detailed historical, cultural, and archaeological background research and a field inspection of the project area—to determine the likelihood that historic properties may be affected by the project and, based on findings, consider cultural resource management recommendations. This document is intended to facilitate the project’s planning and support the project’s historic preservation and environmental review compliance. This investigation does not fulfill the requirements of an archaeological inventory survey investigation, per HAR §13-276. Consequently, this report cannot be used to make formal recommendations for State Historic Preservation Division (SHPD) review and acceptance

1.3 Environmental Setting

1.3.1 Natural Environment

The project area is situated upon the southwestern slopes of Hualālai Volcano within the traditional land divisions of Kaloko, Kealakehe, and Keahuolū. It also directly bounds Honokōhau Ahupua‘a north of Kealakehe. The project area ranges from approximately 200 m (656 feet [ft]) to 2.4 km (1.49 miles) back from the coast, at an elevation of approximately 4–60 m (13–197 ft) AMSL (above mean sea level). The terrain is typically exposed, undulating lava flows with mild to moderate slopes to the west and southwest. Rocky outcrops and lava blisters and tubes are common.

Kona weather is typified by afternoon showers brought on by warm air which has been moved inland by light sea breezes. The humid air gradually condenses over higher altitudes throughout the day. At night the land cools resulting in breezes that send warm air back out to sea. Rainfall in this general area averages 500 mm (20 inches) per year (Giambelluca et al. 2013). While there are no perennial streams within the project area, natural springs have been documented within lava tube caves in the vicinity.

Non-native grasses and *koa haole* (*Leucaena leucocephala*) are the predominant plants within the project area. Other plants include non-native lantana (*Lantana camara*), *kiawe* (*Prosopis pallida*), Christmasberry (*Schinus terebinthifolius*), and succulents; and scattered native *noni*

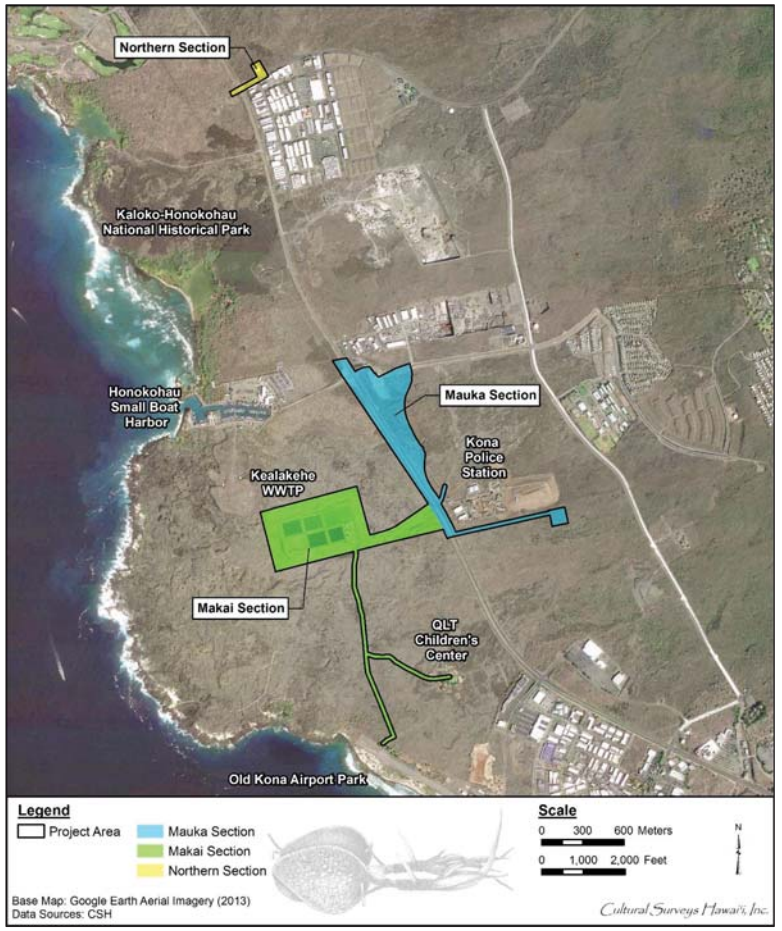

Figure 6. Aerial photograph (Google Earth 2013) showing the three geographical sections of the project area (Mauka Section in blue, Makai Section in green, and Northern Section in yellow)

(*Morinda citrifolia*), *‘ilima* (*Sida fallax*), *‘ōhi‘a* (*Metrosideros polymorpha*), and *maiapilo* (*Capparis sandwichiana*). Vegetation increases with elevation.

According to the U.S. Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) database (2001) and soil survey data gathered by Sato et al. (1973), the project area is situated upon two miscellaneous land types: “Lava flows, pahoehoe” (rLW) and “Lava flows, aa” (rLV) (Figure 7). The majority of the Makai Section and entire Northern Section are *pāhoehoe* (smooth) lava flows (i.e., rLW type), with a small portion of the Makai Section crossing an *‘a‘ā* (rough) lava flow (rLV type) (see Figure 7). The Mauka Section is indicated to cross roughly equal areas of both the rLV and rLW types (see Figure 7). According to Sato et al. (1973:34), Lava flows, pahoehoe (rLW) exhibit “a billowy, glassy surface that is relatively smooth . . . In some areas, however, the surface is rough and broken, and there are hummocks and pressure domes . . . [it] has no soil covering and is typically bare of vegetation” (Sato et al. 1973:34). Lava flows, aa (rLV) are described as “a mass of clinkery, hard, glassy, sharp pieces piled in tumbled heaps” that can contribute significantly to watershed (Sato et al. 1973:34).

The project area is situated upon 1,500–11,000-year-old lava flows from Hualālai (Figure 8). The Mauka Section of the project area is within 1,500–3,000 lava flows (Qh2) and 3,000–5,000-year-old lava flows (Qh1y), as well as a very small area of 5,000–11,000-year-old lava flow (Qh1o; see Figure 8). The entire Makai Section is within 1,500–3,000 lava flows (Qh2; see Figure 8). The entire Northern Section is within 5,000–11,000-year-old lava flows (Qh1o; see Figure 8).

1.3.2 Built Environment

The project area is located between the Kona Industrial Area to the south and the Kohanaiki Golf and Ocean Club to the north. This area of the North Kona district contains such developments as the Old Kona Airport Park, Queen Lili‘oukalani Trust (QLT) Children’s Center, West Hawai‘i Civic Center, Honokōhau Industrial Park, Honokōhau Harbor, Kaloko-Honokōhau National Historical Park, Kaloko Light Industrial Park, quarries, and a number of businesses and public services including the Kona Police Substation, Kona Solid Waste Transfer Station located on Hale Māka‘i Place.

While portions of the project area are undeveloped land, the project area does contain significant prior developments including existing roadways (Queen Ka‘ahumanu Highway, Kealakehe Parkway, Hina Lani Street, Kealakehe WWTP access roadways, and private QLT roadways) and the existing WWTP facility located within the Makai Section (see Figure 3). The WWTP is accessed from Queen Ka‘ahumanu Highway via a gated access road, and the facility, comprising a series of aerated lagoons, is fenced. The existing facility also includes a fenced disposal basin located in the Mauka Section east of Queen Ka‘ahumanu Highway and north of the intersection of the highway and Hale Māka‘i Place. The Makai Section interfaces the Maka‘eo Walking Path at the Old Kona Airport Park.

Adjacent developments have impacted the Mauka Section. A large, former stockpile area is located just east of the Queen Ka‘ahumanu Highway and Kealakehe Parkway intersection. A series of bulldozer and/or jeep roads is also present within the central portion of the Mauka Section east of the highway. A jeep road extends parallel to the western side of the highway ROW between the WWTP access road and the Honokōhau Harbor entrance at Kealakehe Parkway.

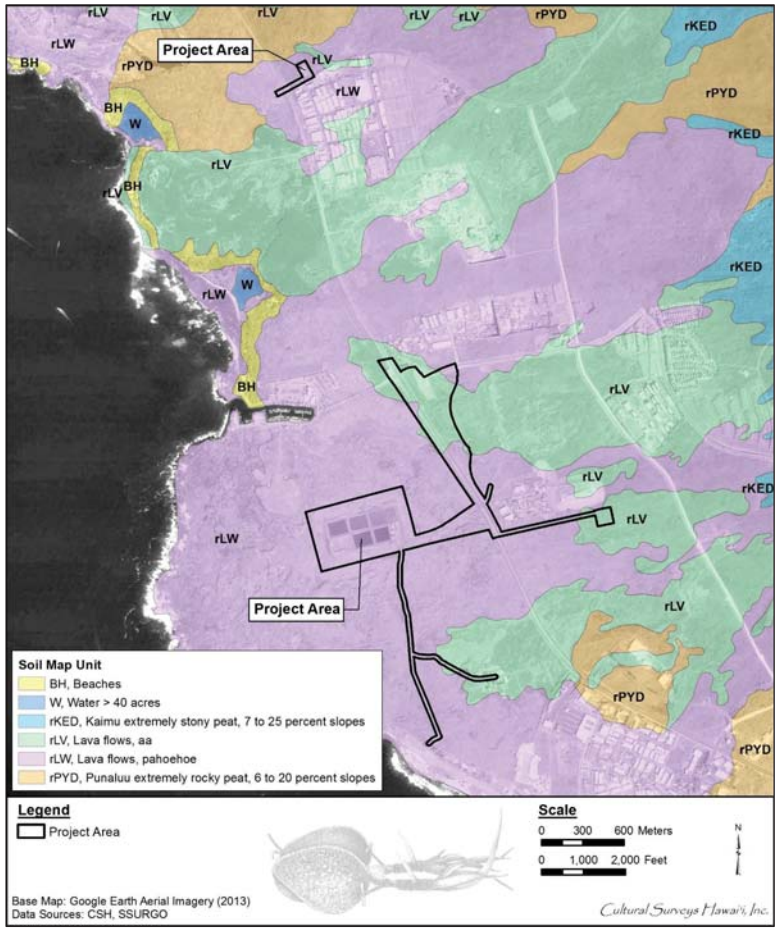

Figure 7. Overlay of *Soil Survey of the State of Hawaii* (Sato et al. 1972), indicating soil types within and surrounding the project area (USDA SSURGO 2001)

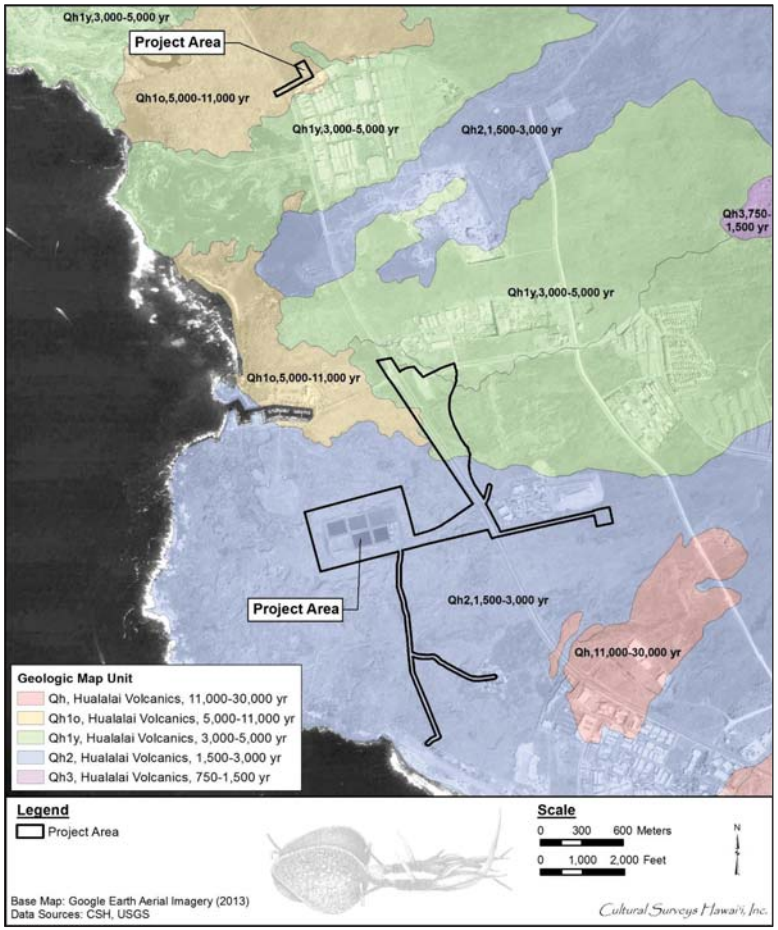

Figure 8. Aerial photograph of the project area (Google Earth 2013) overlain with geological data (Sherrod et al. 2008), indicating geological map units in the vicinity

In the Northern Section, TMK: [3] 7-3-009:027 contains a fenced, large capacity water storage tank that is currently not in use. The land within the tank enclosure has been bulldozed, as well as the adjacent northern shoulder of Hina Lani Street extending to the Queen Ka‘ahumanu Highway intersection. The portion of the Northern Section of the project area extending west from the highway ROW has also been extensively disturbed by bulldozing and landscaping.

Section 2 Methods

2.1 Field Methods

CSH completed the fieldwork component of this study under archaeological fieldwork permit number 17-08, issued by the SHPD pursuant to HAR §13-282. CSH archaeologists conducted fieldwork on 25–26 September 2017 and 6 October 2017; archaeologists included Olivier M. Bautista B.A., McKenzie Wildey, B.A., and Sarah Wilkinson, B.A., under the general supervision of Hallett Hammatt, Ph.D. This work required approximately 9 person-days to complete. In general, fieldwork included 100% pedestrian inspection of the project area, GPS data collection, and photographs.

2.1.1 Pedestrian Survey

The pedestrian survey focused on confirming previously recorded historic properties indicated to exist within and immediately adjacent to the project area, and to determine the potential for previously undocumented historic properties within the project area. The pedestrian survey was accomplished through systematic sweeps throughout the project area and a 10–20 m buffer area surrounding it, with archaeologists spaced 10 m to 20 m apart depending on ground visibility. Archaeologists checked potential new archaeological features against descriptions of previously identified sites indicated in the vicinity, to ensure they did not represent known sites that had been misplotted during prior surveys.

Where known historic properties and new archaeological features were encountered, archaeologists recorded their locations using a Garmin GPSmap 60CSx, and took digital photographs and brief notes.

2.2 Research Methods

Background research included a review of previous archaeological studies on file at the SHPD; review of documents at Hamilton Library of the University of Hawai‘i, the Hawai‘i State Archives, the Mission Houses Museum Library, the Hawai‘i Public Library, and the Bishop Museum Archives; study of historic photographs at the Hawai‘i State Archives and the Bishop Museum Archives; and study of historic maps at the Survey Office of the Department of Land and Natural Resources. Researchers also consulted historic maps and photographs from the CSH library. In addition, researchers examined Māhele records from the Waihona ‘Aina database (Waihona ‘Aina 2000).

This research provided the environmental, cultural, historic, and archaeological background for the project area. Archaeologists used the sources studied to formulate a predictive model regarding the expected types and locations of historic properties in the project area.

2.3 Consultation Methods

Consultation is being undertaken for the project to comply with Section 106 of the National Historic Preservation Act (NHPA). Presently, project proponents are initiating Section 106 consultation with community, agency, and Native Hawaiian Organizations (NHOs). The results of the current investigation will be utilized in these ongoing efforts.

Additionally, a cultural impact assessment (CIA) is being prepared for the project in compliance with HRS §343. The CIA includes consultation with NHOs, agencies, and community members to assess the project’s potential effect on cultural beliefs, practices, and resources.

Section 3 Traditional and Historical Background

3.1 Traditional Background

The project area is primarily within three *ahupua‘a* (traditional land division): Kaloko, Kealakehe, and Keahuolū. It also bounds the *ahupua‘a* of Honokōhau located between Kaloko and Kealaheke. The unit of land divisions comprising Kaloko to Kealakehe is situated within the southernmost portion of the zone traditionally referred to as Kekaha, or *Kekaha wai ‘ole* (“the waterless place”), known for its coastal fishponds and arid environment (see Section 3.1.1 and Section 3.1.4). Keahuolū Ahupua‘a is in a transitional area between the distinct ecological zones of Kekaha and the lands to the south between Kailua Bay and Keauhou Bay known as *Kona kai ‘opua* (“Kona of the distant horizon clouds above the ocean”), which is generally recognized as the fertile agricultural region and population center of the present North Kona District (Kelly 1983; Kirch 1985:166).

3.1.1 Introduction to Kekaha

The *ahupua‘a* of the project area lie within the Kekaha region of the traditional Kona District; according to Kalima (1992:A-l), the *ahupua‘a* comprising Kekaha were generally treated as a unit. Based on a recent translation of the “Legend of Ka-Miki” by Kepā Maly (Henry et al. 1993) the region or *‘okana* of Kekaha extends from Keahuolū northward to the Kona/Kohala boundary. The region is often described as “an arid coastal place,” which extended into the uplands (Maly 1998:4). Despite its desolate appearance, legends and other traditional accounts indicate Kekaha was once a populous and productive region.

The character of Kekaha is represented in an *‘ōlelo no‘eau* or poetical saying recorded by Mary Kawena Pukui (1983:184): “Kekaha wai ‘ole na Kona,” translated as “waterless Kekaha of the Kona district.” Pukui (1983:184) explains that “Kekaha in Kona, Hawai‘i, is known for its scarcity of water but is dearly loved by its inhabitants.” Indeed, early accounts of Kekaha often focused on attributes of its environment. The native historian John Papa ‘Ī‘ī describes the winds of Kekaha:

> . . . a cold wind from Kekaha, the Hoolua. Because of the calm of that land, people often slept outside of [sic] the tapa drying sites at night. It is said to be a land that grows cold with a dew-laden breeze, but perhaps not so cold as in Hilo when the Alahonua blows. [‘Ī‘ī 1959:122]

John Ka‘elemakule Sr., a Kekaha native, wrote newspaper articles between 1928 and 1930 that provide details about life and customs in the last half of the nineteenth century. Kepā and Onaona Maly (2003:41–42) translated these serial accounts that appeared in *Ka Hoku o Hawaii*. The two following excerpts provide additional details related to water collection:

> There were not many water holes, and the water that accumulated from rain dried up quickly. Also there would be weeks in which no rain fell . . . The water which the people who lived in the uplands of Kekaha drank, was found in caves. There are many caves from which the people of the uplands got water . . . [*Ka Hoku o Hawaii*, 17 September 1929:3 in Maly and Maly 2003:41]
>
> . . . The *kūpuna* [elders] had very strict *kapu* (restrictions) on these water caves. A woman who had her menstrual cycle could not enter the caves. The ancient people kept this as a sacred *kapu* from past generations. If a woman did not know that her time was coming and she entered the water cave, the water would die, that is, it would dry up. The water would stop dripping. This was a sign that the *kapu* of Kāne-of-the-water-of-life (Kāneikawaiola) had been desecrated. Through this, we learn that the ancient people of Kekaha believed that Kāne was the one who made the water drip from within the earth, even the water that entered the sea from the caves. This is what the ancient people of Kekaha *wai ‘ole* believed, and there were people who were *kia‘i* (guardians) who watched over and cleaned the caves, the house of Kāne . . . [*Ka Hoku o Hawaii*, 24 September 1929:3 in Maly and Maly 2003:41–42]

Hawaiian historian J.W.H.I. Kihe (also a Kekaha resident) related in *Ka Hōkū o Hawai‘i* a portion of the famed Ka Miki narrative (see Section 3.1.3) which described planting in upland Kekaha. The passage, translated by Kepā Maly, referenced a 10-day ceremonial time of harvesting, which may have served as a source for the place name “Pu‘u Anahulu,” an *ahupua‘a* to the northeast also within Kekaha:

> As the seasons changed from the days of the moon (winter) to the days of the sun (summer), the sun dried all the surface growth, but the taro, sweet potatoes, and different plants continued to growing [*sic*] because there was water below the surface in the rocks of the *kīhāpai* (cultivated patches). When the sweet potatoes matured and were ready for harvest, the family returned to the uplands for ten days. They baked a pig and offered chants and prayers in *kahukahu* ceremonies of the planter. [Maly 1999:20, footnote]

The following passage is from Kihe and appeared in *Ka Hoku o Hawai‘i* between 31 January and 10 April 1928. It relates the variety of agricultural crops that grew in Kekaha:

> Departing from O‘ahu, Makalie and his family landed at Hale‘uki, Ka‘upulehu and were greeted by Ke‘awalena a chief and overseer of the Kekaha region. Ka‘upulehu and all Kekaha were extensively cultivated at this time. Dependent on seasons, the uplands were used for residences and farming, and the coastal lands for residence and fishing. *Pao wai* (dug out water catchments) on the *pāhoehoe* and in upland fields were a means of water catchment. Crops grown here included: taro, sweet potatoes, sugar canes, bananas, and *‘awa* . . . [Maly in Henry et al. 1993:25]

Maly (in Henry et al. 1993:29) explains that traditional accounts of the Kekaha region describe a lush environment that differs from its current state due to several factors. The Hualālai lava flow in 1801 covered the former agricultural and forested lands, residential areas, and fishponds. The loss of forests began with the decrease in rainfall exacerbated by the introduction of livestock and ranching. Goats and cattle stripped the vegetation from the lands causing water resources to dry up. Thus, over the last 150 years, the environment has been significantly altered.

Samuel Kamakau, the native historian, relates that in the fifteenth century, High Chief ‘Umi-a-Līloa fished for *aku* (bonito, skipjack; *Katsuwonus pelamis*) along the Kekaha coast, and around 1810, Kamehameha I also fished the shores of Kekaha (Kamakau 1992:20, 203). Pukui (1983:271) underscores the importance of fishing in this region in the following poetical saying:

> *Ola aku la ka aina kaha, ua pua ka lehua I kai.*

> Life has come to the *kaha* lands for the *lehua* [flower of the ‘ōhi‘a tree] blooms are seen at sea.

Pukui (1983:271) further explains this saying: “Kaha lands refers to Kekaha. When the season for deep-sea fishing arrived, expert fishermen and their canoes headed for the ocean.”

It is likely because of its abundance of fish that Kekaha was “valued by ruling chiefs, inhabited by attendant chiefs, and upon occasion abused by warring chiefs” (Kamakau 1979:31). Kamakau (1992:66) reports that during the war between Alapa‘inui of Hawai‘i and Kekaulike of Maui, Kekaulike “abused the country people of Kekaha” by destroying all the coconut groves and slaughtering “the country people.” The destruction of these valuable trees was devastating.

Describing the apportioning of land by the *ali‘i* before the ascendancy of Kamehameha, Kamakau records this information about the lands of Kekaha:

> Waimea [he is referring in this case to Waimea, O‘ahu] was given to the Pa‘ao kahuna [priest, sorcerer] class in perpetuity and was held by them up to the time of Kamehameha III when titles had to be obtained. But there was one land title held by the kahuna class for many years and that was Puuepa in Kohala. In the same way the land of Kekaha was held by the kahuna class of Ka-uahi and Nahulu [Kamakau 1992:231].

According to Kamakau (1992:310) during the 1770s, “Kekaha and the lands of that section” were held by descendants of the Nahulu line, the Ka-me‘e-ia-moku and Ka-manawa, the twin half-brothers of Ke‘e-au-moku, the Hawai‘i Island chief. The Great Seal of the State of Hawai‘i depicts Kame‘eiamoku and Kamanawa (Springer 1989:23).

A great deal of primary research on legendary references and place names of Kekaha has been undertaken by Kepā Maly and Lehua Kalima. The results of some of this research can be found in “The Historical Documentary Research by Kepā Maly and Lehua Kalima” presented in PHRI report 1275-071493: *Archaeological Assessment Study, Kailua to Keahole Region State Lands LUC Project* (Henry et al. 1993).

3.1.2 Place Names

Wahi pana (“legendary place”; Pukui and Elbert 1986:376) or “place names” are an integral part of Hawaiian culture. In Hawaiian culture, if a location is given a name, it is because an event occurred there that has meaning for the people of that time. The *wahi pana* are then passed on through language and oral tradition, thus preserving the unique significance of the place. Hawaiians have named a wide variety of objects and places, including points of interest that may have gone unnoticed by persons of other cultural backgrounds. Hawaiians have named taro patches, rocks and trees that represented deities and ancestors, sites of houses and *heiau* (pre-Christian places of worship), canoe landings, fishing stations in the sea, resting places in the forests, and the tiniest spots where miraculous or interesting events are believed to have taken place (Pukui et al. 1976:x).

The current project area crosses or directly bounds four *ahupua‘a*; the lexicology of the names of these *ahupua‘a* is a starting point for understanding its traditional background. The meanings of these names are primarily taken from *Place Names of Hawaii* (Pukui et al. 1976); other sources

including Lloyd Soehren’s (2010) online *Hawaiian Place Names* database were consulted as appropriate.

Kaloko Ahupua‘a is home to the famous fishpond of the same name. Pukui et al. (1976) translate the name literally as “the pond,” noting that “Ka-mehameha’s bones may have been hidden near here” and that “the Ka-mehameha family reserved the [Kaloko] pond for themselves in 1848” (Pukui et al. 1976:77–78).

Honokōhau Ahupua‘a lies south of Kaloko. Honokōhau literally translates to “bay drawing dew” (Pukui et al. 1976:49).

Kealakehe, located between the *ahupua‘a* of Honokōhau to the north and Keahuolū to the south, is described by Pukui et al. (1976:101) as “homesteads and elementary school.” No translation of this place name is given by Pukui et al. (1976) or Soehren (2010).

Keahuolū, also written Ke-ahu-o-lū, has been translated in two ways. Pukui et al. (1976:101) translate the place name as “the *ahu* [cairn or altar] of Lū.” The name of the land has also been written as Ke‘ohu‘olu (Maly 1994:A-3), which means “the refreshing mists.”

3.1.3 *Mo‘olelo* (Stories)

Oral-historical accounts or *mo‘olelo* provide insight into the traditional Hawaiian existence. In his work for Kekaha Kai State Park located north of the project area, cultural and historical researcher Kepā Maly (1998:5) explains that in the Kekaha region, many early native *mo‘olelo* have been lost due to major events or trends of the early nineteenth century. Specifically, Maly (1998:5) notes the alteration of the cultural landscape by the 1800 and 1801 eruptions of Hualālai, as well as the loss of traditional knowledge due to decimation of the native population by disease.

According to Maly (1998:6) one of the earliest accounts from Kekaha is the Legend of Punia, recorded by Fornander (1959). Punia and his mother Hina lived in Kohala, subsisting on sweet potatoes. Desiring lobster from a sea cave, Punia outsmarted a number of sharks living there, causing them to be killed one by one until only their king, Kai‘ale‘ale, survived (Fornander 1959:6, 10). Punia convinced Kai‘ale‘ale to swallow him; once inside the shark, Punia tormented him as he swam the Kekaha coastline, finally beaching himself at Alula in the *ahupua‘a* of Keahuolū (Fornander 1959:10, 14; Maly 1998:6). According to the legend, Punia was cut from the shark’s belly by the residents of Alula, which “was the only place in all of Kekaha where people could live, for all of the rest of the area was inhabited by ghosts” (Maly 1998:6). Returning to Kohala, Punia came upon a number of these ghosts trying to fish; in order to protect himself, Punia tricked them by chanting deceitfully of his knowledge of fishing in the area (Fornander 1959:14, 16). The ghosts, like the sharks, were deceived and killed one by one until only one remained (Fornander 1959:16). The last ghost “fled and Kekaha became safe for human habitation,” (Maly 1998:7).

Maly (in Henry et al. 1993) translated the “Kaao Hooniua Puuwai no Ka-Miki” (The Heart stirring Story of Ka-Miki) that appeared in the newspaper *Ka Hoku o Hawai‘i* between 1914 and 1917. The legend provides details about life and the environment of Kekaha as well as for the entire island of Hawai‘i. Ka-Miki, the quick or adept one, and his brother Maka‘iole (“rat or squinting eyes”), traveled around the island to participate in competitions ca. the thirteenth century when Pili-a-Ka‘aiea was the chief of Kona. The boy’s parents were Pōhaku-o-Kāne (male) and Kapa‘ihilani (female), the *ali‘i* of Kaloko and Kohanaiki. The legend relates that the supernatural brothers:

> were empowered by their ancestress Ka-uluhe-nui-hihi-kolo-i-uka (the great entangled growth of *uluhe* fern [*Dicranopteris linearis*] which spreads across the uplands), a reincarnate form of the earth-mother goddess, creative force of nature Haumea (also called Papa) who dwelt at Kalama‘ula on Hualālai, in the uplands of Kohana-iki, Kona. [Maly in Henry et al. 1993:21–22]

The twins were raised by Ka-uluhe, who taught them how to use their supernatural powers.

While the Ka-Miki tale describes events at many of the *ahupua‘a* and other *wahi pana* of Kekaha, most are located well north of the present project *ahupua‘a*. A *pu‘u* or cinder cone at Keahuolū and Kealakehe is named in its association with the plain of Kanoenoe, known for its mists; this excerpt also references the proposed marriage of Ka-Miki to a chiefess of Honokōhau:

> Ka-noenoe (The mist, fogginess) [t]he mound-hill called Pu‘u-o-Kaloa sits upon the plain of Kanoenoe which is associated with both Keahuolu and Kealakehe. The settling of mists upon Pu‘u-o-Kaloa was a sign of pending rains; thus the traditional farmers of this area would prepare their fields. This plain was referenced by Pili when he described to Ka-Miki the extent of the lands which Ka-Miki would oversee upon marrying the scared chiefess Paehala of Honokōhau. The inheritance lands included everything from the uplands of Hikuhia above Nāpu‘u and the lands of the waterless Kekaha, which spanned from the rocky plain of Kanikū (Keahualono) to the plain of Kanoenoe at Pu‘ukaloa. [*Ka Hoku o Hawai‘i* 25 October 1917, as translated by Maly 1994:A-4]

Another legendary account discusses the hill called Pu‘u-o-kaloa:

> Pu‘u-o-kaloa is a mound-hill site in the lands of Keahuolu-Kealakehe, not far from the shore of Kaiwi and Hi-iakanoholae. During periods of dry weather (Ka lā malo‘o) when planted crops, from the grassy plains to the ‘ama‘uma‘u (fern forest zone), and even the ponds (ki‘o wai) were dry, people would watch this hill for signs of coming rains. When the līhau (light dew mists) sat atop the hill of Pu‘u-o-kaloa, rains were on the way. Planters of the districts agricultural fields watched for omens at Pu‘uokaloa, and it was from keen observation and diligent work that people prospered on the land. If a native of the land was hungry and came asking for food, the person would be asked:
>
> *Ua ka ua i Pu‘ukaloa, ihea ‘oe?*
>
> When rains fell at Pu‘ukaloa, where were you? (If the answer was . . .)
>
> *I Kona nei no!*
>
> In Kona (there would be no sweet potatoes for this person)

But if the answer was:

> *I Kohala nei no!*
>
> In Kohala! (The person would be given food to eat for they had been away, thus unable to accomplish the planting.) [*Ka Hōkū o Hawai‘i* 19 March 1914, as translated by Maly 1994:A-5]

These *mo‘olelo* emphasize the importance of rainfall in this relatively dry region for farmers, who were cultivating sweet potatoes and other crops on the plains Kekaha. In pre-Contact times, Hawaiians in this region would have lived primarily along the coast and in a habitation belt about 2 miles inland (Kelly 1983:14). The cultivated lands in between were referred to as the *kula* (plain, grassland) zone by Schilt (1984), essentially corresponding to Kekaha's "Intermediate Zone" (see Section 3.1.4).

3.1.4 Traditional Settlement Zones of Kekaha

Kelly (1971:74) identifies Kekaha as the band of barren lava fields extending north from Kailua-Kona to Anaeho‘omalu. As has been observed throughout the *ahupua‘a* comprising Kekaha, this band of barren lava fields does not encompass the entire *ahupua‘a*, nor does it inhibit land usage from occurring along the coast and inland where rainfall is sufficient for intensive agriculture. Instead, Kekaha refers more accurately to portions or "zones" of the areas where lava flows encompass the lands that, according to elevation, sustain little rainfall. Correspondingly, the lands of Kekaha are suggested, based on ethnographies, ethno-histories, and archaeological sources, to contain three general terrestrial zones that directly influenced land usage of prehistoric and historic populations. These three zones include 1) coastal; 2) intermediate or transitional and; 3) upland. Walsh and Hammatt (1995:32) present a synthesis of five different models of Kekaha's three-zone settlement pattern, originally presented by Rosendahl (1973:60–61, 65–66), Davis (1977:19–21), Cordy (1985:7–8), and Hammatt et al. (1987:69–71). Henry et al. (1993) summarize these models as follows:

> The preceding models, though varying in detail, have several common elements. First, there is a general agreement on separation of the region into three basic environmental zones: the coastal zone, the barren or intermediate zone, and the upland zone. Second, all five models associate the coastal zone with marine exploitation and the upland zone with dryland cultivation. Depending on their proximity to the coast or uplands, sites within the barren zone are considered extensions of the two major patterns into marginal areas, or as sites related to travel between the two poles (e.g. trails, shelters, etc.). Third, and finally, all of the models posit some level of interaction between the coast and the uplands, although there is little agreement concerning the nature and intensity of this interaction. [Henry et al. 1993:55]

Table 1, adapted from that found in Walsh and Hammatt (1995:33), summarizes the major characteristics of the three Kekaha settlement zones. The current project area lies almost entirely within the Intermediate Zone; a small portion of the Makai Section extends into the Coastal Zone near Old Kona Airport Park.

Archaeological evidence from the vicinity of the project area supports traditional accounts of coastal and intermediate zone activities (see Section 4). Studies focused along or extending to the coast (e.g., Emory and Soehren 1971, Renger 1971, Ching 1978, Estioko-Griffin and Lovelace 1980, Folk 1980, Donham 1990c, Haun and Henry 2006, Reeve et al. 2012) illustrated a high site density within the coastal zone, with substantial evidence of habitation-related activities and collection of marine resources. Radiocarbon analysis from survey work at coastal Keahuolū yielded evidence of occupation from the mid-fifteenth century through the historic period (Donham 1990c, Reeve et al. 2012). However, occupation in the area may have begun much

Table 1. Summary of Kekaha zone model characteristics

Zone	Elevation	Topography	Climate	Present Vegetation	Occupation Activities (Traditional and Historic)	Site/Feature Types	Site Density/ Distribution
Coastal	Coastline to 300 m inland; 0 to 9 m contour (0 to 30 ft)	Relatively flat to gradual slope (5-10%), undissected lavas, rocky, little or no soils; includes isolated bays, inland ponds	Central Kona patterns; ave. temp. range 67-83 F; rainfall 10 inches/yr	Strand, pond and *kiawe* (*Prosopis pallida*) thicket communities	Primary traditional use: permanent and temporary occupancy and marine resource exploitation Other uses: limited agriculture, quarrying, transportation, burials, art/communication	Caves, cairns (*ahu*), enclosures, trails, midden scatters, modified outcrops, overhangs, *pāhoehoe* excavations, petroglyphs, platforms, sinkholes, terraces, lava tubes, pavements	Moderate, concentrated along the shoreline and around inland ponds
Inter-mediate (Barren or Middle)	300 to 600 m inland; 9 to 12 m contour (30 to 39 ft) to 130 m contour (425 ft)	Gradual slope, undissected lavas, little or no soils	Central Kona patterns; rainfall 10-30 inches/yr	Grasses dominate, some shrubs	Primary traditional use: temporary or transitory occupancy Other uses: habitation (mostly temporary or recurrent), transportation, quarrying, limited agriculture, burials, art/communication, ranching	Trails, *pāhoehoe* excavations, cairns, midden scatters, platforms, terraces, enclosures, caves, mounds, walls	Very low and scattered, come concen-trations along *mauka-makai* trails
Upland	Extends up to 6 km inland from shore; 130 m contour (425 ft) to 1030 m contour (3379 ft)	Gradual slope; minimal soils below 800 ft, moderate-to-strong soils development above	Central Kona patterns; rainfall 40-50+ inches/yr	Non-native secondary forest dominates	Primary traditional use: permanent and temporary occupancy and intensive dryland agriculture Other uses: forest resource exploitation, ranching, commercial agriculture	Upland agricultural features, platforms, mounds, walls, enclosures, cairns, terraces, trails, lava tubes, *pāhoehoe* excavations	Medium-to-high, very high around 2,000 ft elevation and 25 inches/yr rainfall area

earlier; Cordy et al. (1991:465) published dates fom coastal Kaloko sites ranging between AD 920 and AD 1430, some of the oldest along the leeward Hawai'i coast.

The numerous studies surrounding the project area within the intermediate zone generally documented a lower site density, with traditional features located typically along trails or within lava tubes. Radiocarbon analysis of samples collected from sites in this zone yielded similar ranges of dates as those obtained from coastal sites (see Walker and Haun 1988, Fager and Graves 1993, Barr et al. 1994, O'Hare and Goodfellow 1994, Head and Rosendahl 1995, Colin et al. 1996, Haun et al. 2003). According to Schilt (1984), the *kula* zone in this region was probably not used for agriculture until about AD 1550-1650, although caves in the area could have been used for temporary habitation before this time. Sweet potatoes and other crops would have been the predominant crops.

3.2 Early Historic Period

Archibald Menzies, the first foreigner to record his visit to Kekaha, accompanied Captain Vancouver in 1792. He described the land as "barren and rugged with volcanic dregs and fragments of black lava . . .in consequence of which the inhabitants were obliged to have recourse to fishing for their sustenance" (Menzies 1920:99). On 17 January 1792, Menzies hiked to the top of Hualālai, and observed the following:

> We commenced our march with a slow pace, exposed to the scorching heat of the meridian sun, over a dreary barren track of a gradual ascent, consisting of little else than rugged porous lava and volcanic dregs, for about three miles, when we entered the bread fruit plantations whose spreading trees with beautiful foliage were scattered about that distance from the shore along the side of the mountain as far as we could see on both sides. Here the country began to assume a pleasant and fertile appearance through which we continued our ascent for about two miles further, surrounded by plantations of the esculent roots and vegetables of the country, industriously cultivated . . . From this place we had a delightful view of the scattered villages and shore underneath us, and of the luxuriant plantations around us . . .
>
> January 18th . . .We observed here and there on the path little maraes [shrines] pointed out by taboo sticks in the ground round a bush or under a tree. In passing these places the natives always muttered a prayer or hymn, and made some offering as they said, to their *akua*, by leaving them a little piece of fruit, vegetable or something or other at these consecrated spots. Even in this distant solitary hut, we found a corner of it consecrated by one of these taboo sticks which the natives earnestly requested us not to remove when we took possession of it, and we very strictly obeyed their injunction, conceiving that religious forms whatever they are, ought to be equally inviolable everywhere. [Menzies 1920:151–160]

Vancouver, referring to the North Kona coast in 1794 stated, "the adjacent shores . . . chiefly composed of volcanic matter, and producing only a few detached groves of cocoa nut trees, with the appearance of little cultivation, and very few inhabitants . . ." (Vancouver 1984:3:1187).

William Ellis traveled extensively throughout the island in 1823, and remarked on the 1801 lava flow covering large portions of the landscape at Keahole Point north of the project area in Kalaoa Ahupua'a (Ellis 2004:44–45). Kamakau (1992:86) noted that the 1801 eruption "had been

destroying houses, toppling over coconut trees, filling fish ponds, and causing destruction everywhere." Settlers displaced by the eruption may have moved immediately south, to Keāhole Point (Kalaoa 4), though this is conjecture (Cordy 1985:39). Despite the disruptions caused by the 1801 eruption, in 1840 the explorer C. Wilkes observed "a considerable trade is kept up between the north and south end of this district. The inhabitants of the barren portion of the latter are principally occupied in fishing and the manufacture of salt, which articles are bartered with those who live in the more fertile regions of the south, for food and clothes" (Wilkes 1845:91).

3.2.1 Changes in Population

Missionary censuses of the 1830s chart the diminishing population of Kekaha and North Kona. In 1834, the total population of Kekaha is recorded as 1,244, comprising 21% of the total North Kona population of 5,957 (Schmitt 1973:31). The North Kona figure represents a population loss of 692 since the previous census of 1831 (during which no figure specific to Kekaha was noted), which recorded 6,649 persons in the district (Schmitt 1973:9). One factor inducing the diminishing population of Kona, inter-island migration, was specifically noted by missionaries in 1832: "We have been sensible for some time that the number of inhabitants in this island is on the decrease. There is an almost constant moving of the people to the leeward islands, especially since the removal of the governor (Kuakini) to Oahu. Some leave by order of the chiefs, and others go on their own responsibility," (Schmitt 1973:16).

The pattern of population decrease continued throughout the following decades. According to Schmitt (1973:37), between 1848 and 1849 newly introduced diseases were responsible for the deaths of more than 10,000 people throughout the Hawaiian Islands. Furthermore, Kelly (1971:12) writes that

> . . . the *mahele* and *kuleana* laws displaced people—took land away from them and forced them to go elsewhere, such as into the trade centers of Kailua and Kawaihae. The concentration of large landholdings by ranchers and the subsequent fencing in of lands that were formerly accessible to residents served as an additional impetus to leave. [Kelly 1971:12]

This outmigration from outlying settlements, such as those found at the coast near the project area, represented a drastic change in the settlement pattern of these areas. An 1853 map showing population estimates for Hawai‘i Island (Figure 9) illustrates a few hundred people settled in the general vicinity of the project area, which is in contrast to much higher populations surrounding Kailua and Kealakekua bays.

3.2.2 The Māhele and the Kuleana Act

In the mid-nineteenth century, during the time of Kamehameha III, a series of legal and legislative changes were brought about in the name of land reform (see the works of Jon Chinen 1958, 1971 for a thorough and well-written explanation). Previous to the Māhele, all land belonged to the *akua* (gods), held in trust for them by the paramount chief, and managed by subordinate chiefs.

Following the enactment of a series of new laws from the mid-1840s to mid-1850s, Kamehameha III divided the land into four categories: Crown Lands reserved for himself and the royal house; Government Lands for the government; Konohiki Lands claimed by *ali‘i* and their

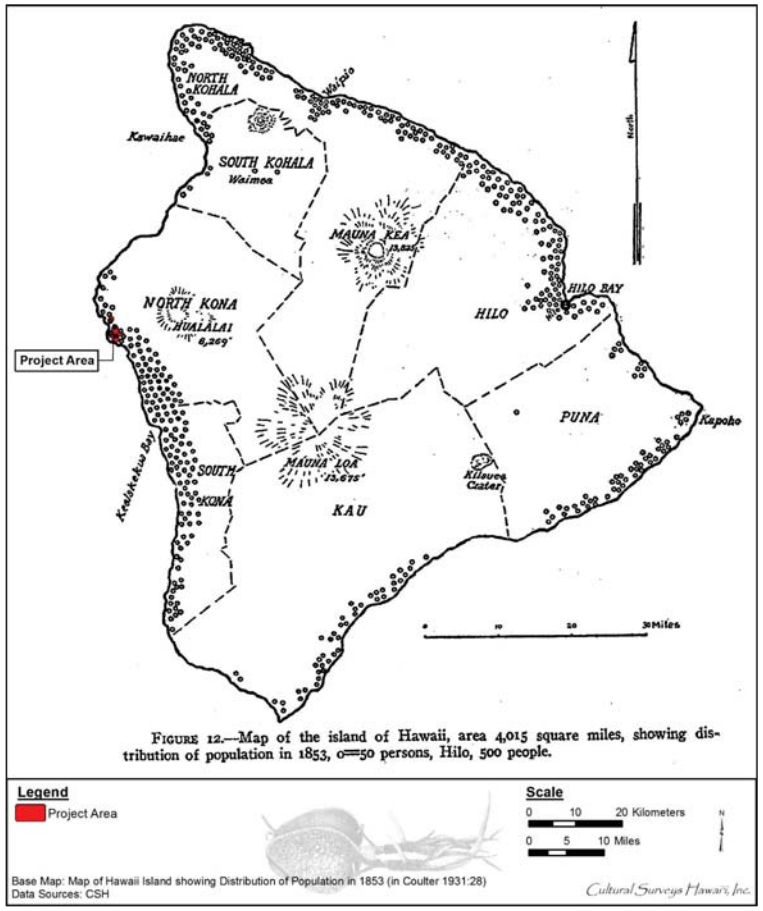

FIGURE 12.—Map of the island of Hawaii, area 4,015 square miles, showing distribution of population in 1853, o=50 persons, Hilo, 500 people.

Figure 9. Map of Hawai‘i Island showing population as of 1853 (Coulter 1931:28); each symbol represents 50 people, indicating a few hundred people settled in the vicinity of the project area

konohiki (supervisors); and *kuleana*, small plots claimed by the *maka‘āinana* (commoners) (Chinen 1958:8–15). These claims are described in Land Commission Award (LCA) testimony from the claimant and witnesses. A Royal Patent (RP), which quitclaimed the government's interest in the land, was issued on most Land Commission Awards (Chinen 1958:14). In some cases, more than one RP number was issued for an LCA, especially in cases where there were several widely separated *‘āpana* (lots), such as an award with agricultural land in one *ahupua‘a* and a house lot in another.

Ali‘i were required to pay a commutation fee to the government for their confirmed Konohiki Land titles; this payment could be in cash or in the return of land to the government or crown. Many *ali‘i* elected to return substantial portions of their awarded lands to avoid the one-third commutation cash fee. The Kuleana Act of 1850 allowed *maka‘āinana*, in principle, to own land parcels where they were currently and actively cultivating and/or residing. In 1851, certain Government Lands became available for purchase in lots of 1 to 50 acres in fee simple; this new category of land ownership became known as Royal Patent Grants or Land Grants.

The Māhele data from each of the subject *ahupua‘a* supports Cordy's findings on Kaloko: by the time of the Māhele, "the coast was virtually abandoned and the economic focus in this area had shifted to the uplands, which may have been a non-traditional pattern in this area" (Cordy et al. 1991:421). In Kekaha, land claim testimonies indicate there were relatively few native tenants that made land claims and most of the lands became property of the government. Of the few land claims made, however, it appears the cultivation of traditional crops within the upper elevations (the Upland Zone), including taro and sweet potatoes, was the predominant land use activity. Only one claimant indicated the cultivation of a commercial crop (coffee). Besides a claim made for "salt lands" at Keahuolū, and several other unawarded claims made for rights to fishpond resources, there is very little indication of land use throughout the intermediate and lower elevations, including an absence of claims made for house lots on the coast. Table 2 summarizes the land classification and number of LCAs and Land Grants awarded within each of the project *ahupua‘a*. Across all four *ahupua‘a*, the total amount of awarded LCAs (47) is approximately twice the number of Land Grants (24). Specific information about LCA awards and land use is given in the following discussions of each *ahupua‘a*.

Table 2. Summary of Māhele and land grant results for the project *ahupua‘a*

Ahupua‘a	Land Classification	No. of LCAs Awarded	No. of Land Grants
Kaloko	Konohiki	14	0
Honokōhau 1, 2	Konohiki	14	3
Kealakehe	Government	11	21
Keahuolū	Konohiki	8	0
Total		47	24

3.2.2.1 Kaloko

Kaloko was awarded to and retained by Lot Kamehameha (LCA 7715), who later ruled Hawai‘i as Kamehameha V. A total of 23 *kuleana* land claims were made in Kaloko, and 13 were awarded (Table 3). Fifteen *‘ili* (smaller land division) names are mentioned in Māhele testimony, but lands were awarded in only 12.

All of the Kaloko *kuleana* awards are *mauka* lands between 1,200 and 1,700 ft elevation, adjacent to or just *makai* of the Government Road well above the current project area. Testimony for Kahiona's LCA 9205/9237 claim (which was not awarded) mentions a fishpond, but no parcel in the coastal area is claimed. The major land use indicated in the claims is dryland agriculture characterized by *māla* (gardens), *kīhāpai* (cultivated patches or fields), and *mo‘o* (strips of land) producing taro and sweet potato. Only five of the claims mention residence on or use of Kaloko lands dating to the time of Kamehameha I, in the first decades of the nineteenth century. The remaining claims testify to residence or land use beginning in the 1830s and 1840s. As Cordy notes about Kaloko: "The historical documents suggest that by the 1840s-1850s, the Coastal Zone had been abandoned as a residential area, except probably for a house used by the fishpond's caretaker. This pattern would have been a stunning change from prehistoric and early historic times, when many coastal residences were present" (Cordy et al. 1991:288).

Table 3. Land Commission Awards in Kaloko Ahupua‘a

LCA	Awardee	*‘Ili*	R.P.	Acreage
4140	Kamanawa	–	2152	2.1
7715	Kapuaiwa, Lota	Ahupua‘a Award	8214	4,320.0
7797	Kamohoalii	Kikahala, Ulauiui	3972	5.3
7909	Kamaole	Makaawe, Hale‘ape	5377	7.0
9060	Kioku	Ulukukahi	4012	4.0
9160	Kanu	Kanaio	6938	2.5
9237	Kahiona	Oloupe	–	2.8
9238	Kahoohanohano	Pāpua‘a	3316	1.8
9241	Kaiama	Kealaehu, Luahine‘eku, Haleolono	3772	4.3
9242	Keaweahokina	Kikahala, Kealaehu	3744	2.8
9243	Kaleiko	Kealaehu, Luahine‘eku, Haleolono	3786	1.8
10327	Nahuina	Hale‘ape	3891	3.5
10694	Puhi	Kiki	3763	3.5
10951	Wahehee	Kealaehu, Kikahala	5095	2.0

3.2.2.2 Honokōhau (1–2)

Honokōhau 1, comprising 2,653 acres, was awarded to Mikahela Kekau‘ōnohi (LCA 11216). Honokōhau 2, comprising 480 acres, was awarded to William Pitt Leleiōhoku (LCA 9971). Both of these awards were retained by the *ali‘i*. Thirty-three *kuleana* claims were made within 18 *‘ili* in Honokōhau; 12 were awarded within ten *‘ili* (Table 4). These awards range in size from 1 acre to 6.8 acres, and occupy land from 800 to 1,680 ft AMSL (Robins et al. 2000:11), well *mauka* of the project area. In regard to indicated land use, testimonies for the awarded parcels in Honokōhau mention *kīhāpai* of taro and sweet potato (Robins et al. 2000:11).

Table 4. Land Commission Awards for Honokōhau 1-2 Ahupua‘a

LCA	Awardee	*Ahupua‘a*	*‘Ili*	R.P.	Acreage
6026	Lanai, Ikaaka	Honokōhau 2	Hanapouli	6787	1.0
7396	Kekipi	Honokōhau 2	Pu‘u Kou	5231	3.9
7490	Polapola, Solomona	Honokōhau 1, Honokōhau 2	‘Onea, Waipi‘o, Pukalani	5247	2.0
7870	Kamohai	Honokōhau 2	Waipi‘o	–	1.0
7890	Kukona	Honokōhau 2	Hanapouli	7766	2.3
8218	Ikiiki	Honokōhau 2	Waipi‘o	–	2.3
9061	Kanae	Honokōhau 2	Pukalani	5049	4.8
9236	Kahaulewahine	Honokōhau 1	Kaeo	–	3.2
10319	Nahina	Honokōhau 2	Haleolono	4896	3.5
10521-B	Puhihale	Honokōhau 1	Haleamahuka	7785	6.8
10762	Ahu	Honokōhau 2	Nu‘uhiwa	3743	2.2
11064	Apuni	Honokōhau 1	Kealaehu	5236	2.5
11216:36	Kekauonohi, Mikahela	Honokōhau 1	Ahupua‘a Award	7587	2,653
9971	Leleiohoku, William P.	Honokōhau 2	Ahupua‘a Award	6855	480

3.2.2.3 Kealakehe

The *ahupua‘a* of Kealakehe was awarded to Kekuapanio in the Māhele. Kekuapanio returned Kealakehe to the government. Twenty-three *kuleana* claims in Kealakehe represented lands in 26 *‘ili;* the 11 awarded claims comprised lands in 18 *‘ili* (Table 5). These awards range in size from 2.0 to 5.78 acres and are located from 900 to 1,900 ft in elevation (Haun and Henry 2001:8), upslope of the project area. Land use was predominately described as house lots or cultivated plots, including taro and sweet potato *kīhāpai* (Haun and Henry 2001:8). LCA 7483 also mentions a banana patch and *kua‘iwi* (short stonewall agricultural features) that served as parcel boundaries (Haun and Henry 2001:8).

Table 5. Land Commission Awards for Kealakehe Ahupua‘a

LCA	Awardee	*‘Ili*	R.P.	Acreage
7483	Kulua	Kaohia, Makakiloia	4040	2.6
7897	Kahuenui 2	Kukuiomino	4002	4.9
8608	Kaahui	Ililoa, Kalilu, Kaohia, Kukuiomino, Puohe	5228	3.9
9252	Kauhai	Kaneohale, Kaohia, Puohe	4005	5.78
10070	Mioi	Ililoa, Kaniohale, Kukuiomino	4003	4.4
10306	Nuole	Kaniohale	4006	5.25
10322	Nuhi	Kaaki, Kaeamaia, Kaluulu, Kealoha, Kumau, Makakiloia	8054	4.75
10597	Puou	Kukuiominoiki, Kukuiominonui	6235	4.12
10671	Pepe	Haleolono, Ililoa, Kaniohala, Kukuiomino	4007	4.96
10692	Paai	Ililoa, Kaohia, Puohu	4004	2.8
10950	Waiwaiole	Kaohia, Puohe	5123	2.0

3.2.2.4 Keahuolū

The *ahupua‘a* of Keahuolū, comprising 4,071 acres, was awarded to Ane Keohokālole (LCA 8452:12). Keohokālole retained Keahuolū. According to Wong Smith (1990),

> The ahupua‘a of Keahuolu was awarded to Ane Keohokalole (d. 1857), who numbered among her offspring King David Kalakaua, Queen Lydia Liliuokalani, and William Pitt Leleiohoku (who was adopted by Ruth Keelikolani). Her youngest daughter, Miriam Likeleke, was the mother of Kaiulani, who was proclaimed heir apparent in 1891 after her aunt, Liliuokalani, took the throne following the death of Kalakaua. Keohokalole was the great-granddaughter of Kameeiamoku, one of the most important of the chiefs supporting Kamehameha I. Approximately half of the lands that Keohokalole received in the Mahele were on the island of Hawaii, and two-thirds of those were lands in Kona District . . . [Wong Smith in Donham 1990c:B-3]

Ane Keohokālole later sold portions of her 15,000-20,000-acre grant to the government and other parties, with the remainder being passed on to her heir, Lili‘uokalani.

Eight *kuleana* were claimed in Keahuolū, with seven awarded (Table 6). Lands were claimed and awarded in four *‘ili*. These awards range in size from 0.6 acres to 2.9 acres. The seven LCAs granted in Keahuolū are located in the *mauka* region of the *ahupua‘a* well upslope of the project area. Testimony provided by Maa in LCA 10303 mentions a portion of land “yielding salt,” but his *kuleana* was awarded in the *‘ili* of Maili, in the Uplands Zone (Wong Smith in Donham 1990c:B-4). The crops mentioned in the testimonies related to these claims include *kalo* (taro), *‘uala* (sweet potatoes), and coffee (Wong Smith in Donham 1990c:B-4).

Table 6. Land Commission Awards for Keahuolū Ahupua‘a

LCA	Awardee	‘Ili	R.P.	Acreage
7351	Kahuenui	–	3985	2.9
8012	Apiki	–	3987	1.1
8452:12	A. Keohokālole	Ahupua‘a Award	6851	4,071
10198	Mailewalewa	Ululele	3986	1.3
10303	Maa	Maili	3981	2.25
10345	Nahaalualu	–	3983	2.0
10672	Paia	Puu o Kaliu	3980	1.9
11071	Aki	Papuaaiki	3982	0.6

3.2.3 Mid- to Late 1800s

3.2.3.1 Settlement

Oral history interviews conducted by Maly and Maly (2002) about life in Honokōhau confirm the settlement pattern suggested by the *kuleana* awards, in that most of the inhabitants of the *ahupua‘a* of Kekaha now lived in the uplands. The land between the upland settlement areas and the coast was used for cattle, donkey, and goat pasturage. *Mauka-makai* trails within each *ahupua‘a* were utilized by upland families to access the coast to fish, and gather water during upland droughts.

Despite these major changes, there was apparently still a significant population living in the area in the later nineteenth century, as indicated by the following extended testimony of Kihe, who was born at Honokōhau in 1854. Kihe talked about the area in 1870:

> Now [1924] the majority of those people are all dead. Of those things remembered and thought of by the people who yet remain from that time in 1870; those who are here 53 years later, we cannot forget the many families who lived in the various (apana) land sections of Kekaha. From the lands of Honokōhau, Kaloko, Kohanaiki, the lands of Ooma, Kalaoa, Haleohiu, Makaula, Kau, Puukala-Ohiki, Awalua, the lands of Kaulana, Mahaiula, Makalawena, Awakee, the lands of Kukio, Kaupulehu, Kiholo, Keawaiki, Kapalaoa, Puuanahulu, and Puuwaawaa. These many lands were filled with people in those days.
>
> There were men, women, and children, the houses were filled with large families. Truly there were many people [in Kekaha]. I would travel around with the young

> men and women in those days, and we would stay together, travel together, eat together, and spend the nights in homes filled with aloha. The lands of Honokōhau were filled with people in those days, there were many women and children with whom I traveled with joy in the days of my youth. Those families are all gone, and the land is quiet. There are no people, only the rocks remain, and a few scattered trees growing, and only occasionally does one meet with a man today (1924). One man and his children are all that remain.
>
> Kaloko was the same in those days, but now, it is a land without people. The men, the women, and the children are all gone, they have passed away. Only one man, J.W. Haau, remains. He is the only native child (keiki kupa) besides this author, who remains. Now the land is desolate, there are no people, the houses are quiet. Only the houses remain standing, places simply to be counted. [Maly and Maly 2002:341–342]

The population of the region continued to decline until around AD 1890 when the population of North Kona bottomed out at 1,754 people. By 1900, the population had increased to 3,189 and continued to increase as people moved into the urban and suburban lands around Kailua-Kona.

3.2.3.2 Trails

Traditional trail systems in Kekaha linked coastal villages laterally and, as noted above, connected coastal villages with upland settlements. In reference to these *mauka-makai* trails, Clark and Rechtman (2006:61) write, “[s]ometimes these were mere footpaths, marked by cairns (*ahu*) across the bare *pāhoehoe* or *‘a‘ā* lava.” Often waterworn stepping-stones were used over *‘a‘ā* flows.

The first improved cross-*ahupua‘a* trails through Kekaha (inland of the coastal trail) were the *alaloa* and the *alahele*. The *alaloa* was modified in the 1840s and called the Alanui Aupuni (Government Road), the King’s Highway, or the Māmalahoa Trail. Cordy et al. (1991:403) believe the curb-lined Māmalahoa Trail was built between 1836 and 1855. Portions of this trail are aligned with the current Queen Ka‘ahumanu Highway. The *alahele*, or *Kealaehu* (“path of Ehu”), extended from Kailua to the uplands of Kekaha; the current Belt Highway, or Māmalahoa Highway, is aligned with portions of this old trail.

Many of these trails were improved in the mid-nineteenth century for horse or carriage traffic. Clark and Collins (2011:7) note this included removal of stepping-stones from some older trails; the stepping-stones would often be deposited along the trail shoulder. The government paid for the work or used prisoners working off penalties to construct the roads, which became straighter back from the coast, and sometimes paved and lined with kerbstones. As the population shifted to the agricultural zone along the inland trail, the Māmalahoa Trail on the lower barren shore was largely abandoned. The portions closer to Kailua, however, may have remained in use. What appears to be a portion of the Māmalahoa Trail in Keahuolū appears on an 1875 map labeled as the “Lower Road to Kona” (Figure 10). This map also depicts the proximity of the Makai Section of the project area to a coconut grove along the coast, marking the location of a small settlement at Pawai Bay.

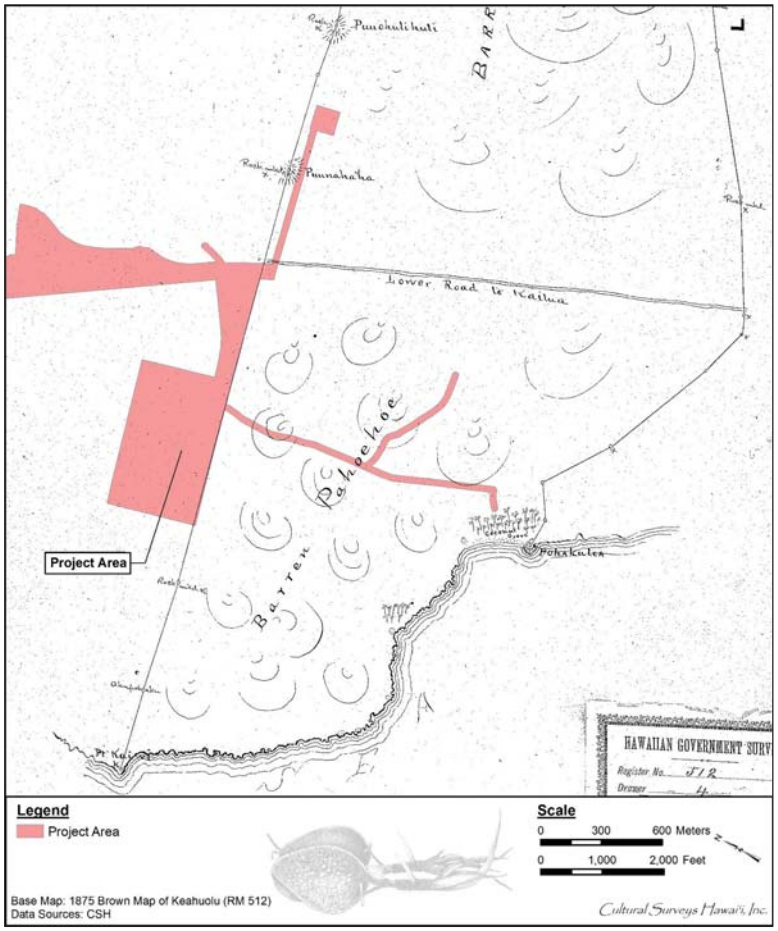

Figure 10. Portion of J.F. Brown's 1875 map of Keahuolu, showing the "Lower Road to Kailua" (Māmalahoa Trail) and "Coconut Grove" at Pawai Bay in relation to the project area

Emerson, a nineteenth century government surveyor, in 1891 mapped a large section of North Kona including the lands of the project area. His 1891 map (Figure 11) names significant locales such as fishponds and notable homes, and provides descriptions of the natural terrain. The inland portions of Kealakehe and neighboring Keahuolū are described as "rough pahoehoe, little vegetation," similar to historic descriptions of the dry and barren lands of Kekaha. The Northern Section of the project area is indicated to overlap "Pahoehoe and aa with vegetation" (see Figure 11). Major trails including the Māmalahoa Trail are depicted but not named; interestingly the Māmalahoa Trail is not shown continuing north beyond Honokōhau (see Figure 11).

3.2.3.3 Ranching

By the later 1800s, the potential commercial applications for the *kula* (plains used for dryland agriculture) lands in Kekaha had been recognized. Ranching, in particular, established the region as a source of market resources (e.g., beef and dairy products) for Honolulu and beyond. While two large ranches (Parker Ranch and Puuwaawaa Ranch) occupied great swaths of Kekaha well north of the project area, another ranch dominated the more southern portions of the Kekaha region:

> In 1899, John A. Maguire, founder of Huehue Ranch applied for a Patent Grant on . . . lots in 'O'oma 2nd, but he only secured Grant No. 4536 . . . Maguire's Huehue Ranch did secure General Lease No.'s 1001 and 590 for grazing purposes on the remaining government lands in the Kohanaiki and 'O'oma vicinity. Thus, by the turn of the century, Huehue Ranch utilized both the upper forest lands and lower kula lands to the shore for ranching purposes. Oral history interviews with elder former ranch hands record that this use extended across the Kapena and Huliko'a grant lands of Kohanaiki, from the fee and leasehold lands of Kaloko and 'O'oma. Nineteenth century goat drives, gave way to formalized cattle drives and round ups on these lands. [Maly and Maly 2003:78]

According to Henke (1929:28), Huehue Ranch was "also known as the Maguire Ranch" after its founder, who started his herd using "native" cattle.

The Greenwell family established themselves in Honokōhau during the late 1800s. Henry Nicholas Greenwell, an Englishman, had arrived on Hawai'i Island during the 1850s and soon began purchasing and leasing land. After starting out growing oranges, Greenwell, during the years until his death in 1891, expanded his commercial interests to coffee and raising sheep and cattle. Mr. James Greenwell, grandson of H.N. Greenwell and son of Frank Greenwell, provided details of his family's life in Honokōhau (personal communication 14 September 1992). Mr. Greenwell recalled that dairy cattle ranching at Honokōhau began in the 1870s at the time when the first Portuguese immigrants arrived in Hawai'i. H.N. Greenwell formed partnerships with Portuguese families in which the families would live on the land and turn out dairy products.

3.2.4 1900s

In the first half of the twentieth century, the primary method of travel was "by foot or on horse or donkey, and those who traveled the land, were almost always native residents . . ." (Maly and Maly 2003:99). The continued difficulty of travel and access throughout this region precluded any significant development and/or population increase during this time period.

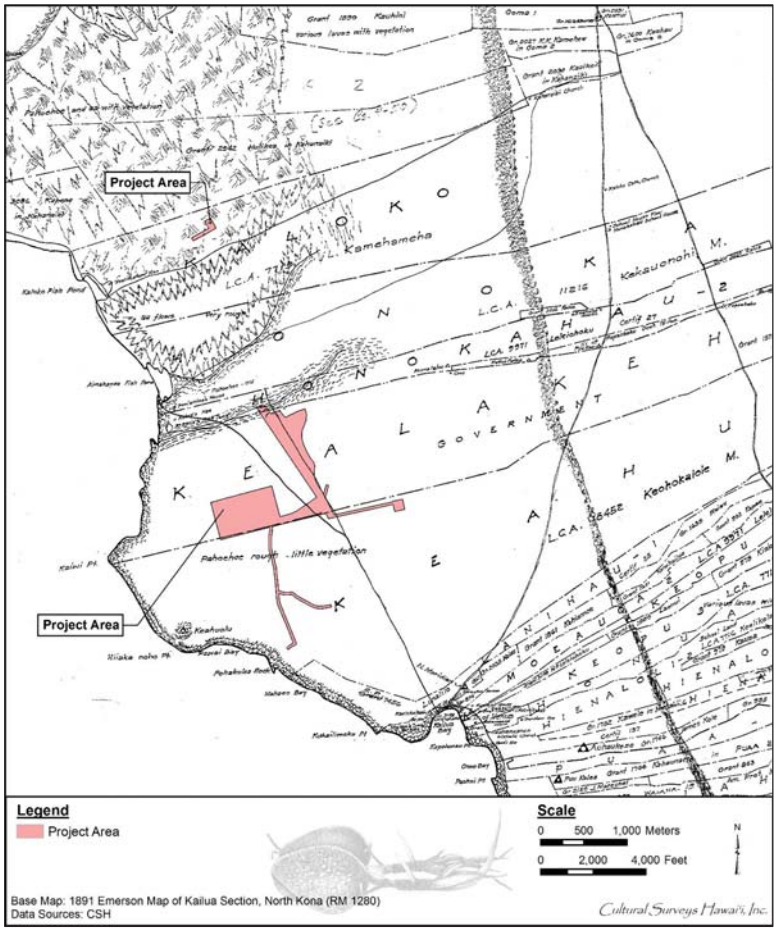

Figure 11. Portion of J.S. Emerson's 1891 map of Kailua Section, North Kona, illustrating the natural terrain and notable features in the vicinity of the project area

Ranching, however, steadily increased. Once John Maguire purchased the former chiefly lands of Kaloko in 1906 after the deaths of Kalakaua and Kapiolani (Kelly 1971:29), the uplands of that *ahupua'a* were absorbed into the Huehue Ranch. Huehue Ranch continued to expand. After John Maguire's death around 1920, his estate maintained ownership of Huehue Ranch under various managers and lessees including, among others, the Stillman family, Alfred Carter of Parker Ranch, and Hollywood movie star Errol Flynn (Henke 1929:28; Schilz et al. 1994:14). In 1966, the Trust successfully sold the Ranch to the Bellevue Cattle Company of Beverly Hills (Schilz et al. 1994:14). Subsequently the ranch was subdivided and sold to various corporations, and the coastal portions were developed as luxury resorts.

During the twentieth century, the Greenwell Ranch lands were divided into three units with the Honokōhau holdings becoming the Frank Greenwell Ranch, named for a son of H.N. Greenwell who had managed that section. The Frank Greenwell Ranch subsequently became the Palani Ranch Company.

A 1906 map of Hawai'i Island (Figure 12) illustrates the limits of grazing lands that completely encompass the project area. Some of this grazing activity, particularly in the southernmost areas of grazing lands shown on Figure 12, was likely still associated with subsistence farming as opposed to commercial ranching.

Following the Hawaiian Homes Commission Act in 1921, portions of Kealakehe were designated Hawaiian Homelands "for the benefit and use of native Hawaiians, upon which they may live, farm, ranch, and otherwise engage in commercial or industrial or any other activities."

A sisal (*Agave sisilana*) mill was constructed in Keahuolū sometime during the late 1890s. The sisal was grown to make rope and other fibers. The mill was located along the southern portion of the old Palani Road corridor at 130 m (428 ft) AMSL. Operating until 1924, the mill was surrounded by sisal fields that covered an area of up to 1,000 acres in Keahuolū and neighboring Kealakehe *ahupua'a* (Jensen 1990).

In 1909, Queen Lili'uokalani executed a Deed of Trust, which established the legal and financial foundation of an institution dedicated to the welfare of orphaned Hawaiian children. She amended her Deed of Trust in 1911 to include destitute children. It states, "[A]ll the property of the Trust Estate . . . shall be used by the Trustees for the benefit of orphan and other destitute children in the Hawaiian Islands, the preference given to Hawaiian children of pure or part aboriginal blood." The lands of Keahuolū are part of this Trust Estate. Until recent years, the Keahuolū lands were in passive, agricultural uses. In the late 1890s and 1900s, the area around Pawai Bay at Keahuolū was a fishing village with a canoe landing (Yent 1993:4). However, before the construction of the airport, the coastal regions of Keahuolū remained largely undeveloped as indicated on a 1924 USGS topographic map (Figure 13). A large brackish pond was present *mauka* of the bay, as well as several planting pits utilized for the cultivation of primarily pineapple and multiple house sites around Pawai Bay (Neighbor Island Consultants 1973:45, 52). This area was inhabited by the Kau'a family until the construction of the old Kona Airport at the coast of Keahuolū and Lanihau to the south in 1948.

The 1959 USGS map (Figure 14) depicts the Kona Airport in relation to the project area, but otherwise illustrates a general lack of development in the vicinity; during that time development

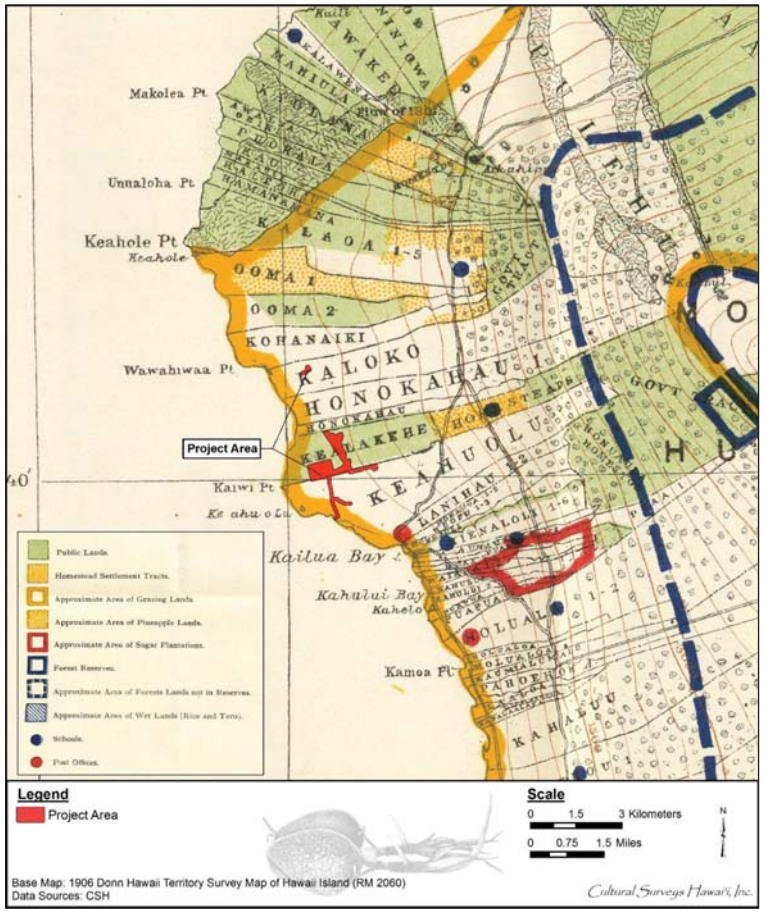

Figure 12. Portion of J.M. Donn's 1906 Hawaii Territory Survey map of Hawai'i Island showing the project area within the approximate area of grazing lands (yellow boundary)

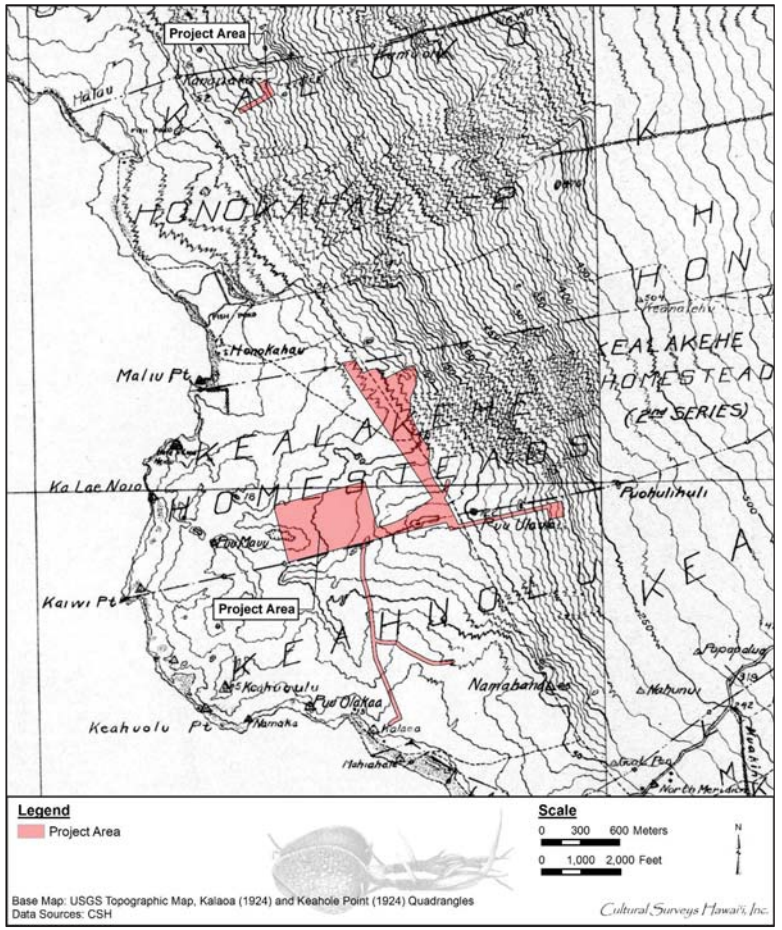

Figure 13. Portion of the 1924 Kalaoa and Keahole USGS 7.5-minute topographic quadrangles showing the project area and features discussed in the text

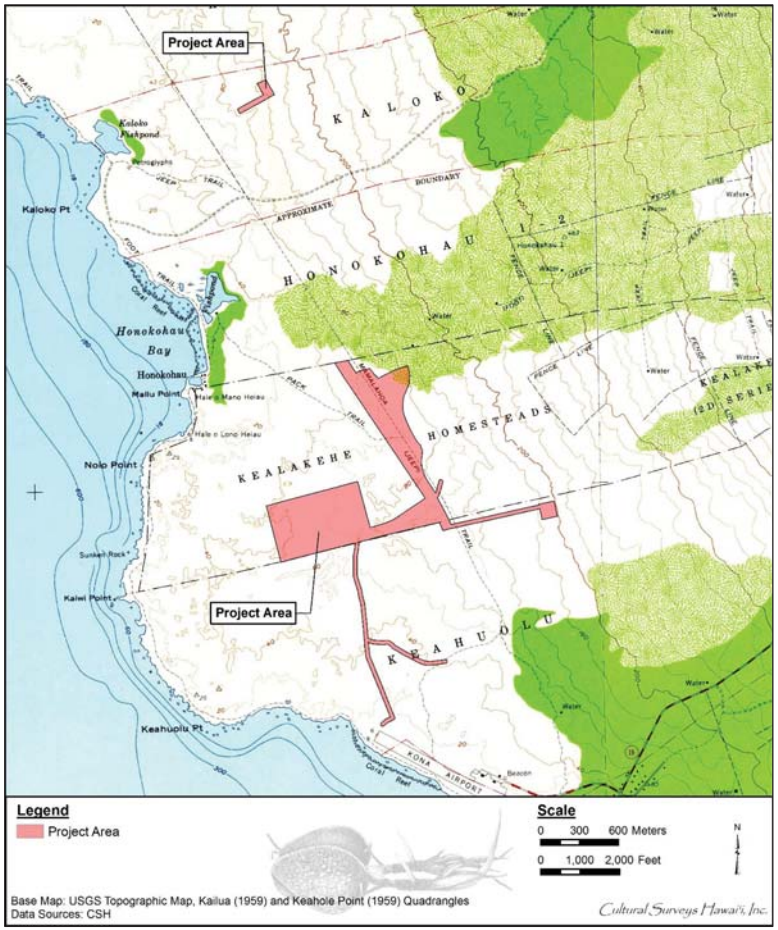

Figure 14. Portion of the 1959 Kailua and Keahole USGS 7.5-minute topographic quadrangles showing the project area and features discussed in the text

was concentrated south around Kailua Bay. Many of the roads and trails shown on the earlier maps are depicted, including the Māmalahoa Trail which is noted as a jeep trail. A “pack trail” extending northwest to Honokōhau Bay from Māmalahoa Trail—which also appears on Figure 13 but is not labeled—is likely SIHP # 50-10-27-21588 (see Section 4.1.3). A series of fence lines associated with either Greenwell/Palani Ranch or homestead activities is depicted in Kealakehe and Honokōhau *mauka* of the project area (see Figure 14).

3.2.5 Contemporary Land Use

With the development of the airport at Keāhole (begun in 1969) and large-scale resorts to the north, the need for a coastal road connecting the harbor at Kawaiahae to the recreational and commercial center of Kailua became increasingly vital. The Queen Ka‘ahumanu Highway, an extension of Highway 19, was completed in 1973 (Clark and Rechtman 2006:66). The new highway appears on a 1977 USGS orthophoto (Figure 15). Little other development in the vicinity of the project area is indicated at that time, aside from expansion of the Honokōhau Harbor, two rock quarries *mauka* of the harbor, and the early stages of development along present Hale Māka‘i Place.

The Kaloko-Honokōhau National Historical Park was established in 1978. The current Kealakehe WWTP facility was constructed in the 1980s to meet the needs of the growing population in and around Kailua town. Additional development has occurred in recent decades, including the construction of residential subdivisions, commercial/industrial centers, schools and other public facilities in lands formerly used for grazing. QLT has also begun to develop the Keahuolū lands to generate revenue for their programs.

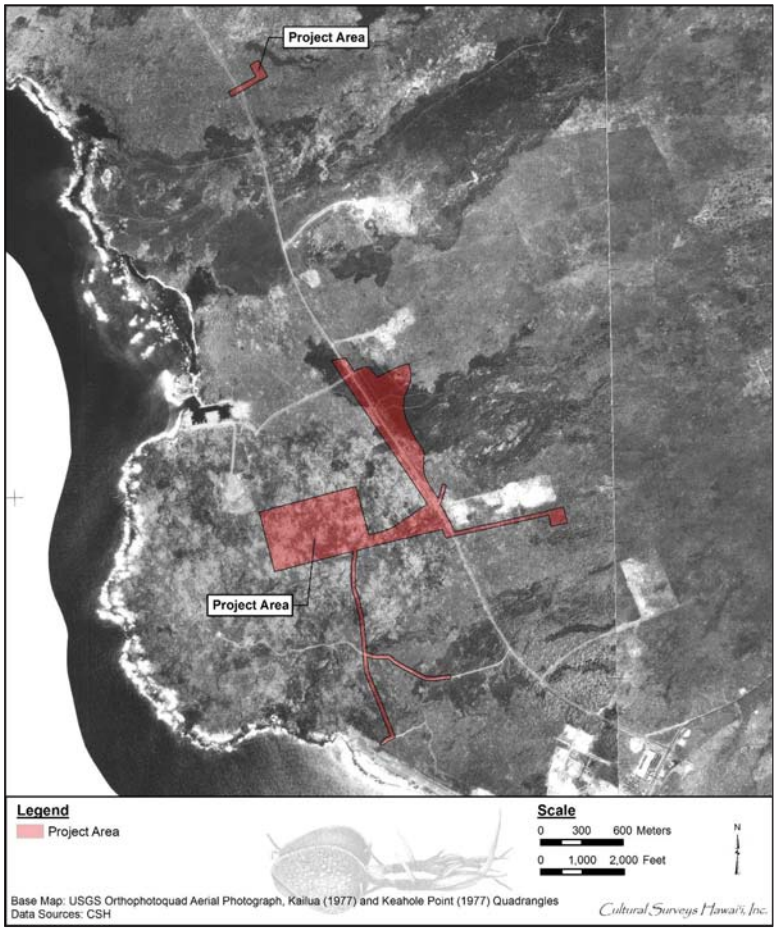

Figure 15. Portions of 1977 USGS orthophotographs (Kailua and Keahole Point Quadrangles) showing the location of the project area in relation to area development

Section 4 Previous Archaeological Research

4.1 Overview of Previous Archaeological Research

This section provides an overview of previous archaeological research conducted in the vicinity of the current project area. Section 4.1.1 is an overview of all previous archaeological studies in the vicinity. Section 4.1.2 provides discussions of those previous studies overlapping the current project area. Section 4.1.3 identifies the archaeological sites previously recorded in and near the current project area. A predictive model summarizing archaeological expectations for the current project area based on the results of background research is given in Section 4.2.

4.1.1 Previous Archaeological Studies in the Vicinity of the Project Area

Over the past century numerous archaeological studies have been conducted within and surrounding the current project area. This body of past work provides information about past land use that can be used to form a predictive model for the current project area. John F.G. Stokes and J.E. Reinecke conducted the earliest studies, which were coastal surveys. In 1906, Stokes was assigned by the Bishop Museum the task of recording the coastal *heiau* of Hawai‘i Island, building upon the preliminary work of Thomas G. Thrum. Visiting the sites of more than 100 *heiau* island-wide, he drew “plans of more than forty of the best preserved foundations, and collected as much oral data as possible” (Stokes and Dye 1991:12). Between Kealakehe and the Keahuolū-Lanihau boundary, Stokes documented five *heiau*; of these, the *heiau* of Kawaluna and Palihiolo at Pawai Bay in Keahuolū are in closest proximity to the current project area, though they do not overlap it.

In 1930, the Bishop Museum undertook an archaeological reconnaissance survey of portions of West Hawai‘i (Reinecke 1930). Reinecke broke the portion of his survey conducted between Kailua Kona and Kalahuipua‘a in South Kohala into four sections: “Lanihau adjoining Kailua village . . . ; Honokohau-kaloko . . . ; the remainder of the coast to Keahole Light; [and] the cursorily survey[ed] coast past the light” (Reinecke 1930:2). The “Lanihau” section appears to have included coastal Keahuolū; Reinecke documented several sites located *makai* of the current project area, along the shoreline fronting what is now Old Kona Airport Park/Kailua Park. He describes the “Honokohau-kaloko” section as having “considerable remains” (Reinecke 1930:2); unfortunately, the maps covering this section are illegible, however, the sites documented by Reinecke (1930) in this area are understood to have been located well *makai* of the current project area.

Table 7 contains summaries of previous archaeological studies; archaeological studies overlapping the current project area are identified using bold font. Previous studies in the vicinity of the Mauka and Makai Sections of the current project area are depicted on Figure 16, excluding those past studies located along the Queen Ka‘ahumanu Highway ROW. Previous studies in the vicinity of the Northern Section of the current project area are depicted on Figure 17, again excluding those past studies located along the Queen Ka‘ahumanu Highway ROW. Previous archaeological studies located along the Queen Ka‘ahumanu Highway ROW in the vicinity of the overall current project area are depicted on Figure 18. The Stokes (1906-1907) and Reinecke (1930) studies are not depicted as their coverage is not clearly defined.

Table 7. Previous archaeological studies in the vicinity of the project area

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Stokes 1906 (Stokes and Dye 1991)	Archaeological reconnaissance survey	Island of Hawai‘i	Identified numerous *heiau* and *ko‘a* (shrines) across the island; documented five *heiau* in current project *ahupua‘a*, none of which are within the current project area
Reinecke 1930	Archaeological reconnaissance survey	Coastal West Hawai‘i	Identified hundreds of sites along coast of West Hawai‘i, including a number of sites in vicinity of Old Kona Airport Park and Honokohau Bay
Ching and Rosendahl 1968	**Archaeological reconnaissance survey**	**Kailua-Kawaiahae Rd corridor** (Section II) **and Keāhole Point Airport, Honokōhau to Kau Ahupua‘a**	**Documented 14 sites (not assigned SIHP #s); three sites recorded in Honokōhau including a trail and burial; no sites documented in Kaloko**
Ladd 1968	Archaeological salvage (data recovery)	Honokōhau Harbor; Kaloko, Honokōhau, and Kealakehe Ahupua‘a	Salvage excavations for four sites previously identified by Bishop Museum in 1961 and not assigned SIHP #s: D11-3/1 (burial), D11-3/2 (burial), D11-3/3 (burial), and D11-4 (house site)
Newman 1970	Field inspection	Old Kona Airport State Park, Lanihau and Keahuolū Ahupua‘a	Documented several features in Lanihau portion of Old Kona Airport, later assigned as SIHP #s -02000 (petroglyphs), -02001 (petroglyphs, *papamū* [stone on which the checker-like game, *kōnane*, was played], and bait cups), and -02002 (house site)
Emory and Soehren 1971	Archaeological and historical survey	Coastal Kaloko, Honokōhau, and Kealakehe Ahupua‘a	Documented 72 sites across three *ahupua‘a*, not assigned SIHP #s; site types included house sites, *ahu* (cairns), fishing *ko‘a*, terraces, enclosures, walls, *papamū*, burial grounds and platforms, *hōlua* (sled; sled course) slides, Makaopi‘o Heiau, Hale O Kāne Heiau, Pu‘uoina Heiau, ‘Aimakapa Pond, petroglyphs; study included search for sites and plane table surveys documented by Bishop Museum in 1961

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Renger 1971	Intensive survey	Kaloko and Kukio Ahupua‘a, *makai* of Queen Ka‘ahumanu Hwy	Documented 89 sites in Kaloko, not assigned SIHP #s; site types included fishponds, house sites, burials, trails, lava tubes, walls, platforms, petroglyphs, enclosures, etc.
Neighbor Island Consultants 1973	**Archaeological reconnaissance survey**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a**	**Documented 19 sites not assigned SIHP #s; site types included planting pits, house sites, burials, and petroglyphs; two sites (KA14, petroglyph; KA15, petroglyph and house site) recorded in *mauka* portion of property near southern terminus of Makai Section of current project area**
Sinoto 1975	Archaeological reconnaissance survey	Honokōhau Small Boat Harbor; Kealakehe Ahupua‘a	Documented three previously identified sites, not assigned SIHP #s: D11-27 (house site), D12-3 (salt pans), and a *papamū*
Sinoto 1977	**Archaeological reconnaissance survey**	**Kealakehe Ahupua‘a, *mauka* of Queen Ka‘ahumanu Hwy; TMK [3] 7-4-008:017 por.**	**Documented four newly identified sites: SIHP #s 50-10-28-05011 (*ahupua‘a* wall possibly overlapping current project area at Kealakehe and Keahuolū boundary), -05012 (lava tube shelter), -05013 (lava tube shelter), and -05014 (lava tube shelter)**
Ching 1978	**Reconnaissance survey**	**987 acres in Keahuolū Ahupua‘a**	**Documented 59 sites with 140 features, predominately located at coast; sites assigned SIHP numbers (SIHP #s -06490 through -06548) which may be problematic; cluster of sites within proximity to Makai Section of current project area: SIHP #s -06528 (two platforms), -06529 (three platforms), -06530 (four *ahu*), -06531 (single *ahu*), -06532 (single *ahu*), -06533 (petroglyphs), -06534 (two *ahu*), -06535 (single *ahu*), and -06536 (enclosure)**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Rosendahl 1979	Reconnaissance survey	Approximately 212 acres in Keahuolū Ahupua‘a; TMKs [3] 7-04-008:001 por., 002 por. and 012 por.	Documented 13 sites, not assigned SIHP numbers, including two large modified lava bubble sinkholes, two long sections of stone wall (Kuakini Wall), a *cairn*, overhang rock shelter, petroglyph, *papamū* and petroglyphs, and a walled enclosure
Estioko-Griffin and Lovelace 1980	**Reconnaissance survey**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a**	**Identified 35 sites not assigned SIHP #s; site types included house sites, petroglyphs, burials, and multiple lava shelters and sinkholes; study area minimally overlaps *makai* terminus of Makai Section of current project area; no sites identified in proximity to current project area**
Folk 1980	Archaeological survey and subsurface testing	Three *kīpuka* within QLT Lands, Keahuolū Ahupua‘a	Documented 21 sites: SIHP #s -06444 through -06447, -06498, -06522, -06524, -06666 through -06669, -06671 through -06679, -06502, and -06503; site types included pavements, caves, habitation complexes, an enclosure, a platform, a shrine, and historic-era campsites; testing in one *kīpuka* exposed a buried cultural layer; archaeological salvage recommended for all sites
Neller 1980	**Archaeological reconnaissance survey**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a**	**Survey focus on documenting areas of human remains exposed by stormy seas; also documented a number of previously identified sites at Park including SIHP #s -02001 and -02002 and areas of petroglyphs; no sites identified in proximity to current project area (Makai Section)**
Soehren 1980	**Archaeological reconnaissance survey**	**Kailua Wastewater Treatment Site, Kealakehe Ahupua‘a, TMK: [3] 7-4-008:003 (por.)**	**Documented SIHP # -07704, a north-south oriented trail located just west of existing WWTP and western boundary of Makai Section of current project area**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Soehren 1980a	**Archaeological reconnaissance survey**	**Approx. 90 acres in Kaloko Ahupua‘a; TMK: [3] 7-3-009:001 por.**	**Documented a single waterworn stone near Queen Ka‘ahumanu Hwy (possible sling stone), not assigned a site number; noted potential for “graves” within property**
Soehren 1980b	Archaeological reconnaissance survey	Kaloko Ahupua‘a; TMK: [3] 7-3-009:001 por.	Documented stepping-stone trails, a possible burial, a lava tube containing a cultural deposit, and a lava tube used for temporary habitation, water collection, and possibly refuge; no SIHP numbers assigned
Soehren 1981	Archaeological reconnaissance survey	Kealakehe Ahupua‘a, TMK: [3] 7-4-008:003 por.	Documented three previously recorded sites near coast in proposed ocean outfall alignment for Kealakehe WWTP: SIHP #s -01888 (shrine and/or house site), -01889 (remnant house site or platform), -01890 (burial platform and remnant house sites)
Bonk 1987	**Preliminary archaeological reconaissance survey**	**Lower Kealakehe Ahupua‘a (coast up to 630 ft amsl)**	**Noted findings within three general areas: 1) Honokōhau Harbor vicinity; 2) 1,000-m-wide coastal strip, both found to contain numerous archaeological features; and 3) everything *mauka* of these coastal areas, found to contain ranching and homesteading features; only site noted within bounds of current project area is Māmalahoa Trail (SIHP # -00002)**
Rosendahl 1989	**Archaeological inventory survey**	**Kaloko Ahupua‘a; TMK: [3] 7-3-010:017 por.**	**Documented SIHP # -13493, segment of a stepping-stone trail located just northeast of Northern Section of current project area**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Donham 1990a	**Archaeological inventory survey**	**950 acres in Kealakehe and Keahuolū Ahupua‘a, TMKs: [3] 7-4-008:017, 012 por.**	**Documented four previously identified sites including SIHP #s -00002 (Māmalahoa Trail) and -05011 (*ahupua‘a* wall), and 78 new sites comprising 840 individual features, predominately agricultural in function; assigned 80 new SIHP #s: -13175 through -13254; of these, six (SIHP #s -00002, -05011, -13182, -13194, -13195, and -13253) are indicated in proximity to Mauka Section of current project area**
Donham 1990b	**Archaeological inventory survey**	**Kealakehe and Keahuolū Ahupua‘a, TMKs: [3] 7-4-008:017, 012 por.**	**Addendum to Donham 1990a study reported on finds of Donham 1990c AIS in QLT lands in Keahuolū Ahupua‘a; notes 24 sites comprising 250 features (SIHP #s -13420 through -13440 and -13447 through -13449); sites not in proximity to current project area**
Donham 1990c	**Archaeological inventory survey**	**1100 acres in QLT Lands; Keahuolū Ahupua‘a, TMKs: [3] 7-4-008:002 por. and 012**	**Documented 239 sites comprising over 1,810 individual features similar to those observed by Donham (1990a); of these, two previously documented: SIHP # -00002 (Mamalaohoa Trail) and SIHP # -07276 (Kuakini Wall); a number of sites initially documented by Ching (1978) likely confirmed but assigned new SIHP numbers; 237 new SIHP designations include SIHP #s 50-10-[27 or 28]-13255 through -13491; seven sites are in proximity to Mauka Section of current project area: SIHP #s -00002, -13315, -13321, -13326 through -13328, and -13482; 13 sites in proximity to Makai Section of project area: SIHP #s -13284, -13286, -13288 through -13298, and -13353; radiocarbon testing yielded evidence of occupation as early as fifteenth century**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Pietrusewsky 1990	**Osteological analysis**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a**	**Examination of skeletal remains of one female individual collected from park, which technically overlaps *makai* terminus of Makai Section of current project area; exposure location and subsequent reinterment location not in proximity to current project area**
Rosendahl and Walker 1990	**Archaeological inventory survey**	**Kaloko Ahupua‘a; TMK: [3] 7-3-010:017 por.**	**Attempted recording additional information about SIHP # -13493 (stepping-stone trail); no additional information obtained**
Smith and Yent 1990	Archaeological inventory survey and data recovery	**25 acres at Old Kona Airport Park, Lanihau Ahupua‘a; TMK: [3] 7-5-005:007**	Documented six sites: two previously identified by Estioko-Griffin and Lovelace (1980) comprising a wall and numerous *ahu*; and four newly documented sites including a wall, platform, and filled crevices; sites not assigned SIHP numbers
Borthwick and Hammatt 1992a	**Archaeological assessment (negative finds AIS)**	**Kealakehe and Keahuolū Ahupua‘a, TMK: [3] 7-5-004:067, 7-5-05:007, 7-4-008:002**	**Documented ten previously recorded sites (including three without SIHP numbers at Old Kona Airport Park, and SIHP #s -13266, -13291 through -13294, -13296, -13298 recorded by Donham 1990c) and four newly recorded sites (SIHP #s -17167 through -17170); of these, six are in proximity to Makai Section of current project area (SIHP #s -13291, -13292, -13294, -13298, -17168, and -17169)**
Borthwick and Hammatt 1992b	**Archaeological field inspection and interim preservation plan**	**Kealakehe Ahupua‘a; TMK [3] 7-1-008:017 por.**	**Documented two newly identified sites in Donham (1990a)/Burgett and Rosendahl (1992) project area: SIHP #s -15537 (lava tube) and -15538 (terrace); recommends further mitigation at SIHP # -00002 and two stepping-stone trails (SIHP #s -13194 and -13197)**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Burgett and Rosendahl 1992	**Archaeological inventory survey**	**Kealakehe and Keahuolū Ahupua‘a, TMK: [3] 7-4-008:017, 012 por.**	**Addendum to Donham (1990a) AIS documented 44 newly identified sites comprising 225 features (SIHP #s -16001 through -16044), and 103 additional features associated with Donham (1990a and b) sites; of these, only one (SIHP # -13253) is indicated in proximity to Mauka Section of current project area**
Yent 1992	Archaeological field inspection	Old Kona Airport Park, Lanihau Ahupua‘a; TMK: [3] 7-7-005:005 por.	Documented a partial anthropomorphic petroglyph (State Park Site #1992-40), not assigned a SIHP #
Borthwick et al. 1993	**Archaeological reconnaissance survey**	**Kealakehe and Honokōhauū Ahupua a**	**Documented 43 new sites (no SIHP #s assigned); identified 44 previously documented sites (with SIHP designations from multiple different studies); two sites documented in proximity to Mauka Section of current project area include trail sites SIHP #s -00002 and -13194**
Fager and Graves 1993	Archaeological inventory survey	15+ acres at Kaloko Industrial Park, Kaloko Ahupua‘a; TMK: [3] 7-3-051:001 por.	Documented 17 sites comprising 60 component features: SIHP #s 50-10-28-15335 through -15351; feature types included terraced, modified outcrops, mounds, walls, lava tubes, *pāhoehoe* excavations, *ahu*, filled cracks, enclosures, and a stepping-stone trail; assessments of function included agriculture, animal husbandry, temporary habitation, marker, quarry, and transportation; a charcoal sample yielded a probable age of AD 1617–1884

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Henry and Graves 1993	**Archaeological inventory survey**	**Queen Ka ahumanuū Hwy and Kaiwi St ROW, Keahuolūtoū Kalaoaū Ahupua a**	**Phase 1 AIS (site identification) documented 25 sites comprising 60 features; of these, five previously identified (SIHP #s -00002, -06432 [*ahupua‘a* boundary wall], -13194 [trail], -13195 [trail], and -13334 [complex]); newly identified sites assigned as SIHP #s -15314 through -15333**
O’Hare and Rosendahl 1993	Archaeoloigcal inventory survey	100 acreas of QLT lands, Keahuolū Ahupua‘a; TMK: [3] 7-4-008:002 por.	Documented 18 sites comprising 38 features: one previously identified (SIHP # -00002, Māmalahoa Trail) and 17 newly identified (SIHP #s 50-10-28-18502 through -18518) used for agriculture, temporary habitation, temporary habitation/possibly ceremonial, burial, historic dump, transportation, quarry, and marker
Barr et al. 1994	**Archaeological inventory survey**	**206 acres in Kealakehe and Honokōhau Ahupua‘a; TMKs: [3] 7-4-008:003 por., 005 por., 017 por., and 034 por.**	**Documented 83 sites including 33 newly recorded sites and 50 previously identified sites (with SIHP designations from multiple studies); two sites documented in proximity to Mauka Section of current project area include trail sites SIHP #s -00002 and -13194; charcoal samples yielded ages generally within between 1600s–1890s, though one sample dated to AD 1439-1693**
O’Hare and Goodfellow 1994	**Archaeological data recovery**	**800 acres in Kealakehe Ahupua‘a; TMKs: [3] 7-4-008:012 por., and 017**	**Documented 422 archaeological features within Donham (1990a) survey area; excavated 88 test units; conducted laboratory analysis on soil, artifact, and charcoal samples; majority of features found to be agricultural in nature; radiocarbon analysis indicated majority of sampled habitation and agricultural features ranged in age from AD 1400-1850**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Carpenter 1995	**Burial recovery and reinterment**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a, TMK: [3] 7-5-005:007**	**Included collection of human remains from 24 individuals exposed by high surf and subsequent reinterment at park, which technically overlaps *makai* terminus of Makai Section of current project area; exposure locations and subsequent reinterment location not in proximity to current project area**
Head and Rosendahl 1995	Archaeological data recovery	Keahuolū Ahupua‘a; TMKs: [3] 7-04-008:002 por., 012 por.	Data recovery conducted at SIHP #s -00002 (Māmalahoa Trail) and 50-10-28-18506 (complex); efforts at SIHP # -00002 involved documentation of construction techniques at seven sample areas; test excavations at SIHP # -18506 yielded a radiocarbon date of AD 1453-1824
Walsh and Hammatt 1995	**Archaeological inventory survey**	**Queen Ka‘ahumanu Hwy, Keahuolū to Kalaoa Ahupua‘a**	**Documented 17 sites comprising 29 individual features; five sites previously recorded (SIHP #s -00002, -02238, -06432, -13194, and -15324) and 12 sites newly recorded (SIHP #s -19943 through 19954); of documented sites, only SIHP #s -00002 and -13194 in proximity to current project area**
Colin et al. 1996	**Archaeological inventory survey and limited subsurface testing**	**224 acres in Kaloko and Kohanaiki Ahupua‘a; TMKs: [3] 7-3-009:002 por. and 017**	**Documented 55 sites comprising 93 features, including two previously identified sites (SIHP #s -13493 and -15324) and 53 newly identified sites (SIHP #s -20696 through -20722 and -20724 through -20749), of which six are in proximity to Northern Section of current project area (SIHP #s -13493, -20722, -20744, -20745, 20726, and -20728); documented sites included *ahu*, simple agricultural features, recurrent and temporary habitation sites, trails, enclosures, walls, and a quarry; subsurface testing conducted at eight sites; two charcoal samples yielded date ranges falling between AD 1670-1945**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Hammatt et al. 1999	Archaeological data recovery	Queen Ka‘ahumanu Hwy, Honokōhau Ahupua‘a	Data recovery at SIHP # -00002 (Māmalahoa Trail) and -19953 (*mauka-makai* trail) involved production of archival-quality photo documentation and cross-sectional drawings of portions of subject trails to be impacted by construction
Wolforth 1999	**Archaeological monitoring**	**Queen Ka‘ahumanu Hwy and Kaiwi St ROW, Keahuolū to Kalaoa Ahupua‘a**	**Involved inspection of 31 previously documented sites (including those documented by Henry and Graves 1993 in proximity to current project area) and documentation of eight newly recorded sites: SIHP #s -21252 through -21258 and -21756; portions of a 3.3-km section of SIHP # -00002 within the 1999 mapped and described area**
Haun and Henry 2000	Archaeological inventory survey	102 acres at Kaloko Industrial Park, Kaloko Ahupua‘a; TMK: [3] 7-3-051:60	Documented 45 sites comprising 81 individual features: nine previously identified, of which five found to be disturbed; and 36 newly identified sites; site types and functions conform to those expected within subject elevational/zonal settlement pattern
Haun and Henry 2001	Archaeological inventory survey	Kealakehe Ahupua‘a, TMK: [3] 7-4-008:003 por.	Located directly adjacent to but not overlapping current project area; documented 58 sites comprising 123 features (SIHP #s -23007 through -23062); feature types included *pāhoehoe* excavations, stone alignments, *ahu*, mounds, petroglyphs, enclosures, trails, and a cave, overhang, and platform; functional categories included quarrying, markers, agriculture, rock art, temporary habitation, transportation, possible ceremony, indeterminate; several sites located in proximity to Mauka and Makai Sections of current project area (SIHP #s -23020, -23023, -23026, -23029, -23033, -23047, -23048)

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Gmirkin and Bond 2002	Archaeological inventory survey	Kaloko-Honokōhau National Historical Park	Located directly adjacent to but not overlapping current project area; documented four sites in one area (SIHP #s -19954, -23352 through -23354), and ten in another area (assigned temporary site numbers NPS SP-1 through 10); of these, sites SP-1 through -10 in proximity to Mauka Section of current project area
Rechtman and Escott 2002	**Archaeological inventory survey**	**40 acres in Kealakehe Ahupua‘a; TMK: [3] 7-4-008:003 por.**	**Documented eight sites: three previously identified (SIHP #s -23020, *pāhoehoe* excavation; -23021, lava tube; and -23023, trail segment) and five newly identified (SIHP #s -23549, C-shaped enclosure; -23550 and -23552, *pāhoehoe* excavations; -23551, modified lava blister; and -23554, trail segment; all eight sites located within or in proximity to Mauka or Makai Sections of current project area; all recommended for no further work**
Haun et al. 2003	Archaeological data recovery	Kaloko Industrial Park, Kaloko Ahupuaā; TMK: [3] 7-3-051:60	Data recovery efforts at SIHP #s -21999, -22010, -22014, -22016, -22017, -22018, -22023, and -22032 involved determinations of site age and function; all sites determined to have functioned for temporary habitation and associated activity; radiocarbon analyses indicated occupation between AD 1445 and the early 1800s
Pestana and Spear 2005	Archaeological assessment (no finds AIS)	Old Kona Airport Park, Lanihau and Keahuolū Ahupuaā, TMK: [3] 7-5-005:007 por.	Survey effort involved hand excavation of 22 shovel tests and three test units; no cultural materials identified

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Haun and Henry 2006	**Archaeological inventory survey**	**370 acres in Kealakehe and Keahuolū Ahupua‘a; TMKs: [3] 7-4-008:002 por., 003 por., 071 por., and 072 por.**	**Documented 127 sites comprising 432 features; 23 sites previously identified (with SIHP designations from multiple studies); 104 sites newly identified (SIHP #s -25549 through -25653); feature types included *pāhoehoe* excavations, *ahu*, alignments, overhangs, lava blisters, enclosures, terraces, platforms, trails, walls, pavements, midden scatters, mounds, sand areas, filled cracks, lava tubes, C-shapes, a metal tower, and an upright; sites occur as expected following elevational/zonal settlement patterns; SIHP #s -07704, -23033, -25643, -25556, -25557, -25558 indicated to be within or in close proximity to current project area**
Rosendahl 2006	Historic preservation review	Kealakehe Ahupuaā; TMK: [3] 7-4-008 por.	Noted two previously recorded sites: SIHP #s -13180 (complex of land division, ranching, and agriculture features) and -16010 (agricultural complex); both sites fully mitigated in previous work
Bell et al. 2008	Archaeological inventory survey	224 acres in Kaloko and Kohanaiki Ahupuaā; TMK: [3] 7-3-009:017	Located directly adjacent to but not overlapping current project area; documented 59 sites, including 53 previously identified (with SIHP designations from multiple studies) and six newly identified (SIHP #s -26259 through -26264); distribution of sites corresponds with expectations according to elevation, with sites most frequent on ridges, tumuli or in lava tubes; SIHP #s -13493, -15329, -20722, -20726, -20728, -20744, and -20745 indicated in proximity to Northern Section of current project area
Hammatt and Shideler 2008	Documentation of damage	TMKs: [3] 7-4-020:009 and 010	Assessed damage to a portion of SIHP # -00002 (Māmalahoa Trail)
Hammatt et al. 2008	Mitigation implementation	TMKs: [3] 7-4-020:009 and 010	Reported on renaturalization and restoration efforts at a disturbed portion of SIHP # -00002 (Māmalahoa Trail)

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Clark and McCoy 2009	Archaeological assessment (no finds AIS)	Kalaoa 5 Ahupua‘a; TMK: [3] 7-03-043:003 por.	Area of Potential Effect (APE) included existing facility in Keahuolū; no archaeological features identified
Simonson et al. 2010	**Archaeological literature review and field inspection**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a, TMKs: [3] 7-5-005:007 and 083**	**Confirmed location of numerous previously identified sites and documented four new sites, not assigned SIHP #s; many previously identified sites not confirmed; study area minimally overlaps *makai* terminus of Makai Section of current project area; no sites identified in proximity to current project area**
Wilkinson et al. 2011	**Archaeological literature review and field inspection**	**Keahuolū through Kaloko Ahupua‘a; TMKs: [3] 7-3-009:025; 7-4-008:005; 7-4-020: 003, 004, 007, 010; 7-4-021:008, 023**	**Study confirmed 11 previously recorded sites; similar number of previously recorded sites not confirmed; several new features observed including *pāhoehoe* and *‘a‘ā* excavations, possible trails, a lava tube opening, a bulldozed concentration of waterworn stones and artifacts, and a potentially historic fence line; one site located in proximity to Mauka Section of current project area (SIHP # -13194, trail)**
Monahan et al. 2012	**Archaeological inventory survey**	**Queen Ka‘ahumanu Hwy, Kealakehe to Kalaoa Ahupua‘a; TMKs: [3] 7-4-008, 7-3-009, and 7-3-043**	**Documented 75 sites: 20 previously documented (with SIHP designations from multiple different studies) and 55 newly recorded; feature types included trails, *pāhoehoe* and *‘a‘ā* excavations, mounds, *ahu*, walls, modified outcrops, petroglyphs, lava tubes, enclosures, leveled areas, filled crevices, modified depressions and blisters, and a burial platform; SIHP #s -10714, -28794, -28796, and -29344 indicated in proximity to current project area (Northern Section)**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Reeve et al. 2012	**Archaeological inventory survey**	**628 acres in Keahuolū; TMK: [3] 7-4-008:002**	**Documented 322 sites comprising 464 component features, as well as 139 *pāhoehoe* excavations not assigned SIHP designations; some sites previously recorded by Ching (1978) and/or Folk (1980); new site designations include SIHP #s -27273 through -27419, -27421 through -27542, and -27559 through -27569; 48 sites indicated within proximity to Makai Section of current project area; site density highest at coast, where excavations at habitation sites yielded wide variety of cultural materials; radiocarbon dating of charcoal samples provided evidence of occupation from as early as sixteenth century**
Lizama et al. 2015	Archaeological monitoring	Keahuolū Ahupua‘a; TMK: [3] 7-4-008:002	Ensured protection of SIHP #s -06492 (enclosure) and -27384 (cemetery); documented a new site, SIHP # -30224 (buried cultural deposit)
Yucha et al. 2016	Archaeological inventory survey	Kealakehe and Keahuolū Ahupua‘a; TMKs: [3] 7-4-020:003, 010 por., 023 por., 024 por.	Documented ten sites, including three previously identified (SIHP #s -13308, -13310, and -16013) and seven newly identified (SIHP #s -29892 through -29894, -29896, -29898, -30196, and -30197); feature types included trails, *ahu*, modified outcrops, terraces, and *pāhoehoe* excavations; SIHP # -13310 found to represent modern bulldozer track
Wilkinson et al. 2017	**Archaeological inventory survey**	**Queen Ka‘ahumanu Hwy, Kealakehe to Kalaoa Ahupua‘a; TMKs: [3] 7-2-005; 7-3-009, 043, 049, 051, 058; 7-3-043:091, 083; 7-4-020**	**Supplemental survey documented two segments of SIHP # -00002 (Māmalahoa Trail) located adjacent to intersection of Kealakehe Pkwy and Queen Ka‘ahumanu Hwy; one segment within Mauka Section of current project area**

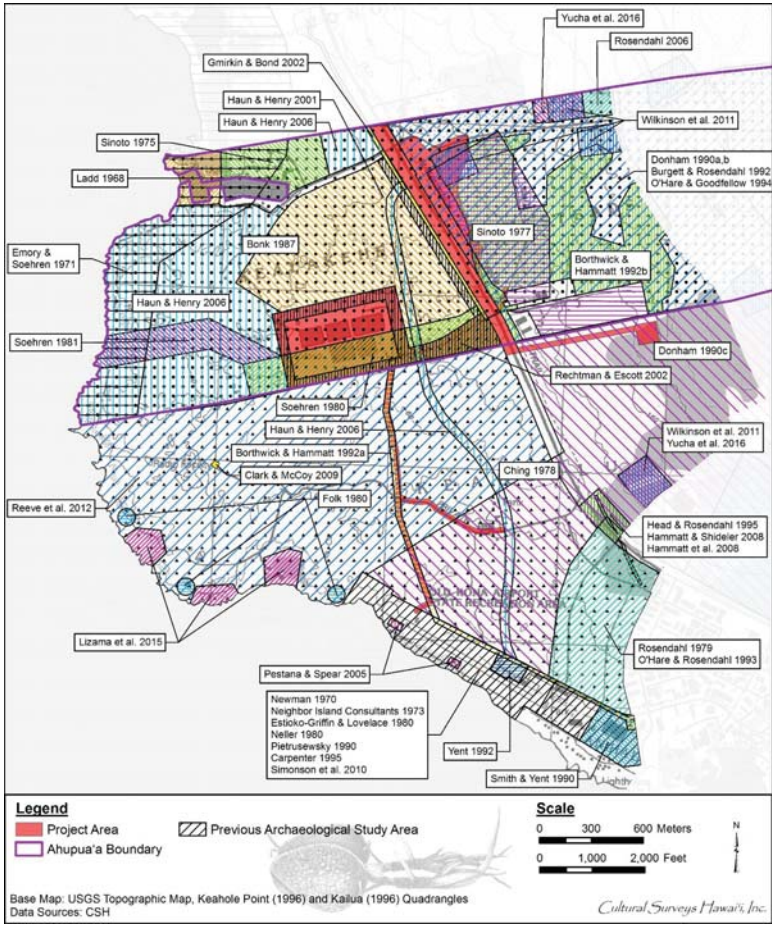

Figure 16. Portions of the 1996 Keahole Point and Kailua USGS 7.5-minute topographic quadrangles showing previous archaeological studies in the vicinity of the Mauka and Makai Sections of the project area (in red); this map does not include previous studies along Queen Ka‘ahumanu Highway (see Figure 18)

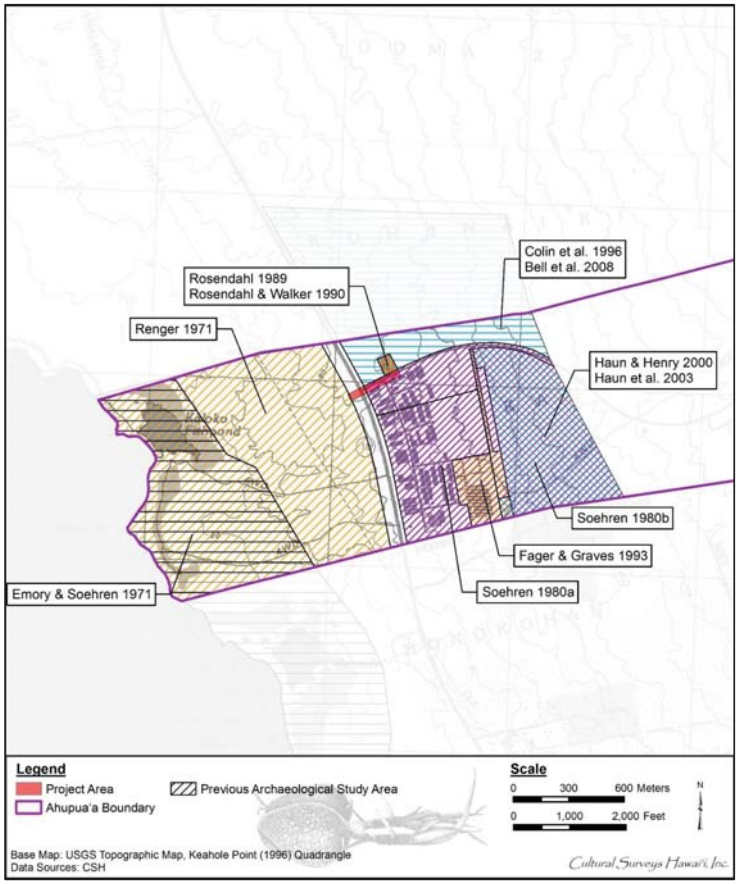

Figure 17. Portion of the 1996 Keahole Point USGS 7.5-minute topographic quadrangle showing previous archaeological studies in the vicinity of the Northern Section of the project area (in red); this map does not include previous studies along Queen Ka‘ahumanu Highway (see Figure 18)

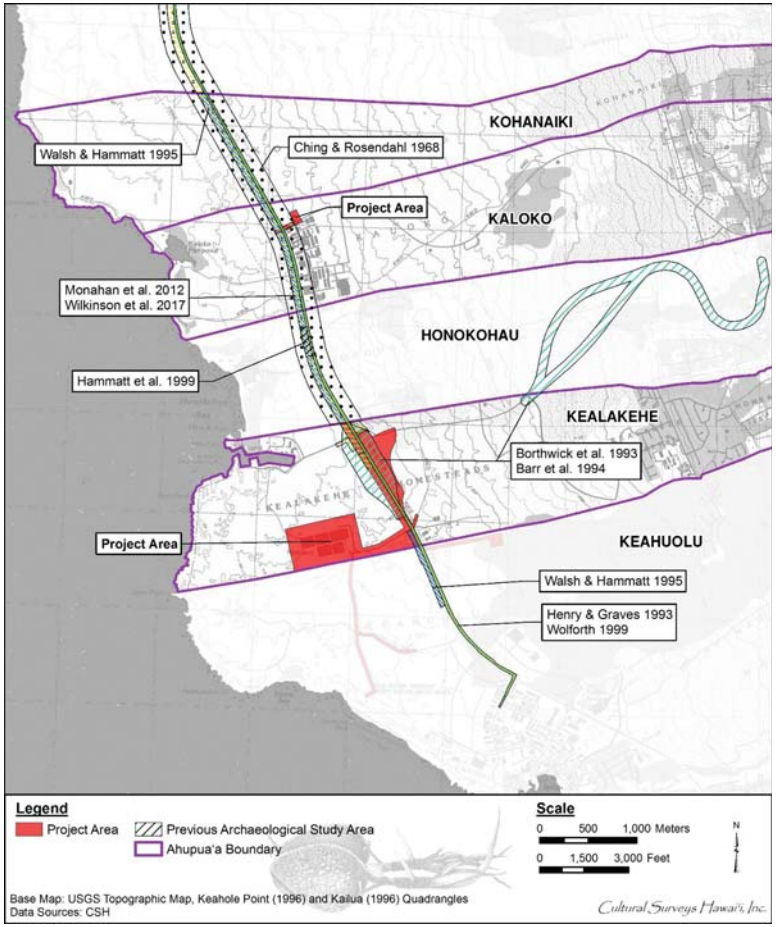

Figure 18. Portions of the 1996 Keahole Point and Kailua USGS 7.5-minute topographic quadrangles showing previous archaeological studies along the Queen Ka‘ahumanu Highway in relation to the overall project area (in red)

4.1.2 Previous Archaeological Studies Overlapping the Project Area

All the SIHP numbers listed in this section are prefixed “50-10-27,” unless otherwise noted.

4.1.2.1 Ching and Rosendahl 1968

In 1968, the Department of Land and Natural Resources (DLNR) reported on the results of a reconnaissance survey conducted for a section of the proposed Kailua-Kawaihae Road (present Queen Ka‘ahumanu Highway) located between Honokōhau and Kau Ahupua‘a/Keāhole Point, and for the proposed new airport at Keāhole (Ching and Rosendahl 1968; see Figure 18). Fourteen sites were documented but not assigned SIHP numbers. Three sites (T1–T3) were documented in Honokōhau Ahupua‘a, not in the vicinity of the current project area. T3 is described as a kerbstone, *mauka-makai* trail. The descriptions of T2 and T3 are missing from the report, but a photo caption indicates T2 was a grave of some sort. No sites were documented in Kaloko, where the Northern Section of the project area is located.

4.1.2.2 Neighbor Island Consultants 1973, Estioko-Griffin and Lovelace 1980

In 1973, Neighbor Island Consultants carried out a reconnaissance survey of Old Kona Airport Park, minimally overlapping the southern terminus of the Makai Section of the current project area (see Figure 16). Nineteen sites were documented but not assigned SIHP numbers, consisting of house sites—including a historic habitation complex, bait mortars, planting pits, lava cave shelters, enclosures, petroglyphs, and a number of burial sites. Two sites (KA14, petroglyph; KA15, petroglyph and house site) were recorded in the *mauka* portion of the property near the southern terminus of the Makai Section of the current project area, but were not confirmed during later surveys.

In 1980, State Parks archaeologists conducted an updated reconnaissance survey of Old Kona Airport Park, minimally overlapping the southern terminus of the Makai Section of the current project area (Estioko-Griffin and Lovelace 1980; see Figure 16). The survey identified 35 sites, some of which were previously recorded by Neighbor Island Consultants (1973). The sites were designated 1980-1 through 1980-35, and included enclosures, lava tube shelters, lava “pits,” rock mounds or *ahu*, burials, bait mortars, salt pans, petroglyphs, building foundations, subsurface deposits, a wall, a *papamū*, a cistern, and a *lua* or outhouse. None of the identified sites are in proximity to the current project area.

4.1.2.3 Sinoto 1977

In 1977, the Bishop Museum conducted an archaeological reconnaissance survey of portions of Kealakehe, overlapping the Mauka Section of the current project area (Sinoto 1977; see Figure 16). Four new historic properties were identified, including one that may partially overlap the current project area: SIHP # 50-10-28-05011, wall delineating the Kealakehe and Keahuolū *ahupua‘a* boundary (see Section 4.1.3). The site was recommended for preservation and/or monitoring (Sinoto 1977:3). The other three sites, SIHP # -05012 through -05014, are lava tube shelters located *mauka* of the current project area.

4.1.2.4 Ching 1978

In 1978, Archaeological Research Center Hawai‘i, Inc. (ARCH) undertook an archaeological reconnaissance of 987 acres in Keahuolū Ahupua‘a *makai* of Queen Ka‘ahumanu Highway, overlapping the Makai Section of the project area (Ching 1978; see Figure 16). A total of 59 sites comprising 140 features were documented, and were concentrated at the coast. The sites were assigned SIHP numbers but a notation in the report states many of the numbers were reassigned. The site distribution map included in the report indicates a cluster of sites documented by Ching (1978) are within proximity to the southwestern boundary of the existing WWTP facility: SIHP #s -06528 (two platforms), -06529 (three platforms), -06530 (four *ahu*), -06531 (single *ahu*), -06532 (single *ahu*), -06533 (petroglyphs), -06534 (two *ahu*), -06535 (single *ahu*), and -06536 (enclosure) (see Section 4.1.3).

4.1.2.5 Neller 1980, Pietrusewsky 1990, and Carpenter 1995

In 1980, DLNR conducted a reconnaissance survey at Old Kona Airport Park, which may have minimally overlapped the southern terminus of the Makai Section of the current project area (Neller 1980; see Figure 16). The survey was undertaken in response to reports of multiple exposed burials along the shoreline following a winter storm event. The survey identified the presence of several areas of exposed human burials, and other areas containing cultural deposits, petroglyphs, and hearths. Previously recorded SIHP #s -02001 and -02002 were also confirmed. None of the burial areas or other sites or features are in proximity to the current project area. The 1980 report asserts that a comprehensive archaeological study should be conducted at the park.

In following years, additional studies were undertaken at the park in response to exposure of human remains following storm events (Pietrusewsky 1990, Carpenter 1995). Since the “project area” for these studies is designated as the overall park parcel, these studies are illustrated on Figure 16 as overlapping the southern terminus of the Makai Section of the current project area; however, the burial find locations and their subsequent reinterment locations are not in proximity to the current project area.

4.1.2.6 Soehren 1980

In 1980, Lloyd J. Soehren completed an archaeological reconnaissance survey for the Kailua Wastewater Treatment Site in Kealakehe, overlapping the existing WWTP site in the Makai Section of the current project area (Soehren 1980; see Figure 16). The survey identified a north-south oriented trail (SIHP # -07704) located just *makai* of the existing WWTP and western boundary of the Makai Section of the current project area. According to Soehren (1980:2), “The trail appears to join the village and pond at Honokohau with the small settlement at Pawai in Keahuolu.” Based on its construction, the trail likely “represents a ‘preliminary route selection’ for a nineteenth century horse trail (Apple 1965) subsequently abandoned, perhpas [*sic*] in favor of the ‘Old Mamalahoa Trail’ farther inland. It would, therefore, seem to be of interest primarily to the historian and of little or no interpretive value to the public” (Soehren 1980:2).

4.1.2.7 Soehren 1980a

In 1980, Soehren undertook an archaeological reconnaissance survey of approximately 90 acres in Kaloko Ahupua‘a *mauka* of the Queen Ka‘ahumanu Highway, overlapping the Northern Section

of the current project area along the Hina Lani Street ROW (Soehren 1980a; see Figure 17). No archaeological features were identified, though the reconnaissance appears to have been limited to transects along the project area boundaries. Soehren (1980:1–2) notes, “In my opinion, there is little liklihood [*sic*] that any archaeological features will be found in the area with the possible exception of graves. These may be concealed in lava flows and can be exceedingly difficult to find. Some may be marked with stone cairns but none were seen.” A waterworn pebble was found “near the highway” which Soehren (1980a:1) described as a probable slingstone.

4.1.2.8 Bonk 1987

In 1987, the University of Hawai‘i at Hilo conducted a preliminary archaeological reconnaissance (termed a “walk-through” survey) of “lower” Kealakehe, between the coast and approximately 630–730 ft amsl (Bonk 1987). The 1987 study area overlaps the portions of the Makai and Mauka Sections of the current project area in Kealakehe (see Figure 16). The study organizes its preliminary findings into three general areas:

1. According to Bonk (1987:7), “The area north of the [Honokōhau] harbor, along the ahupua‘a border, and into the adjacent ahupua‘a of Honokohau, has a good deal of prehistoric as well as historic remains,” including such significant sites as Puuoina Heiau.
2. Bonk (1987:7) describes “A coastal tract of land, extending up to 1,000 feet in depth and running the full width of the ahupua‘a of Kealakehe” containing numerous significant sites previously recorded by Reinecke (1930) and Emory (1971), and including such significant sites as Makaopi‘o Heiau and Hale O Kane Heiau.
3. While no sites were observed “in the area between the above mentioned coastal strip and the [Queen Ka‘ahumanu] highway,” the Māmalahoa Trail was noted just *mauka* of the highway; further *mauka*, features associated with historic ranching and homesteading were observed (Bonk 1987:11).

Additional research was recommended for all the areas covered by the walk-through survey. Except for Māmalahoa Trail (SIHP # -00002), no historic properties were explicitly identified by Bonk (1987) within the bounds of the current project area.

4.1.2.9 Rosendahl 1989, Rosendahl and Walker 1990

In 1989 and 1990, Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed archaeological inventory surveys for a water tank site located on the north side of Hina Lani Street (Rosendahl 1989, Rosendahl and Walker 1990; see Figure 17). This water tank site is the present location of the unused potable water storage tank proposed to be recommissioned for R-1 service in the Northern Section of the current project area. The 1989 survey identified a 7.5-m segment of a stepping-stone trail (SIHP # -13493) crossing the *‘a‘ā* lava in a northeast-southwest orientation. According to Rosendahl (1989:1), “The trail appears to be prehistoric, and appears to have been used as a secondary transportation route.” The location of SIHP # -13493 is indicated just northeast of the Northern Section project area boundary (see Section 4.1.3).

The following year, PHRI conducted an addendum AIS at the water tank site at the request of SHPD (Rosendahl and Walker 1990; see Figure 17). The purpose of the addendum study was to obtain additional information for SIHP # -13493 through both fieldwork and archival research. These efforts did not yield any additional information about the trail.

4.1.2.10 Donham 1990a, Donham 1990b, Burgett and Rosendahl 1992, and O’Hare and Goodfellow 1994

In 1990, PHRI reported on the results of archaeological inventory survey of the 950-acre proposed Kealakehe Planned Community project area, located in Kealakehe and Keahuolū Ahupua‘a and overlapping the Mauka Section of the current project area (Donham 1990a; see Figure 16). The survey fieldwork consisted of an aerial reconnaissance and 100%-coverage pedestrian survey. Four previously identified sites were confirmed; of these, two had been previously assigned SIHP designations (SIHP # -00002, Māmalahoa Trail, and SIHP # -05011, *ahupua‘a* boundary wall), and two were newly assigned SIHP designations. A total of 78 sites were newly identified and assigned SIHP designations. The 80 newly obtained SIHP numbers included SIHP #s -13175 through -13254. Six of the documented sites are located in proximity to the current project area (see Section 4.1.3): SIHP #s -00002, -05011, -13182, -13194, -13195, and 13253. Donham (1990a:i) noted a predominance of agricultural features including rock mounds, *pāhoehoe* excavations, modified outcrops, terraces, small enclosures and low mounded walls. Twenty-one sites were recommended for no further work, data recovery was recommended for 42 sites, and the remainder were recommended for preservation upon further data collection or “as is” (Donham 1990a:i).

Later that year, PHRI prepared an addendum AIS report for an expansion of the Kealakehe Planned Community project into Keahuolū (Donham 1990b; not visible on Figure 16). The expansion area overlapped another concurrent PHRI survey area in Keahuolū (Donham 1990c), and therefore summarized the findings of the Donham (1990c) survey within the addendum project area, in which 24 sites had been documented: SIHP #s -13420 through -13440 and -13447 through -13449. Like those documented by Donham (1990a) in Kealakehe, the site types included predominately agricultural features with associated habitation, transportation, and miscellanea. Because the addendum AIS area was well upslope of the Mauka Section of the current project area, none of the sites are in proximity.

In 1992, PHRI prepared a report for another addendum AIS, this one located within the Donham 1990a survey area but focused on examination of proposed roadways associated with the planned community (Burgett and Rosendahl 1992; see Figure 16). This addendum AIS study documented 44 newly identified sites comprising 225 features (SIHP #s -16001 through -16044), and 103 additional features associated with Donham (1990a and b) sites. Of these, only one (SIHP # -13253) is indicated in proximity to the Mauka Section of the current project area (see Section 4.1.3).

Two years later, PHRI reported on data recovery efforts conducted at 800 acres within the Kealakehe Planned Community project area, also overlapping the Mauka Section of the current project area (O’Hare and Goodfellow 1994; see Figure 16). The data recovery effort included transit recordation of site locations, additional description and mapping, and excavation of 88 test units. Over 40 soil, pollen, and charcoal samples were collected and submitted for specialized analysis. All but eight of the 422 documented features were found to be agricultural in nature. The results of pollen analysis and wood taxa identification were found to “support the model of different environmental zones corresponding with the different elevation zones at Kealakehe” (O’Hare and Goodfellow 1994:ii). The majority of the habitation and agricultural features in the project area were dated to AD 1400-1850.

4.1.2.11 Donham 1990c

Also in 1990, PHRI reported on an AIS conducted on 1,100 acres of Queen Lili‘uokalani Trust lands in Keahuolū overlapping portions of both the Mauka and Makai Sections of the current project area (Donham 1990c; see Figure 16). The survey fieldwork consisted of an aerial reconnaissance and 100%-coverage pedestrian survey. A total of 239 sites comprising over 1,810 individual features were documented. Two of the sites, SIHP # -00002 (Māmalaohoa Trail) and SIHP # -07276 (the Kuakini Wall) had been previously recorded and assigned site numbers; a number of additional sites initially documented by Ching (1978) *makai* of Queen Ka‘ahumanu Highway were likely confirmed but were assigned new SIHP numbers as correlation proved difficult. The 237 new SIHP designations included SIHP #s 50-10-[27 or 28]-13255 through -13491. Seven sites identified by Donham 1990c (and 1990b) are in proximity to the southern portion of the Mauka Section of the current project area (see Section 4.1.3): SIHP #s -00002, -13315, -13321, -13326 through -13328, and -13482 (see Section 4.1.3). Thirteen sites identified by Donham (1990c) are in proximity to the Makai Section of the project area: SIHP #s -13284, -13286, -13288 through -13298, and -13353 (see Section 4.1.3). Predominate feature types are listed as *pāhoehoe* excavations, rock mounds, and modified blisters and outcrops. An agricultural function is assigned to 85-90% of all identified features. Other functional types included temporary habitation, transportation, aquaculture, water collection, ceremony, cave shelters, and burials. Several charcoal samples were submitted for radiocarbon dating, indicating possible occupation as early as the mid-fifteenth century. Eighty-four sites were recommended for no further work; data recovery was recommended for 123 sites; the remainder were recommended for preservation upon further data collection or “as is” (Donham 1990c:ii).

4.1.2.12 Borthwick and Hammatt 1992a

In 1992, CSH conducted an archaeological assessment (AIS with negative finds) for the proposed Kealakehe Sewer Force Main and Pump Station, comprising an inventory-level surface survey and review of pertinent literature (Borthwick and Hammatt 1992a). The study area, which consisted of a 100-ft-wide, 9,300-ft-long force main corridor and rectangular 1-acre pumping station, overlaps the Makai Section of the current project area along the proposed R-1 line extending to Old Kona Airport Park (see Figure 16). The survey documented ten previously recorded sites: two caves and a petroglyph not assigned SIHP numbers and located within the *mauka* portion of Old Kona Airport Park; and SIHP #s -13266, -13291 through -13294, -13296, -13298 recorded by Donham 1990c, which generally represent quarrying, agricultural, and temporary habitation complexes. Four sites were newly recorded: SIHP #s -17167 and -17168 (modified sink shelters), -17169 (modified blister shelter), and -17170 (clearing mounds). Of the 14 documented sites, all are described as pre-Contact in age except for SIHP # -17170 which is an historic-era site. Six of the 14 sites are in proximity to the Makai Section of the current project area (SIHP #s -13291, -13292, -13294, -13298, -17168, and -17169) (see Section 4.1.3). Six sites were recommended for no further work, one was recommended for subsurface testing, and the remainder were recommended for preservation.

4.1.2.13 Borthwick and Hammatt 1992b

Also in 1992, CSH conducted a field inspection with an associated preservation plan for a proposed golf course in the Kealakehe Planned Community project area, slightly overlapping the

Mauka Section of the current project area (Borthwick and Hammatt 1992b; see Figure 16). The study was intended to confirm sites previously documented by Donham (1990a) and/or Burgett and Rosendahl (1992) in the area and document any newly discovered sites. Ten previously recorded sites comprising trails, *ahu*, and agricultural features were confirmed (SIHP #s -00002, -13193 through -13198, -13201, -16003, and -16025) and two sites were newly recorded and assigned as SIHP #s -15537 (lava tube cave) and -15538 (terrace). Three sites (SIHP #s -00002, -13194, and -13195) are within the current project area (see Section 4.1.3). The preservation plan component of the study recommended preservation measures for three trail sites (SIHP #s -00002, -13194, and -13197).

4.1.2.14 Borthwick et al. 1993, Barr et al. 1994

In 1993, CSH undertook an archaeological reconnaissance for the proposed Kealakehe Parkway Extension (Borthwick et al. 1993). The project area comprised fours discrete areas including an interchange along Queen Ka‘ahumanu Highway, an area of alternative road alignments in *mauka* Kealakehe and Honokōhau, an area where the two *mauka* road alignments are converged, and an area near the Palani Road and Māmalahoa Highway intersection in *mauka* Honokōhau. Of these, only the proposed interchange area is in proximity to the current project area, along the Mauka Section (see Figure 18). A total of 44 previously identified and 43 newly identified sites were documented, comprising pre-Contact and historic habitations, lava tubes, *heiau*, and both confirmed and possible burial sites. Agricultural features were typically not documented though they were commonly present, particularly in the more *mauka* areas. Sites identified in proximity to the current project area included SIHP #s -00002 and -13194 (see Section 4.1.3), the latter noted to be bisected by SIHP # -00002 and Queen Ka‘ahumanu Highway. Many of the documented sites were recommended for either data recovery or preservation.

The following year, CSH conducted an AIS for the Kealakehe extension project (Barr et al. 1994). The AIS largely overlapped the 1993 reconnaissance project area, with the exception of the alternative road alignments which had been redrawn. Like the 1993 reconnaissance project area, only the proposed interchange along Queen Ka‘ahumanu Highway is in proximity to the current project area (see Figure 18). A total of 83 sites were documented, of which 50 were previously recorded comprising a wide variety of site types. Almost all the sites were documented in the *mauka* road alignment areas, with only previously identified SIHP #s -00002 and -13194 in proximity to the current project area (see Section 4.1.3). Eight charcoal samples were submitted for radiocarbon dating. Age ranges were generally found to be within the late prehistoric to late historic time periods (i.e., 1600s to 1890s), though one sample collected from a lava tube yielded a date range of AD 1439-1693 at 83% probability (Barr et al. 1994:248). Sixty sites were recommended for data recovery, seven sites were to be preserved, and no further work was warranted for the remaining 16 sites (Barr et al. 1994:i).

4.1.2.15 Henry and Graves 1993, Wolforth 1999

In 1993, PHRI undertook a Phase 1 AIS, comprising surface site identification only, for the Keahole-Kailua 69kV Transmission Line project located along the Queen Ka‘ahumanu Highway and Kawiwi Street ROW (Henry and Graves 1993). The project area corridor ranged from 50-100 ft wide and extended from Keahuolū to Kalaoa Ahupua‘a, overlapping the Mauka and Northern Sections of the current project area (see Figure 18). The Phase 1 survey conducted 100%

pedestrian coverage within previously unsurveyed areas; in the portions of Kealakehe and Keahuolū previously surveyed by Donham (1990a and c), the survey work focused on confirming previously documented sites. The Phase 1 survey documented 25 sites comprising 60 component features. Of these, five were previously identified, including SIHP #s -00002 (Māmalahoa Trail), -06432 (*ahupua‘a* boundary wall), -13194 (trail), -13195 (trail), and -13334 (complex). The 20 newly identified sites were assigned as SIHP #s -15314 through -15333. The 25 documented sites represented a wide veriety of feature types. Assessments of function included agriculture, marker, transportation, boundary, habitation, quarry, storage, and indeterminate. Sites indicated in proximity to the current project area include SIHP #s -00002, -13194, and -13195 in the Mauka Section and SIHP # -15329 located just northwest of the Northern Section (see Section 4.1.3). A signficiant amount of prior disturbance was noted in the project area, including an access roadway extending along most of the transmission line corridor and modern industrial and agricultural developments.

Several years later, PHRI conducted archaeological monitoring for the Keahole-Kailua 69kV Transmission Line installation, once again overlapping the Mauka and Northern Sections of the current project area (Wolforth 1999; see Figure 18). The monitoring involved inspection of 31 previously documented sites (including those documented by Henry and Graves 1993 in proximity to the current project area) and documentation of eight newly recorded sites: SIHP #s -21252 (filled lava blister), -21253 through -21255 (modified outcrops), -21256 (cupboards and modified lava tube), -21257 and -21258 (trails), and -21756 (boundary wall). Portions of the approximately 3.3-km section of SIHP # -00002 within the transmission line project area were mapped and described in detail—possibly including parts of the site within the current project area. Wolforth (1999:ii) concluded that “The relationship of the Mamalahoa Trail to other sites and trails suggests that Mamalahoa Trail was built over, and incorporates parts of a prehistoric trail.”

4.1.2.16 Walsh and Hammatt 1995, Hammatt et al. 1999

In 1995, CSH undertook an AIS for a proposed expansion of the Queen Ka‘ahumanu Highway ROW, located between Palani Road and the Keahole Airport entrance road (Walsh and Hammatt 1995). The project area corridor averaged 309 ft wide and extended from Keahuolū to Kalaoa, overlapping the Mauka and Northern Sections of the current project area (see Figure 18). A total of 17 sites comprising 29 individual features were identified, including five previously documented sites (SIHP #s -00002, -02238, -06432, -13194 and -15324) and 12 newly identified sites (SIHP #s -19943 through -19954). Of these, only SIHP #s -00002 and -13194 are in proximity to the current project area (Mauka Section; see Section 4.1.3). Formal site and feature types included trails, modified outcrop, *ahu*; walls, mounds, petroglyphs, enclosures, and a road, terrace alignment, ash deposit, midden scatter, and *pāhoehoe* excavation. Functional types included transportation, temporary habitation, boundary/ranching, markers, symbolism, quarry, agriculture, and indeterminate. Three features were tested for human remains; none were found. Eight sites were recommended for data recovery, four were recommended for preservation following data recovery, and five were recommended for no further work.

4.1.2.17 Colin et al. 1996

In 1996, CSH conducted an AIS of a 224.43-acre parcel in Kaloko and Kohanaiki Ahupua‘a bounding the *mauka* shoulder of Queen Ka‘ahumanu Highway (Colin et al. 1996). The study area

overlapped the Northern Section of the current project area (see Figure 17). A total of 55 sites comprising 93 features were documented, including two previously identified sites (SIHP #s -13493 and -15324) and 53 newly identified sites (SIHP #s -20696 through -20722 and -20724 through -20749); six of these are in proximity to the Northern Section of the current project area (SIHP #s -13493, -20722, -20744, -20745, 20726, and -20728; see Section 4.1.3). The documented features comprised a wide variety of features types associated with agriculture, habitation, transportation, boundary, and resource collection. Two charcoal samples were obtained from subsurface excavations that yielded date ranges falling between AD 1670-1945. Forty sites were recommended for data recovery, ten were recommended for preservation, one site was recommended for both data recovery and preservation, and no further work was recommended for the remaining four sites.

4.1.2.18 Rechtman and Escott 2002

In 2002, Rechtman Consulting conducted an AIS of approximately 40 acres for an extension of the Kealakehe WWTP, overlapping the Makai Section of the current project area (Rechtman and Escott 2002; see Figure 16). The survey documented eight sites within and adjacent to the 2002 project area, of which three were previously identified (SIHP #s -23020, *pāhoehoe* excavation; -23021, lava tube; and -23023, trail segment) and five were newly identified. The five new sites included SIHP #s -23549 (C-shaped enclosure), -23550 and -23552 (*pāhoehoe* excavations), -23551 (modified lava blister), and -23554 (trail segment). All eight sites are located within or in proximity to the Mauka or Makai Sections of the current project area (see Section 4.1.3); all were recommended for no further work (Rechtman and Escott 2002:22).

4.1.2.19 Haun and Henry 2006

In 2006, Haun and Associates undertook an AIS of approximately 370 acres (Haun and Henry 2006). The survey examined two discrete areas in Kealakehe Ahupua‘a, and a corridor extending through both Kealakehe and Keahuolū Ahupua‘a; the corridor crossed the Makai Section of the current project area, terminating adjacent to the Queen Ka‘ahumanu Highway ROW and the Mauka Section, and another portion of the 2006 project area also abutted the highway ROW and the Mauka Section of the current project area (see Figure 16). A total of 127 sites comprising 432 features were documented. Of these, 23 sites were previously identified (with SIHP designations from multiple different studies) and 104 sites were newly identified (SIHP #s -25549 through -25653). Documented feature types included *pāhoehoe* excavations, *ahu*, alignments, overhangs, lava blisters, enclosures, terraces, platforms, trails, walls, pavements, midden scatters, mounds, sand areas, filled cracks, lava tubes, C-shapes, a metal tower, and an upright. The distribution of the features and their associated functions were found to be as expected following elevational/zonal settlement patterns. Forty-seven sites were recommended for data recovery, 27 for preservation, and 54 for no further work. SIHP #s -07704, -23033, -25643, -25556, -25557, and -25558 are indicated to be within or in close proximity to the current project area (see Section 4.1.3).

4.1.2.20 Simonson et al. 2010

In 2010, CSH prepared a literature rievew and field inspection report for the 117-acre Old Kona Airport Park, which had transferred ownership from the State of Hawai‘i to the County of Hawai‘i

in 2009 and was renamed “Kailua Park” (Simonson et al. 2010). The 2010 project area minimally overlaps the southern terminus of the Makai Section of the current project area (see Figure 16). The field inspection effort confirmed numerous previously identified sites (only some of which had been previously assigned SIHP designations) and documented four new sites (which were not assigned SIHP designations). A number of other previously identified sites were not confirmed. None of the identified sites are in proximity to the current project area.

4.1.2.21 Wilkinson et al. 2011

In 2011, CSH prepared a literature review and field inspection of approximately 70 acres in Keahuolū through Honokōhau Ahupua‘a for a proposed judiciary site (Wilkinson et al. 2011). The project area comprised seven non-contiguous candidate development sites; of these, one candidate site in Kealakehe overlapped the Mauka Section of the current project area. The field inspection effort confirmed 11 previously identified sites (SIHP #s -05011, -13179, -13180, -13308, -13323, -26291, -26292, -26303, -26307, -26308, and -27855). A similar number of previously identified sites expected within the project area could not be confirmed; this result was attributed to inaccuracies in previous site distribution maps and typically low ground visibility. In addition, several new features were observed (but not assigned SIHP designations), including modified outcrops, *pāhoehoe* and *‘a‘ā* excavations, possible trails, a lava tube opening, a bulldozed concentration of waterworn stones and artifacts, and a potentially historic fenceline. One previously recorded site (SIHP # -13194, trail) was indicated in proximity to the current project area (see Section 4.1.3); the documented portion of SIHP # -05011 was located well upslope.

4.1.2.22 Monahan et al. 2012, Wilkinson et al. 2017

In 2012, CSH completed an AIS report for the Queen Ka‘ahumanu Highway Widening Phase 2 project, located between Kealakehe and Kalaoa Ahupua‘a and overlapping the Northern Section of the current project area (Monahan et al. 2010; see Figure 18). The survey documented 75 sites, including 20 previously documented sites (with SIHP designations from multiple different studies) and 55 newly recorded sites. Feature types included trails, *pāhoehoe* and *‘a‘ā* excavations, mounds, *ahu*, walls, modified outcrops, petroglyphs, lava tubes, enclosures, leveled areas, filled crevices, modified depressions and blisters, and a burial platform. Of these, SIHP #s -10714, -28794, and -29344 are indicated in proximity to the current project area (see Section 4.1.3). Another feature indicated in proximity was initially assigned as SIHP # -28796, but was ultimately absorbed as a component of SIHP # -10714, since it is a small cairn marking the Feature B trail routes. As such, the report does not contain a separate site description for SIHP # -28796. Only two of the 75 documented sites were recommended for no further work; the remainder were recommended for data recovery, preservation, and/or relocation.

In 2017, CSH prepared a supplemental AIS addressing an expansion of the 2012 project area (Wilkinson et al. 2017). The revised project area overlapped the Northern and Mauka Sections of the current project area, along the Hina Lani Street ROW and in the highway ROW surrounding the Kealakehe Parkway intersection (see Figure 18). The supplemental survey documented two segments of SIHP # -00002 (Māmalahoa Trail) adjacent to Kealakehe Parkway, one of which is located within the Mauka Section of the current project area (see Section 4.1.3). Both documented portions of the trail were recommended for preservation.

4.1.2.23 Reeve et al. 2012

In 2012, Pacific Legacy, Inc. completed an AIS report for the 628-acre conservation portion of QLT lands in Keahuolū Ahupua‘a, overlapping the Makai Section of the current project area (Reeve et al. 2012; see Figure 16). The survey documented 322 archaeological sites comprising 464 component features. Of these, a number were found to correspond to sites documented by Ching (1978) and Folk (1980); correlation issues are addressed in the report. The report provides somewhat contradictory information on the total numbers of previously recorded vs. newly recorded sites. New site number designations included SIHP #s -27273 through -27419, -27421 through -27542, and -27559 through -27569. The designated sites did not include an additional 139 *pāhoehoe* excavations documented throughout the project area, which were attributed to possible quarrying activites (Reeve et al. 2012:i). The documented feature types were as expected for the area and were largely assessed as pre-Contact in age. Forty-eight of the sites documented by Reeve et al. (2012) are indicated to be located within or in proximity to the Makai Section of the current project area (see Section 4.1.3).

Site distribution indicated two distinct zones of land use based on elevation and distance from the coast: a coastal zone "which stretches from the high surf line inland for approximately 200 meters" containing an abundance of archaeological features; and an inland area characterized by a markedly lower density of archaeological features, with almost a complete absence of sites in the inlandmost portions of the study area (Reeve et al. 2012:37–38). Excavations at coastal habitation sites

> yielded an abundance of cultural material including traditional artifacts and food remains. The presence of fishhooks and other fishing gear within the artifact assemblage at these sites, as well as the abundance of shell fish and fish remains recovered from them, indicates the close relationship between the residents of coastal Keahuolū and the sea. [Reeve et al. 2012:i]

Eight charcoal samples collected from coastal habitation sites were subjected to radiocarbon analysis. While most of the results suggested late pre-Contact to early historic occupation, two samples indicated possibility of occupation from the sixteenth century. The relatively late settlement dates are suggested to support "ethnohistoric documentation indicat[ing] that the main loci of settlement within coastal Keahuolū was toward the southern portion of the *ahupua‘a* in the area now occupied by the Old Kona Airport Park," (Reeve et al. 2012:139). All the documented sites were recommended for either preservation or data recovery.

4.1.3 Sites Previously Recorded in the Vicinity of the Project Area

As described in the summaries of previous archaeological studies in Sections 4.1 and 4.1.2, numerous archaeological sites have been documented within and in proximity to the current project area. The locations of these sites are illustrated in relation to the Mauka, Makai, and Northern, Sections of the project area on Figure 19, Figure 20, Figure 21, respectively.

While many site locations are indicated within the bounds of the current project area, the present research also examined any sites within an arbitrary 100 m (330 ft) "buffer" surrounding the project area. This buffer was developed for the current reseach because site locational data from older archaeological surveys has at times proven inaccurate. It is possible that some of the sites indicated outside but adjacent to the project area may actually be located within its bounds.

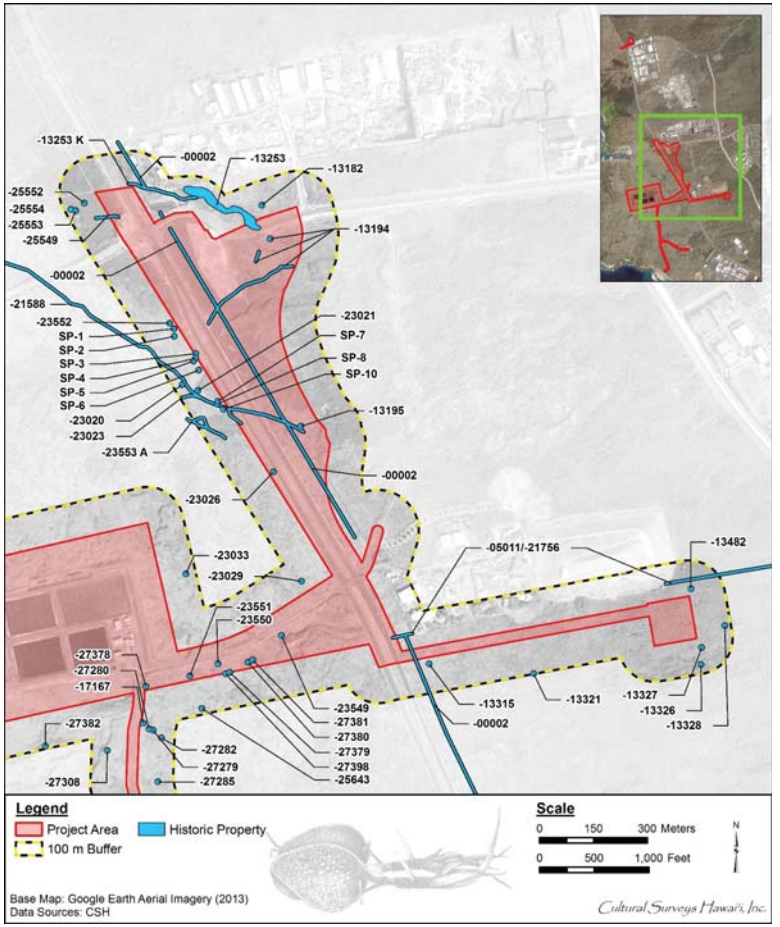

Figure 19. Google Earth (2013) aerial image showing archaeological sites previously documented in or adjacent to the Mauka Section of the project area; note Mauka Section includes sites in and along the Queen Ka‘ahumanu Highway ROW

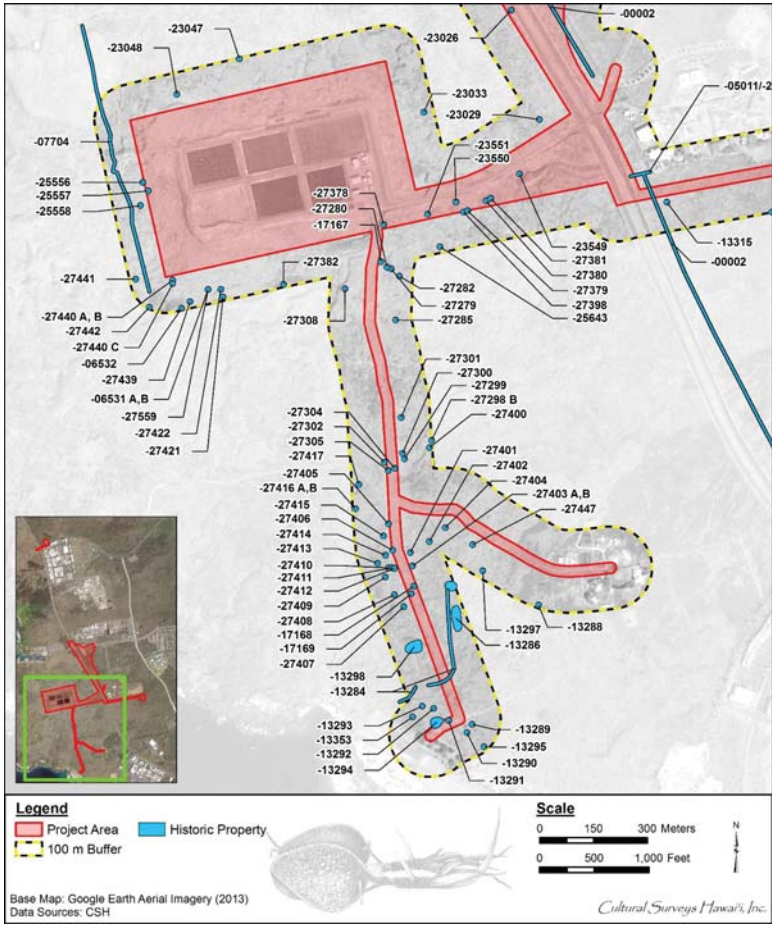

Figure 20. Google Earth (2013) aerial image showing archaeological sites previously documented in or adjacent to the Makai Section of the project area; note Makai Section does not include sites located in and along the Queen Ka'ahumanu Highway ROW

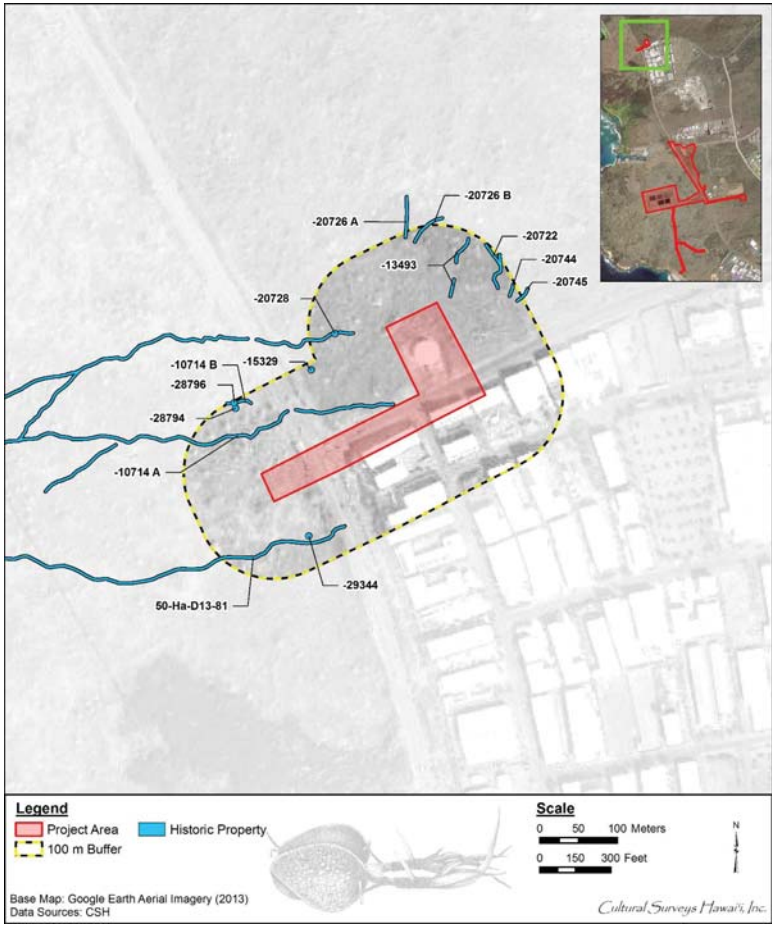

Figure 21. Google Earth (2013) aerial image showing archaeological sites previously documented in or adjacent to the Northern Section of the project area

Conversely, some of the sites depicted within the project area may actually be located outside its bounds. Typically, the more recent the study, the more accurate the site locational data.

Table 8, Table 9, and Table 10 provide by project area section as applicable, the SIHP number; any temporary site numbers; the primary source study or studies; site type; number of features; site function; site age; most recent identified treatment recommendations; and notes on the sites' status or any other comments taken from applicable reports. The descriptive wording for site type, function, and age in these tables are given as expressed in the source material; therefore, variation in wording may occur (for example, a pre-Contact site may be listed as "Pre-contact," "prehistoric," or "traditional"). While significance assessments and evaluations of eligibility to the Hawai‘i Register and/or National Register of Historic Places (HRHP/NRHP) were made for many of these sites, until quite recently there has been little consistency in how these assessments and/or evaluations were made and expressed, so that information in not included. Verbatim descriptions from previous studies are included in Appendix A for the sites in Table 8, Table 9, and Table 10.

Table 8. Previously documented archaeological sites in or near the vicinity of the Mauka Section of the project area (site numbers prefixed "50-10-27" unless otherwise noted)

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
00002	–	Bonk 1987; Donham 1990a and c; Borthwick and Hammatt 1992b, Borthwick et al. 1993; Henry and Graves 1993; Barr et al. 1994; O'Hare and Goodfellow 1994; Head and Rosendahl 1995; Walsh and Hammatt 1995; Hammatt et al. 1999; Wolforth 1999; Hammatt and Shideler 2008; Hammatt et al. 2008; Monahan et al. 2012; Wilkinson et al. 2017	Trail (Māmalahoa Trail)	–	Transportation	Historic	Data recovery (archival research) and partial preservation	Māmalahoa Trail has been impacted in multiple locations by various developments; extant portions in fair to reconstructed condition; various portions in active preservation and/or ongoing mitigation, including portions overlapping current project area
50-10-28-05011 /21756	50-Ha-D1 1-29; Site 1 (Sinoto 1977); T-94 (Donham 1990a); 927-25,39 (Burgett and Rosendahl 1992)	Sinoto 1977; Donham 1990a; Burgett and Rosendahl 1992; O'Hare and Goodfellow 1994; Wilkinson et al. 2011	Wall	–	*Ahupua'a* boundary	Historic	Further data collection (Burgett and Rosendahl 1992); no further work (?) (O'Hare and Goodfellow 1994)	Good condition
13182	T-8	Donham 1990a	Complex	2	Agriculture, marker	Indeterminate	No further work	Good condition
13194	T-21	Donham 1990a; Borthwick and Hammatt 1992b; Borthwick et al. 1993; Henry and Graves 1993; Barr et al. 1994; O'Hare and Goodfellow 1994; Walsh and Hammatt 1995	Stepping-stone trail	–	Transportation	Prehistoric	Preservation	Disturbed to fair condition
13195	T-22	Donham 1990a; Borthwick and Hammatt 1992b; Henry and Graves 1993	Complex	3	Marker	Historic	No further work	Fair condition
13253	T-96 (Donham 1990a)	Soehren 1976; Donham 1990a; Burgett and Rosendahl 1992; O'Hare and Goodfellow 1994	Complex	24	Burial, temporary habitation	Prehistoric	Preservation	Fair to good condition
13253K	Site 1 (Soehren 1976); T-96 (Donham 1990a)	Soehren 1976; Donham 1990a	Stepping-stone trail	–	Transportation	Prehistoric	Preservation	Fair to good condition; trail impacted by bulldozing sometime after 1976
13315	T-68	Donham 1990c	Rubble wall	1	Indeterminate	Prehistoric, historic	Further data collection	Fair condition
13321	T-74	Donham 1990c	Boulder concentration	1	Agriculture	Prehistoric	No further work	Good condition
13326	T-85	Donham 1990c	Platform	1	Agriculture	Prehistoric	No further work	Good condition
13327	T-88	Donham 1990c	*Pāhoehoe* excavation	2	Quarry	Prehistoric	No further work	Good condition
13328	T-89	Donham 1990c	Cave	1	Habitation	Prehistoric	Further data collection necessary	Fair condition
13482	T-87	Donham 1990c	*Pāhoehoe* excavation	1	Quarry	–	No further work	–
21588	SP-9	Emory and Soehren 1971; Cluff 1977; Durst 1999; Gmirkin and Bond 2002	Trail	–	Transportation	Historic	Preservation/avoidance during construction	Disturbed to excellent condition
23020	7 (Haun and Henry 2001)	Haun and Henry 2001; Rechtman and Escott 2002	*Pāhoehoe* excavation	1	Quarry	Pre-Contact	No further work	Good condition

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
23021	6 (Haun and Henry 2001)	Haun and Henry 2001; Rechtman and Escott 2002	Cave	1	Temporary habitation	Pre-Contact	No further work	Good condition
23023	2 (Haun and Henry 2001)	Haun and Henry 2001; Rechtman and Escott 2002	Trail	1	Transportation	Pre-Contact	No further work	–
23026	3 (Haun and Henry 2001)	Haun and Henry 2001	Complex	5	Marker	–	No further work	Good condition
23029	4 (Haun and Henry 2001)	Haun and Henry 2001	*Pāhoehoe* excavation	1	Quarry	–	No further work	Good condition
23552	–	Rechtman and Escott 2002	*Pāhoehoe* excavation	1	Quarry	Pre-Contact	No further work	–
23553A	–	Rechtman and Escott 2002	Trail	2	Transportation	Pre-Contact	No further work	–
25549	–	Haun and Henry 2006	Trail	–	Transportation	–	No further work	Fair to good condition
25552	–	Haun and Henry 2006	L-Shaped wall	1	Temporary habitation	–	No further work	Fair condition
25553	–	Haun and Henry 2006	Cairn	1	Marker	–	No further work	Fair condition
25554	–	Haun and Henry 2006	Enclosure	1	Permanent habitation	–	No further work	Fair condition
–	SP-1	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-2	Gmirkin and Bond 2002	Battering	1	–	–	Avoidance and monitoring during construction	–
–	SP-3	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-4	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-5	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-6	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-7	Gmirkin and Bond 2002	Wall	1	–	–	Avoidance and monitoring during construction	–
–	SP-8	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-10	Gmirkin and Bond 2002	Stone mound	1	–	–	Avoidance and monitoring during construction	Poor condition

Table 9. Previously documented archaeological sites in or near the vicinity of the Makai Section of the project area (site numbers prefixed "50-10-27" unless otherwise noted)

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
06531	T-153	Ching 1978, Reeve et al. 2012	Complex	2	Habitation/marker	Traditional	Data recovery	Poor condition
06532	T-197	Ching 1978, Reeve et al. 2012	Stone mound	1	Burial	Traditional	Preservation	Fair condition
07704	–	Soehren 1980, Haun and Henry 2006	Trail	27	Transportation	Historic	No further work	Trail marked by 26 associated cairns
13284	T-32	Donham 1990c	Complex	4	Agriculture	Prehistoric	No further work	Good condition
13286	T-34	Donham 1990c	Complex	10	Indeterminate/ markers/ possible agriculture	Prehistoric, early historic	No further work	Good condition
13288	T-37	Donham 1990c	Retaining wall/terrace	1	Loading ramp	Historic	No further work	Fair to good condition
13289	T-38	Donham 1990c	Complex	15	Quarry/ possible agriculture	Prehistoric, early historic	Further data collection	Good condition
13290	T-39	Donham 1990c	Complex	6	Quarry/ agriculture	Prehistoric, early historic	Further data collection	Good condition
13291	T-40	Donham 1990c; Borthwick and Hammatt 1992a	Complex	6	Quarry	Prehistoric, early historic	Preservation	Fair condition
13292	T-41	Donham 1990c; Borthwick and Hammatt 1992a	Complex	18	Quarry/ possible agriculture	Prehistoric, early historic	No further work	Good condition
13293	T-42	Donham 1990c; Borthwick and Hammatt 1992a	Complex	9	Quarry/ possible agriculture	Prehistoric	No further work	Good condition
13294	T-43	Donham 1990c; Borthwick and Hammatt 1992a	Complex	73	Agriculture	Indeterminate/ Prehistoric, historic	Preservation	Good condition
13295	T-44	Donham 1990c	Complex	10	Quarry	Prehistoric, early historic	Further data collection	Good condition
13297	T-47	Donham 1990c	Complex	9	Quarry/ possible agriculture	Prehistoric	No further work	Good condition
13298	T-48	Donham 1990c; Borthwick and Hammatt 1992a	Complex	7	Quarry/ agriculture/ temporary habitation	Prehistoric	No further work	Good condition
13353	T-128	Donham 1990c	Complex	3	Rock art, aquaculture, bathing	Prehistoric, early historic	Further data collection	Good condition
17167	CSH1	Borthwick and Hammatt 1992a	Modified sink	1	Shelter	Prehistoric	Preserve	Good condition with fair excavation potential
17168	CSH2	Borthwick and Hammatt 1992a	Modified sink	1	Shelter	Prehistoric	Preservation	Fair to good condition with poor excavation potential
17169	CSH3	Borthwick and Hammatt 1992a	Modified blister	1	Shelter	Prehistoric	No further work	Poor condition with poor excavation potential
23033	80	Haun and Henry 2001; Haun and Henry 2006	Overhang	1	Temporary habitation	–	Data recovery	Good condition
23047	55	Haun and Henry 2001	Cairn	1	Marker	–	No further work	Good condition
23048	74	Haun and Henry 2001	*Pāhoehoe* excavation	1	Quarry	–	No further work	Good condition
23549	–	Rechtman and Escott 2002	C-shaped enclosure	1	Temporary habitation	Pre-Contact	No further work	Good condition
23550	–	Rechtman and Escott 2002	Pahoehoe exavation	1	quarry	Pre-Contact	No further work	Good condition
23551	–	Rechtman and Escott 2002	Modified blister, cairn	2	Temporary habitation, marker	Pre-Contact	No further work	Good condition
25556	–	Haun and Henry 2006	Alignment	1	Indeterminate	–	No further work	Fair condition
25557	–	Haun and Henry 2006	Alignment	1	Indeterminate	–	No further work	Fair condition
25558	–	Haun and Henry 2006	Alignment	1	Indeterminate	–	No further work	Fair condition

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
25643	–	Haun and Henry 2006	Alignment	1	Indeterminate	–	No further work	Fair condition
27279	T-009	Reeve et al. 2012	Modified overhang	1	Storage	Traditional	Data recovery	Fair condition
27280	T-010	Reeve et al. 2012	Filled crevice	1	Indeterminate	Traditional	Data recovery	Good condition
27282	T-012	Reeve et al. 2012	Sinkhole	1	Indeterminate	Traditional	Data recovery	Good condition
27285	T-016	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27298	T-030	Reeve et al. 2012	Stone mound	2	Marker	Traditional	Preservation	Feature A: fair condition; Feature B: poor condition
27299	T-031	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27300	T-032	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27301	T-033	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27302	T-036	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Poor condition
27304	T-039	Reeve et al. 2012	Battering	1	Processing	Traditional	Data recovery	Fair condition
27305	T-040	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27308	T-045	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Poor condition
27378	T-116	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Poor condition
27379	T-117	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Preservation	Fair condition
27380	T-118	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Preservation	Fair condition
27381	T-119	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Poor condition
27382	T-123	Reeve et al. 2012	Stone mound	1	Marker	Historic	Data recovery	Fair condition
27398	T-154	Reeve et al. 2012	Stone mound	1	Marker	Modern	Data recovery	Good condition
27400	T-156	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27401	T-157	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27402	T-158	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Poor condition
27403	T-159	Reeve et al. 2012	Complex	2	Marker	Traditional	Data recovery	Fair condition
27404	T-160	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Fair condition
27405	T-161	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27406	T-162	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27407	T-163	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Poor condition
27408	T-164	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27409	T-165	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27410	T-166	Reeve et al. 2012	Enclosure	1	Indeterminate	Traditional	Data recovery	Fair condition
27411	T-167	Reeve et al. 2012	Enclosure	1	Indeterminate	Traditional	Data recovery	Fair condition
27412	T-168	Reeve et al. 2012	Modified overhang	1	Habitation	Traditional	Data recovery	Fair condition
27413	T-169	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27414	T-170	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27415	T-171	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27416	T-172	Reeve et al. 2012	Complex	2	Habitation	Traditional	Data recovery	Feature A: fair condition; Feature B: poor condition
27417	T-173	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27421	T-177	Reeve et al. 2012	Modified crevice	1	Indeterminate	Traditional	Data recovery	Fair condition

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
27422	T-178	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27439	T-198	Reeve et al. 2012	Wall segment	1	Indeterminate	Traditional	Data recovery	Fair condition
27440	T-199	Reeve et al. 2012	Complex	3	Habitation	Traditional	Data recovery	Fair condition
27441	T-200	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27442	T-201	Reeve et al. 2012	Scatter	1	Activity area	Traditional	Data recovery	Good condition
27447	T-208	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27559	–	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition

Table 10. Previously documented archaeological sites in or near the vicinity of the Northern Section of the project area (site numbers prefixed "50-10-27" unless otherwise noted)

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Feat.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
10714A, B	A: T-091010-4, B: T-091010-5 (Monahan et al. 2012)	Renger 1971; Monahan et al. 2012	Trail system (*mauka-makai*)	3	Transportation	Prehistoric, historic	Data recovery (archival research) and partial preservation	Part of the Road to the Sea trail system; absorbed SIHP # -28796 (trail marker)
13493	PHRI 547-1	Rosendahl 1989; Rosendahl and Walker 1990; Colin et al. 1996; Bell et al. 2008	Trail	–	Transportation	Prehistoric	No further work	–
15329	PHRI 92-1118-18	Henry and Graves 1993; Bell et al. 2008	Modified tumulus	1	Temporary habitation	Pre-contact	No further work	Fair condition
20722	–	Colin et al. 1996; Bell et al. 2008	Trail	1	Transportation	Pre-contact	No further work	Fair condition
20726	–	Colin et al. 1996; Bell et al. 2008	Trail	2	Transportation	Pre-contact	No further work	Fair condition
20728	–	Colin et al. 1996; Bell et al. 2008	Enclosure	1	Temporary habitation	Pre-contact	No further work	Fair condition
20744	–	Colin et al. 1996; Bell et al. 2008	Trail	1	Transportation	Pre-contact	No further work	Poor condition
20745	–	Colin et al. 1996; Bell et al. 2008	Trail	1	Transportation	Pre-contact	No further work	Fair condition
28794	T-091010-7	Monahan et al. 2012	Filled crevice	1	Indeterminate; possible agricultural clearing feature	Indeterminate	Avoidance during construction	–
28796 (see 10714)	T-091010-6	Monahan et al. 2012	Stacked boulders	1	Marker	–	–	Absorbed by SIHP # -10714 as a marker of Feature B trail
29344	Excavation 0 (Monahan and Yucha 2012)	Monahan et al. 2012	Excavated pit	1	Indeterminate; possible quarry or sweet potato planter or bird pit	Indeterminate—probably prehistoric (pre-Contact)	Data recovery	–
–	50-Ha-D13-81	Renger 1971	Trail	–	Transportation	–	–	–

4.2 Project Area Predictive Model

The project area is located at the southern edge of the arid Kekaha region, partially overlapping a transitional zone between Kekaha and the more verdant and abundantly populated region extending south from Kailua Bay. The project area is mostly situated within the Intermediate Zone, though the Makai Section does overlap the Coastal Zone at its interface with Old Kona Airport Park. In the early historic era, the region experienced a significant decline in population, with shifts in settlement from coastal hamlets to upland homesteads or commercial centers such as Kailua Bay. During the historic era ranching was the predominant type of land use in the area, though some scattered agriculture was still being practiced. Research indicates 119 archaeological sites (dating largely to the pre-Contact era) have been documented during previous studies within 100 m of the current project area.

The coastal zone typically contains a high density of sites associated predominately with clustered habitation and associated marine resource procurement. Expected pre-Contact site types include enclosures, platforms, trails, pavements, modified lava features (including lava tubes, outcrops, or blisters), anchialine ponds, *pāhoehoe* excavations, *papamū*, salt pans, petroglyphs, and/or cultural deposits. Burial sites are also present in lava tubes, platforms, rock mounds, or sand dunes. Ceremonial sites are common and can include *heiau* or *ko‘a*. Historic-era habitation sites and burials have been identified at Old Kona Airport Park, and the old airport infrastructure itself represents a potential historic property.

The Intermediate Zone exhibits a lower site density than the coastal zone. Pre-Contact sites are associated primarily with agriculture, temporary habitation or shelter, transportation, or quarrying. *Pāhoehoe* excavations are ubiquitous throughout this zone, and may be the result of quarrying, agricultural, or water collection activities. Agricultural features can also include mounds, terraces, and/or walls. Temporary habitation features include enclosures, pavements, platforms, and modified lava features. Burials are commonly present in lava tubes, platforms, and rock mounds. Lava tubes may also contain water collection or shelter features. Due to the characterization of soil deposition in the area, significant subsurface deposits of cultural materials not associated with surface features are not expected. Trails connecting coastal and upland areas extend through the intermediate zone, and more localized trails connecting features within agricultural and/or habitation complexes are also common. Some pre-Contact trails exhibit signs of continued use or modification in the hisoric era. The Māmalahoa Trail (SIHP # -00002), extending through the Mauka Section of the project area, was a major historic-era cross-*ahupua‘a* transportation route likely constructed over existing pre-Contact trails. Ranching features associated with post-Contact use of the area may also be present in the project area and can include walls, fence lines, unimproved roads, and water tanks.

Section 5 Results of Fieldwork

5.1 Overview

A field inspection was conducted on 25–26 September 2017 and 6 October 2017 by CSH archaeologists including Olivier Bautista, B.A., McKenzie Wildey B.A., and Sarah Wilkinson, B.A., under the general supervision of Hallett H. Hammatt, Ph.D. This work required approximately 9 person-days to complete and involved pedestrian inspection of the project area. The fieldwork focused on confirming sites located within or immediately adjacent to (within 5 m of) the project area bounds, and determining the potential presence of previously unrecorded features. Archaologists recorded previously documented archaeological sites and newly identified archaeological features encountered during the inspection with GPS, photos, and brief written notes.

Archaeologists found the project area contained variable levels of prior disturbance associated with existing roadways and other developments. As noted in Section 1.3, terrain is typically exposed lava flows supporting variable densities of vegetation. Ground visibility was generally fair to excellent. Thirty of 119 previously identified archaeological sites/historic properties were confirmed with confidence, and eight previously identified sites (or portions thereof) were possibly confirmed. In addition, archaeologists documented 16 newly identified archaeological features throughout the overall project area during the field inspection.

The results of fieldwork are organized by geographical section (Mauka Section, Makai Section, and Northern Section). For each geographical location, we provide a brief description of environmental conditions. A table adapted from those found in Section 4.1.3 summarizes the findings of the field inspection for each previously recorded site listed within that section. Another table summarizes the new archaeological features identified in that section during the field inspection. A map illustrates the locations of confirmed sites/features and newly identified archaeological features. We also provide descriptions of the located archaeological sites/features (previously recorded and new) and include photographs.

5.2 Mauka Section

The Mauka Section of the project area comprises portions of the Queen Ka‘ahumanu Highway, Kealakehe Parkway, and Hale Māka‘i Place ROWs and TMKs: [3] 7-4-020:007, 019, 021, and 022 located *mauka* of the Queen Ka‘ahumanu Highway ROW (Figure 22 through Figure 24). This section exhibits significant levels of prior disturbance related to construction of the existing paved roadways, a former baseyard located adjacent to the Queen Ka‘ahumanu Highway and Kealakehe Parkway intersection, and a network of jeep trails in the northeastern portion (Figure 25 through Figure 27). Along these jeep trails, archaeologists observed evidence of geotechinal boring, including bore holes and pieces of extracted cores. An existing WWTP disposal basin and associated pipeline are located directly adjacent to the central portion of the Mauka Section. The undisturbed areas are characterized by undulating *pāhoehoe* or *‘a‘ā* lava supporting *koa haole* and foreign grasses.

Figure 22. Photo overlooking the northern portion of the Mauka Section, *mauka* of Queen Ka‘ahumanu Highway; view to southeast

Figure 23. Photo showing the *makai* portion of the Queen Ka‘ahumanu Highway ROW within the Mauka Section; view to north

Figure 24. Photo overlooking the southern portion of the Mauka Section, *mauka* of Queen Ka‘ahumanu Highway; view to west

Figure 25. Photo overlooking the Queen Ka‘ahumanu Highway and Hale Māka‘i Place intersection with the Mauka Section of the project area; view to southeast

Figure 26. Photo showing an existing roadway in the spur extending from Hale Māka‘i Place in the Mauka Section; view to northeast

Figure 27. Photo showing bulldozer roads and a former stockpile location (visible as a grassy area in the background) in the northern portion of the Mauka Section; view to north

The field inspection of the Mauka Section of the project area confirmed eight of 34 sites previously documented within 100 m of the project area (see Section 5.2.1), possibly confirmed one additional previously documented site, and identified 12 previously undocumented sites (CSH-04 through CSH-16; see Section 5.2.2). Figure 28 depicts the locations of all sites identified in the Mauka Section during the field inspection.

5.2.1 Previously Documented Sites Confirmed in the Mauka Section

Background research indicated 34 previously recorded sites located within 100 m of the Mauka Section of the project area (see Section 4.1.3). Of these, eight were confirmed during the field inspection (see Figure 28, Figure 29 through Figure 45, and Table 11). One additional previously documented site was possibly confirmed (SIHP # -23023; see Table 11). Of the previously documented sites indicated in the immediate vicinity that were not confirmed, 12 may have been destroyed by prior developments such as the Queen Ka‘ahumanu Highway widening and construction of Honokōhau Industrial Park. The remainder are likely located well outside the current project area (see Table 11).

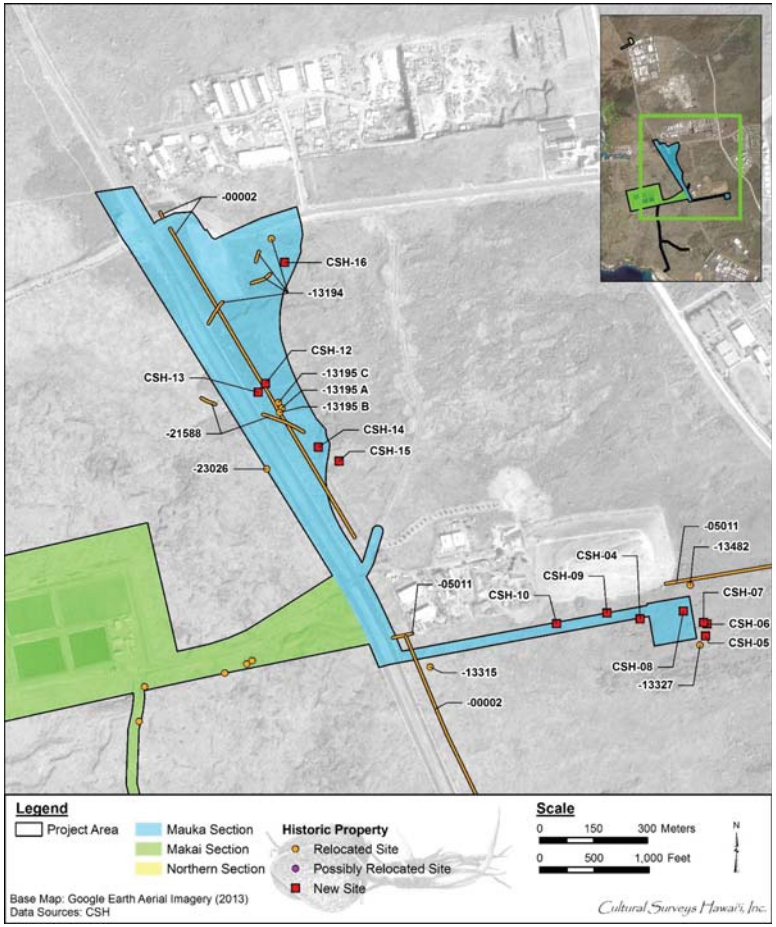

Figure 28. Aerial photo showing the sites documented during the field inspection in the Mauka Section of the project area (Google Earth 2013)

Table 11. Results for previously documented archaeological sites in the vicinity of the Mauka Section of the project area

SIHP # 50-10-27-	Site Type	# of Fea.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
00002	Trail (Māmalahoa Trail)	–	Transportation	Historic	Yes	Appears as documented in prior studies; present throughout most of the portion of Mauka Section upslope of Queen Ka‘ahumanu Hwy; portions of trail adjacent to Kealakehe Pkwy and Hale Māka‘i Place have been disturbed	Figure 29, Figure 30, Figure 31
50-10-28-05011 /21756	Wall	–	*Ahupua‘a* boundary	Historic	Yes	Extends *mauka* from disturbed Queen Ka‘ahumanu Hwy shoulder, with intermittent breaches	Figure 32, Figure 33
13182	Complex	2	Agriculture, marker	Indeterminate	No	Likely located well outside project area	–
13194	Stepping-stone trail	–	Transportation	Prehistoric	Yes	Some but not all sections of trail confirmed; confirmed portions appear as documented in prior studies; may have experienced some additional disturbance from bulldozing/use of adjacent area for base yard	Figure 34, Figure 35, Figure 36
13195	Complex	3	Marker	Historic	Yes	All three features appear as documented in prior studies	Figure 37, Figure 38, Figure 39
13253	Complex	24	Burial, temporary habitation	Prehistoric	No	May be disturbed/destroyed or located well outside project area	–
13253K	Stepping-stone trail	–	Transportation	Prehistoric	No	May be disturbed/destroyed	–
13315	Rubble wall	1	Indeterminate	Prehistoric, historic	Yes	Appears as documented in prior study	Figure 40
13321	Boulder concentration	1	Agriculture	Prehistoric	No	Likely located well outside project area	–

SIHP # 50-10-27-	Site Type	# of Fea.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
13326	Platform	1	Agriculture	Prehistoric	No	Likely located well outside project area	–
13327	*Pāhoehoe* excavation	2	Quarry	Prehistoric	Yes	Appears as documented in prior study	Figure 41
13328	Cave	1	Habitation	Prehistoric	No	Likely located well outside project area	–
13482	*Pāhoehoe* excavation	1	Quarry	–	Yes	Appears as documented in prior study	Figure 42
21588	Trail	–	Transportation	Historic	Yes—at least on *mauka* side of highway; portion on *makai* side of highway less clear	Appears as documented in prior studies; waypoint taken at intersection with SIHP # -00002 on *mauka* side of highway, and along *makai* side of highway at potential overlap with SIHP # -23023	Figure 43, Figure 44
23020	*Pāhoehoe* excavation	1	Quarry	Pre-Contact	No	Likely located well outside project area	–
23021	Cave	1	Temporary habitation	Pre-Contact	No	Likely located well outside project area	–
23023	Trail	1	Transportation	Pre-Contact	Possibly	Portion of trail sharing route with SIHP # -21855 *makai* of highway possibly confirmed	Figure 44
23026	Complex	5	Marker	–	Yes	Several mounds identified; appear as documented in prior study	Figure 45
23029	*Pāhoehoe* excavation	1	Quarry	–	No	Likely located well outside project area	–
23552	*Pāhoehoe* excavation	1	Quarry	Pre-Contact	No	Likely located well outside project area	–
23553A	Trail	2	Transportation	Pre-Contact	No	Likely located well outside project area	–
25549	Trail	–	Transportation	–	No	May be disturbed/destroyed or located well outside project area	–

SIHP # 50-10-27-	Site Type	# of Fea.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
25552	L-shaped wall	1	Temporary habitation	–	No	Likely located well outside project area	–
25553	Cairn	1	Marker	–	No	Likely located well outside project area	–
25554	Enclosure	1	Permanent habitation	–	No	Likely located well outside project area	–
–	*Pāhoehoe* excavation	1	–	–	No	May be destroyed	–
–	Battering	1	–	–	No	May be destroyed	–
–	*Pāhoehoe* excavation	1	–	–	No	May be destroyed	–
–	*Pāhoehoe* excavation	1	–	–	No	May be destroyed	–
–	*Pāhoehoe* excavation	1	–	–	No	May be destroyed	–
–	*Pāhoehoe* excavation	1	–	–	No	May be destroyed	–
–	Wall	1	–	–	No	May be destroyed	–
–	*Pāhoehoe* excavation	1	–	–	No	May be destroyed	–
–	Stone mound	1	–	–	No	May be destroyed	–

Figure 29. Photo of SIHP # -00002 (Māmalahoa Trail) in the northern portion of the Mauka Section, visible as the linear band of vegetation extending through the center of the photo; view to south

Figure 30. Photo of SIHP # -00002 (Māmalahoa Trail) at the *‘a‘ā* and *pāhoehoe* flow interface in the northern portion of the Mauka Section, archaeologists are standing on a causeway along the trail; view to west

Figure 31. Photo showing SIHP # -00002 (Māmalahoa Trail) obscured by *koa haole* in the southern portion of the Mauka Section; view to south

Figure 32. Photo of SIHP # -05011/21756 (*ahupua‘a* wall) adjacent to Queen Ka‘ahumanu Highway; view to west

Figure 33. Photo of SIHP # -05011/21756 (*ahupua'a* wall); view to north

Figure 34. Photo showing the *makai* section of SIHP # -13194 (trail) adjacent at its intersection with SIHP # -00002; view to southwest

Figure 35. Photo showing the central section of SIHP # -13194 (trail) located east of the former stockpile area; views to northeast (left frame) and west (right frame)

Figure 36. Photo showing the *mauka* section of SIHP # -13194 (trail); note stepping-stones; view to north

Figure 37. Photo of SIHP # -13195 Feature A (*ahu*); view to west

Figure 38. Photo of SIHP # -13195 Feature B (*ahu*); view to west

Figure 39. Photo of SIHP # -13195 Feature C (*ahu*); view to southwest

Figure 40. Photo of SIHP # -13315 (rubble wall); view to east

Figure 41. Photo of SIHP # -13327 (*pāhoehoe* excavation); view to east

Figure 42. Photo of SIHP # -13482 (quarry area); view to north

Figure 43. Photo of SIHP # -21855 (trail) at intersection with SIHP # -00002 *mauka* of Queen Ka‘ahumanu Highway; view to northwest

Figure 44. Photo of possible SIHP # -21855/-23023 (trail) *makai* of Queen Ka‘ahumanu Highway; view to west

Figure 45. Photo of two rock mounds at SIHP # -23026 (mound complex); view to northeast

5.2.2 Newly Recorded Archaeological Sites in the Mauka Section

Archaeologists documented 12 newly identified archaeological sites within the Mauka Section of the project area (CSH-04 through CSH-10, and CSH-12 through CSH-16; see Figure 28). For each site Table 12 provides the formal site type, a brief description, and the associated figure reference(s).

Table 12. Newly identified archaeological sites documented in the Mauka Section of the project area

Temporary Site #	Site Type	Description	Figure (photo) #
CSH-04	Lava tube (unknown if tube contains cultural modifications)	Tube observed to trend upslope and downslope for undetermined distances; cultural modifications and/or materials not observed at opening; potential for cultural features within unexplored portions of tube	Figure 46
CSH-05	Mound	Large stone mound constructed of loosely piled cobbles on an outcrop with view of coastline; potential to contain burial	Figure 47
CSH-06	Mound	Small stone mound constructed of loosely piled cobbles on a rocky knoll	Figure 48
CSH-07	Mound	Small stone mound constructed of loosely piled cobbles on a rocky knoll	Figure 49
CSH-08	*Pāhoehoe* excavation	–	Figure 50
CSH-09	Modified depression	Modifications consist of stacking and alignments of basalt cobbles and boulders within/along depression	Figure 51
CSH-10	*Pāhoehoe* excavation	Located along a flow interface	Figure 52
CSH-12	Complex	Multiple *pāhoehoe* excavations located along SIHP # -00002; may have previously been assigned as features of that trail	Figure 53
CSH-13	Filled crevice	Natural crevice filled with basalt and coral cobbles	Figure 54
CSH-14	Trail	Short segment of stepping-stone trail at *pāhoehoe* and *ʻaʻā* flow interface	Figure 55
CSH-15	Complex	Modern slab mounds and quarry area	Figure 56
CSH-16	*Pāhoehoe* excavation	–	Figure 57

Figure 46. Photo of CSH-04 (lava tube); view to southeast

Figure 47. Photo of CSH-05 (mound); view to west

Figure 48. Photo of CSH-06 (mound); view to west

Figure 49. Photo of CSH-07 (mound); view to north

Figure 50. Photo of CSH-08 (*pāhoehoe* excavation); view to west

Figure 51. Photo of CSH-09 (modified sink); view to west

Figure 52. Photo of CSH-10 (*pāhoehoe* excavation); view to west

Figure 53. Photo of CSH-12 (complex of *pāhoehoe* excavations) located adjacent to SIHP # -00002; view to northwest

Figure 54. Photo of CSH-13 (filled crevice with corals); view to southeast

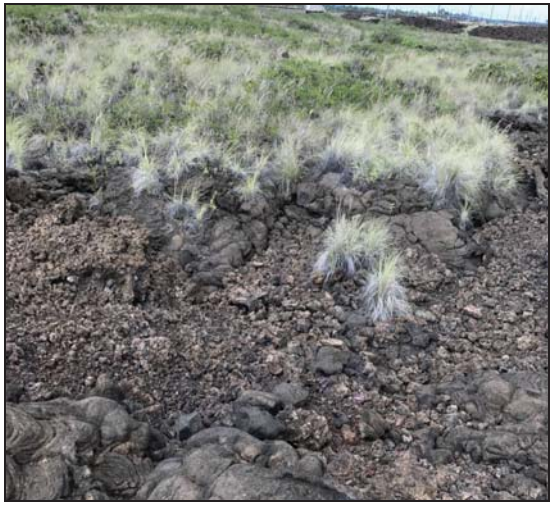

Figure 55. Photo of CSH-14 (stepping-stone trail); view to west

Figure 56. Photo overlooking CSH-15 (modern quarry complex), showing a modern slab mound (foreground) and slab quarry area (background); view to northeast

Figure 57. Photo of CSH-16 (*pāhoehoe* excavation); view to southwest

5.3 Makai Section

The Makai Section of the project area comprises portions of TMKs: [3] 7-4-008:002, 058, 073 and 7-5-005:007 located *makai* of the Queen Ka‘ahumanu Highway ROW, slightly overlapping the QLT Children’s Center and Old Kona Airport Park properties (due to proposed R-1 line extending to these locations from the WWTP; see Figure 5). The Makai Section exhibits significant levels of prior disturbance related to construction of the existing Kealakehe WWTP facility, paved roadways, and unimproved roadways running between the WWTP, Old Kona Airport Park, and the QLT Children’s Center (Figure 58 through Figure 61). Homeless encampments are common in the vicinity of Old Kona Airport Park; one was observed in an area of archaeological features adjacent to the project area (Figure 62). The undisturbed areas are characterized by undulating *pāhoehoe* (with a small area of *‘a‘ā* lava near the QLT Children’s Center) supporting predominately *koa haole* and foreign grasses.

The field inspection of the Makai Section of the project area confirmed 21 of 73 previously documented sites (see Section 5.3.1), possibly confirmed seven additional previously documented sites, and identified three previously undocumented sites (CSH-01 through CSH-03; see Section 5.3.2). The locations of all sites identified in the Makai Section during the field inspection are depicted in Figure 64.

5.3.1 Previously Documented Sites Confirmed in the Makai Section

Background research indicated 73 previously recorded sites are located within 100 m of the Makai Section of the project area (see Section 4.1.3). Of these, 21 were confirmed during the field inspection (see Figure 64 and Table 13). Seven additional previously documented sites were possibly confirmed (see Table 13). Of the previously documented sites indicated in the immediate vicinity that were not confirmed, five may have been destroyed by prior development of roadways associated with the Kealakehe WWTP facility. The remainder are likely located well outside the current project area (see Table 13).

The difficulty in correlating certain features encountered during the field inspection in the Makai Section is not unexpected. These features are, by and large, clustered in the southernmost portion of the Makai Section, where it overlaps the coastal zone. This zone is characterized by its high density of archaeological features, which are typically organized into and recorded as site complexes assigned based on typological, functional, and/or spatial considerations. Reeve et al. (2012:35) were able to correlate their findings with those of the previous coastal Keahuolū studies (Ching et al. 1978, Folk 1980) though not without challenge. The hard work of site confirmation/correlation has not yet been accomplished for the majority of the Donham (1990c) project area—in particular the portions surrounding the current project area. Donham’s (1990c) descriptions of SIHP #s -13284, -13286, -13291, -13292, -13293, -13298, and -13353 are brief and contain little cartographic or photographic information. While several site tags from the Reeve et al. (2012) fieldwork were found on features likely previously recorded by Donham (1990c) as part(s) of these site complexes, the information obtained from these features was not included in the report as they are technically outside the 2012 study area. Furthermore, while Borthwick and Hammatt’s (1992a) study for the Kealakehe Sewer Force Main and Pump Station was in this area, it comprised a narrow corridor that crossed through or past only a handful of Donham (1990c) sites, and the 1990 site descriptions were not updated with new information.

Figure 58. Photo overlooking the Kealakehe WWTP facility from the entry gate; view to west

Figure 59. Photo overlooking the Kealakehe WWTP facility; view to west

Figure 60. Photo showing a paved jeep road extending *makai* from the QLT Children's Center in the Makai Section; view to west

Figure 61. Photo of the gravel road extending from existing WWTP to the Old Kona Airport Park; view to south

Figure 62. Photo of a homeless encampment located in the indicated vicinity of SIHP # -13192; view to north

Figure 63. Photo showing the paved entry road to the Kealakehe WWTP in the Makai Section; view to east

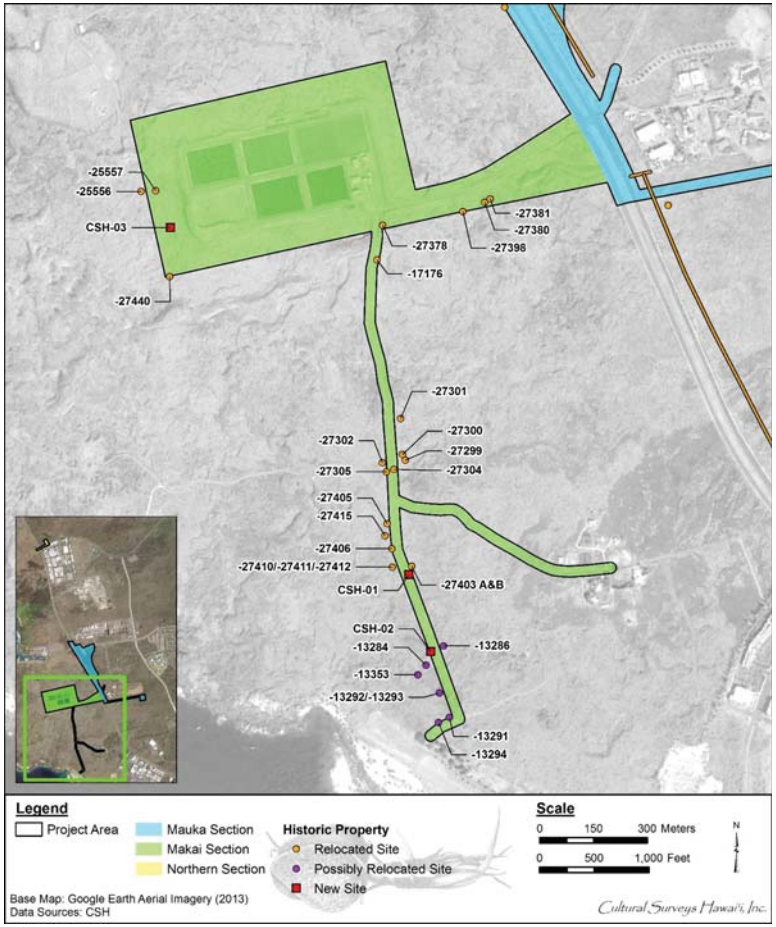

Figure 64. Aerial photo showing the sites documented during the field inspection in the Makai Section of the project area (Google Earth 2013)

Table 13. Results for previously documented archaeological sites in the vicinity of the Mauka Section of the project area

SIHP # 50-10-27-	Site Type	# of Fea.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
06531	Complex	2	Habitation/marker	Traditional	No	Likely located well outside project area	–
06532	Stone mound	1	Burial	Traditional	No	Likely located well outside project area	–
07704	Trail	27	Transportation	Historic	No	Likely located well outside project area	–
13284	Complex	4	Agriculture	Prehistoric	Possibly	Likely features of site confirmed; positive correlation outside present scope of work; Reeve et al. (2012) site tag(s) found (T-97)	Figure 65, Figure 66, Figure 67
13286	Complex	10	Indeterminate/ markers/ possible agriculture	Prehistoric, early historic	Possibly	Likely features of site confirmed; Reeve et al. (2012) site tag(s) found (T-86), but not included in 2012 report; positive correlation outside present scope of work	Figure 67
13288	Retaining wall/ terrace	1	Loading ramp	Historic	No	Likely located well outside project area	–
13289	Complex	15	Quarry/ possible agriculture	Prehistoric, early historic	No	Likely located well outside project area	–
13290	Complex	6	Quarry/ agriculture	Prehistoric, early historic	No	Likely located well outside project area	–
13291	Complex	6	Quarry	Prehistoric, early historic	Possibly	Likely features of site confirmed; positive correlation outside present scope of work	Figure 68
13292	Complex	18	Quarry/ possible agriculture	Prehistoric, early historic	Possibly	Likely features of site confirmed; positive correlation outside present scope of work	Figure 69
13293	Complex	9	Quarry/ possible agriculture	Prehistoric	Possibly	Likely features of site confirmed; positive correlation outside present scope of work	Figure 69
13294	Complex	73	Agriculture	Indeterminate / Prehistoric, historic	Possibly	Likely features of site relocated; positive correlation outside of present scope of work	Figure 70
13295	Complex	10	Quarry	Prehistoric, early historic	No	Likely located well outside of project area	–

SIHP # 50-10-27-	Site Type	# of Fea.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
13297	Complex	9	Quarry/ possible agriculture	Prehistoric	No	Likely located well outside project area	–
13298	Complex	7	Quarry/ agriculture/ temporary habitation	Prehistoric	No	Likely located well outside project area	–
13353	Complex	3	Rock art, aquaculture, bathing	Prehistoric, early historic	Possibly	Possible feature of site confirmed (Feature B?); positive correlation outside present scope of work	Figure 71, Figure 72
17167	Modified sink	1	Shelter	Prehistoric	Yes	Appears as documented in prior study	Figure 73
17168	Modified sink	1	Shelter	Prehistoric	No	May be destroyed	–
17169	Modified blister	1	Shelter	Prehistoric	No	May be destroyed	–
23033	Overhang	1	Temporary habitation	–	No	Likely located well outside project area	–
23047	Cairn	1	Marker	–	No	Likely located well outside project area	–
23048	*Pāhoehoe* excavation	1	Quarry	–	No	Likely located well outside project area	–
23549	C-shaped enclosure	1	Temporary habitation	Pre-Contact	No	May be destroyed	–
23550	*Pāhoehoe* excavation	1	Quarry	Pre-Contact	No	May be destroyed	–
23551	Modified blister, Cairn	2	Temporary habitation, Marker	Pre-Contact	No	May be destroyed	–
25556	Alignment	1	Indeterminate	–	Yes	Appears as documented in prior study	Figure 74
25557	Alignment	1	Indeterminate	–	Yes	Appears as documented in prior study	Figure 75
25558	Alignment	1	Indeterminate	–	No	Likely located well outside project area	–
25643	Alignment	1	Indeterminate	–	No	Likely located well outside project area	–

SIHP # 50-10-27-	Site Type	# of Fea.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
27279	Modified overhang	1	Storage	Traditional	No	Likely located well outside project area	–
27280	Filled crevice	1	Indeterminate	Traditional	No	Likely located well outside project area	–
27282	Sinkhole	1	Indeterminate	Traditional	No	Likely located well outside project area	–
27285	C-shaped wall	1	Habitation	Traditional	No	Likely located well outside project area	–
27298	Stone mound	2	Marker	Traditional	No	Likely located well outside project area	–
27299	C-shaped wall	1	Habitation	Traditional	Yes	Appears as documented in prior study	Figure 76
27300	C-shaped wall	1	Habitation	Traditional	Yes	Appears as documented in prior study	Figure 77
27301	Enclosure	1	Habitation	Traditional	Yes	Appears as documented in prior study	Figure 78
27302	Enclosure	1	Habitation	Traditional	Yes	Appears as documented in prior study	Figure 79
27304	Battering	1	Processing	Traditional	Yes	Appears as documented in prior study	Figure 80
27305	C-shaped wall	1	Habitation	Traditional	Yes	Appears as documented in prior study	Figure 81
27308	Stone mound	1	Marker	Traditional	No	Likely located well outside project area	–
27378	Stone mound	1	Marker	Traditional	Yes	Appears as documented in prior study	Figure 82
27379	Stone mound	1	Marker	Traditional	No	Indicated in proximity to SIHP # -27398; though area appears undisturbed feature could not be confirmed, possibly indicating it is located further away from project area than depicted	–
27380	Stone mound	1	Marker	Traditional	Yes	Appears as documented in prior study	Figure 83
27381	Stone mound	1	Marker	Traditional	Yes	Appears as documented in prior study	Figure 84
27382	Stone mound	1	Marker	Historic	No	Likely located well outside project area	–
27398	Stone mound	1	Marker	Modern	Yes	Appears as documented in prior study	Figure 85
27400	Enclosure	1	Habitation	Traditional	No	Likely located well outside project area	–
27401	Enclosure	1	Habitation	Traditional	No	Likely located well outside project area	–
27402	Stone mound	1	Marker	Traditional	No	Likely located well outside project area	–
27403	Complex	2	Marker	Traditional	Yes	Both features appear as documented in prior study	Figure 86, Figure 87
27404	Stone mound	1	Marker	Traditional	No	Likely located well outside project area	–

SIHP # 50-10-27-	Site Type	# of Fea.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
27405	C-shaped wall	1	Habitation	Traditional	Yes	Appears as documented in prior study	Figure 88
27406	Enclosure	1	Habitation	Traditional	Yes	Appears as documented in prior study	Figure 89
27407	Enclosure	1	Habitation	Traditional	No	Likely located well outside project area	–
27408	U-shaped wall	1	Habitation	Traditional	No	Likely located well outside project area	–
27409	C-shaped wall	1	Habitation	Traditional	No	Likely located well outside project area	–
27410	Enclosure	1	Indeterminate	Traditional	Yes	In same area as SIHP #s -27411 and -27412; positive correlation of feature to site number not achieved	Figure 90, Figure 91
27411	Enclosure	1	Indeterminate	Traditional	Yes	In same area as SIHP #s -27410 and -27412; positive correlation of feature to site number not achieved	Figure 90, Figure 91
27412	Modified overhang	1	Habitation	Traditional	Yes	In same area as SIHP #s -27410 and -27411; positive correlation of feature to site number not achieved	Figure 90, Figure 91
27413	C-shaped wall	1	Habitation	Traditional	No	Likely located well outside project area	–
27414	C-shaped wall	1	Habitation	Traditional	No	Likely located well outside project area	–
27415	C-shaped wall	1	Habitation	Traditional	Yes	Appears as documented in prior study; site description is erroneous in 2012 report in that the site number is listed incorrectly as SIHP # -27414	Figure 92
27416	Complex	2	Habitation	Traditional	No	Likely located well outside project area	–
27417	C-shaped wall	1	Habitation	Traditional	No	Likely located well outside project area	–
27421	Modified crevice	1	Indeterminate	Traditional	No	Likely located well outside project area	–
27422	C-shaped wall	1	Habitation	Traditional	No	Likely located well outside project area	–
27439	Wall segment	1	Indeterminate	Traditional	No	Likely located well outside project area	–
27440	Complex	3	Habitation	Traditional	Yes	Two of three features confirmed (likely Features A and B); positive correlation outside present scope of work	Figure 93, Figure 94
27441	Enclosure	1	Habitation	Traditional	No	Likely located well outside project area	–

SIHP # 50-10-27-	Site Type	# of Fea.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
27442	Scatter	1	Activity area	Traditional	No	Likely located well outside project area	–
27447	Enclosure	1	Habitation	Traditional	No	Likely located well outside project area	–
27559	C-shaped wall	1	Habitation	Traditional	No	Likely located well outside project area	–

Figure 65. Photo of a *pāhoehoe* excavation, possibly a feature of SIHP # -13284 (complex); jeep road visible in background; view to northeast

Figure 66. Photo showing a stepping-stone trail and constructed spring opening (archaeologist visible inside opening to spring), possible features of SIHP # -13284 (complex) or other Donham (1990c) sites in the vicinity; view to east

Figure 67. Photo showing features along a trail, possibly representing SIHP #s -13284 and/or -13286 (complexes); view to west

Figure 68. Photo of *pāhoehoe* excavations in the indicated vicinity of SIHP # -13291 (complex); view to northeast

Figure 69. Photo overlooking portion of a large area containing *pāhoehoe* excavations and rock deposits in the vicinity of SIHP #s -13292, -13294, and -13293 (complexes); view to southeast

Figure 70. Photo of a rock concentration, possibly a feature of SIHP # -13294 (complex); view to west

Figure 71. Photo of a modified spring, possibly a feature of SIHP # 13353 (complex); view to east

Figure 72. Photo showing the interior of the modified spring pictured in Figure 71; view to east

Figure 73. Photo overlooking SIHP # -17167 (modified sink); view to west

Figure 74. Photo of SIHP # -25556 (alignment); view to southeast

Figure 75. Photo of SIHP # -25557 (alignment); view to southeast

Figure 76. Photo of SIHP # -27299 (c-shape); view to southwest

Figure 77. Photo of SIHP # -27300 (C-shape); view to southwest

Figure 78. Photo of SIHP # -27301 (enclosure); view to southwest

Figure 79. Photo of SIHP # -27302 (enclosure); view to southwest

Figure 80. Photo of SIHP # -27304 (battering); view to southwest

Figure 81. Photo of SIHP # -27305 (C-shape); view to southwest

Figure 82. Photo of SIHP # -27378 (mound), entry to Kealakehe WWTP visible in background; view to north

Figure 83. Photo of SIHP # -27380 (mound); view to north

Figure 84. Photo of SIHP # -27381 (mound); view to south

Figure 85. Photo of SIHP # -27398 (mound); view to southwest

Figure 86. Photo of SIHP # -27403 Feature A (mound); view to south

Figure 87. Photograph of Site -27403 Feature B (mound): view to west

Figure 88. Photo of SIHP # -27405 (C-shaped wall); view to east

Figure 89. Photo of SIHP # -27406 (enclosure); view to southeast

Figure 90. Photo overlooking SIHP #s -27410 (enclosure), -27411 (enclosure), and/or -27412 (modified overhang); view to west

Figure 91. Photo of SIHP #s -27410 (enclosure), -27411 (enclosure), or -27412 (modified overhang); view to northwest

Figure 92. Photo of SIHP # -27415 (C-shaped wall); view to west

Figure 93. Photo showing one of two confirmed features at SIHP # -27440 (complex); view to northeast

Figure 94. Photo showing another of two confirmed features at SIHP # -27440 (complex); view to southeast

5.3.2 Newly Recorded Archaeological Sites in the Makai Section

Archaeologists documented three newly identified archaeological sites within the Mauka Section of the project area (CSH-01 through CSH-03; see Figure 28). For each site Table 14 provides the formal site type, a brief description, and the associated figure reference(s). CSH-02 may be associated with one of several large complexes previously documented by Donham (1990c), but this is unclear when comparing the nature and position of CSH-02 to the nature and locations of Donham (1990c) sites depicted on Figure 20.

Table 14. Newly identified archaeological sites documented in the Makai Section of the project area

Temporary Site #	Site Type	Description	Figure (photo) #
CSH-01	*Ahu*	Located on an outcrop on the *mauka* side of jeep trail	Figure 95
CSH-02	Modified outcrop complex	Located on *makai* side of jeep trail; large outcrop contains numerous modifications including *pāhoehoe* excavations and potentially modified overhangs (some as possible water collection areas); two waterworn basalt artifacts observed at site; may be associated with site complexes previously recorded by Donham (1990c) in this general area; *mauka* edge of outcrop obscured by kiawe trees	Figure 96, Figure 97
CSH-03	Complex (three features; circular alignments)	Loose, circular alignments of stones on smooth *pāhoehoe* exposures	Figure 98, Figure 99

Figure 95. Photo of CSH-01, *ahu*; view to north

Figure 96. Photo overlooking CSH-02, modified outcrop complex, taken from jeep road; outcrop is obscured by kiawe trees; view to north

Figure 97. Photo of a waterworn basalt artifact at CSH-02; view to northwest

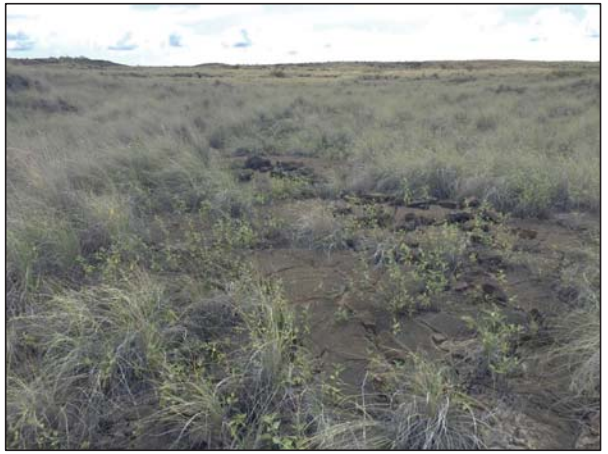

Figure 98. Photo overlooking CSH-03, circular alignment complex; view to southwest

Figure 99. Photo showing a circular alignment feature at CSH-03; view to west

5.4 Northern Section

The Northern Section of the project area comprises TMK: [3] 7-3-009:027 and portions of the Hina Lani Street and Queen Ka‘ahumanu Highway ROWs. This section has been almost entirely disturbed by construction related to the existing roadways and the graded and fenced water tank site (Figure 100 through Figure 102). The fringes of the tank site within the project area and a small area within the western-most portion of the project area extending *makai* from the highway are undulating *pāhoehoe* lava supporting *koa haole* and foreign grasses (Figure 103).

The field inspection of the Northern Section of the project area confirmed one feature of a previously documented site (SIHP # -10714 Feature A), and identified one previously undocumented site (CSH-11). Figure 104 shows the locations of all sites identified in the Northern Section during the field inspection.

5.4.1 Previously Documented Sites Confirmed in the Northern Section

Background research indicated 14 previously recorded sites located within 100 m of the Northern Section of the project area (see Section 4.1.3). Of these, only one was indicated in proximity: SIHP # -10714 Feature A (see Figure 21). This was the only site confirmed during the field inspection (see Figure 104 and Table 15), signifying that the remaining sites are likely situated well outside the project area.

Figure 100. Photo (Google Earth 2018) showing the existing tank site within the Northern Section of the project area; view to northwest

Figure 101. Photo showing the Queen Ka‘ahumanu Highway and Hina Lani Street intersection within the Northern Section of the project area; view to west

Figure 102. Photo of bulldozed area *makai* of Queen Ka‘ahumanu Highway within the Northern Section of the project area; view to west

Figure 103. Photo showing typical vegetation and terrain in the undisturbed areas in and adjacent to the Northern Section of the project area; view to east

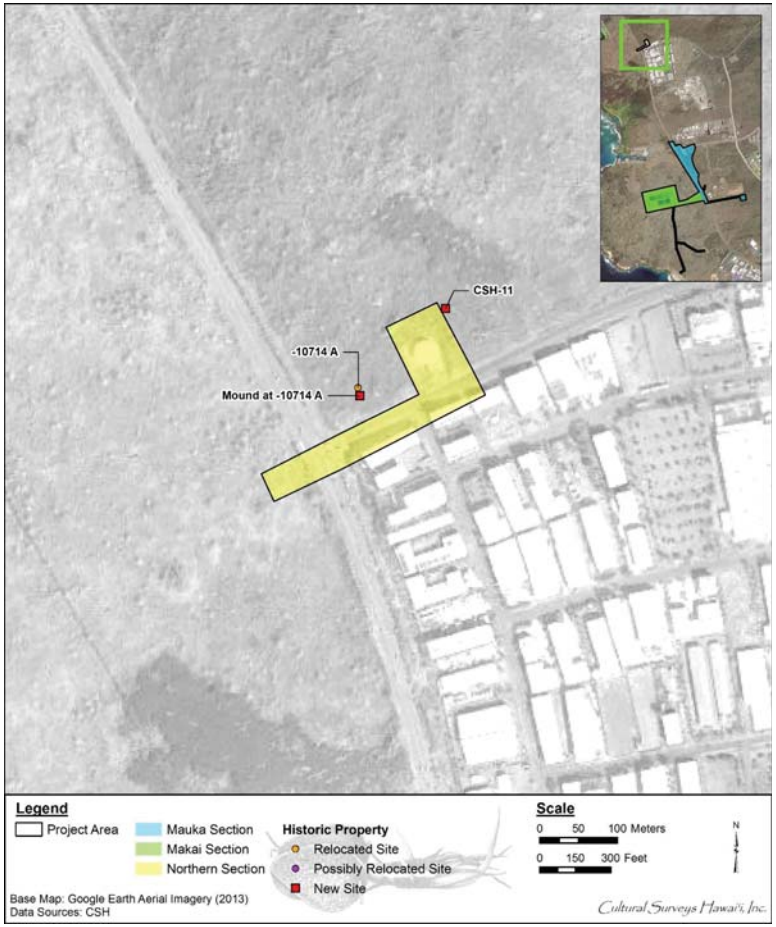

Figure 104. Aerial photo showing the sites documented during the field inspection in the Northern Section of the project area (Google Earth 2013)

Table 15. Results for previously documented archaeological sites in the vicinity of the Northern Section of the project area

SIHP # 50-10-27-	Site Type	# of Feat.	Site Function	Site Age	Relocated? (Yes/No/Possibly)	Comment(s)	Figure (photo) #
10714A, B	Trail system (*mauka-makai*)	3	Transportation	Prehistoric, historic	Yes (Feature A only)	Confirmed portion of Feature A adjacent to project area appears as documented in prior study, except for presence of a new rock mound feature along it; Feature B located well outside project area	Figure 105, Figure 106
13493	Trail	–	Transportation	Prehistoric	No	Likely located well outside project area	–
15329	Modified tumulus	1	Temporary habitation	Pre-Contact	No	Likely located well outside project area	–
20722	Trail	1	Transportation	Pre-Contact	No	Likely located well outside project area	–
20726	Trail	2	Transportation	Pre-Contact	No	Likely located well outside project area	–
20728	Enclosure	1	Temporary habitation	Pre-Contact	No	Likely located well outside project area	–
20744	Trail	1	Transportation	Pre-Contact	No	Likely located well outside project area	–
20745	Trail	1	Transportation	Pre-Contact	No	Likely located well outside project area	–
28794	Filled crevice	1	Indeterminate; possible agricultural clearing feature	Indeterminate	No	Likely located well outside project area	–
28796 (see 10714)	Stacked boulders	1	Marker	–	No	Likely located well outside project area along SIHP # -10714 Feature B	–
29344	Excavated pit	1	Indeterminate; possible quarry or sweet potato planter or bird pit	Indeterminate – probably pre-Contact	No	Likely located well outside project area	–
–	Trail	–	Transportation	–	No	Likely located well outside project area	–

Figure 105. Photo of SIHP # -10714 Feature A; view to east

Figure 106. Photo of a rock mound feature observed along SIHP # -10714 Feature A; view to west

5.4.2 Newly Recorded Archaeological Sites in Northern Section

Archaeologists documented one new archaeological site within the Northern Section of the project area (CSH-11; see Figure 104). This site is summarized in Table 16.

Table 16. Newly identified archaeological site documented in the Northern Section of the project area

Temporary Site #	Site Type	Description	Figure (photo) #
CSH-11	Complex (two features; circular alignments)	Small circular alignments of stones on smooth *pāhoehoe* exposures	Figure 107

Figure 107. Photo of one of the features at CSH-11 (circular alignment complex); view to southeast

Section 6 Summary and Recommendations

6.1 Summary

The project area is situated between the *ahupua‘a* of Kaloko to the north and Keahuolū to the south. This unit of land divisions represents the southernmost extent of the Kekaha region, known for its arid environment. Dependent on seasons, the uplands were used for residences and farming, and the coastal lands for residence, fishing, and aquaculture. Networks of trails connected coastal and upland settlements by extending through the Intermediate Zone, along which shelter and water collection caves, quarries, and scattered agricultural sites were located. In the historic era the area was used widely for ranching.

Numerous previous archaeological studies have been conducted in the vicinity of the current project area. Background research indicated the presence of 119 previously identified archaeological sites/historic properties overlapping or within 30 m of the bounds of the project area. Most of these were pre-Contact sites associated with agriculture, habitation, transportation, resource procurement, ceremony, burial, artistic expression, and/or recreation. Historic era sites included trails (including but not limited to SIHP # -00002, Māmalahoa Trail), habitation areas, a cemetery, and ranching-related features like boundary walls.

Archaeologists conducted the field inspection on 25–26 September 2017 and 6 October 2017; CSH archaeologists included Olivier Bautista, B.A., McKenzie Wildey, B.A., and Sarah Wilkinson, B.A., under the general supervision of Hallett H. Hammatt, Ph.D. This work required approximately 9 person-days to complete and involved pedestrian inspection of the project area. The fieldwork focused on confirming sites located within or immediately adjacent to (within 5-10 m of) the project area bounds, and determining the potential presence of previously unrecorded features.

The project area was found to contain variable levels of prior disturbance associated with existing roadways and other developments. The Mauka Section contained the largest extents of undisturbed land, particularly in the areas proposed for development of the SAT and future elevated storage tank.

Thirty of the 119 previously identified archaeological sites/historic properties indicated within 100 m of the project area were confirmed with confidence, and eight previously identified sites (or portions thereof) were possibly confirmed:

- A total of 73 previously documented sites were indicated to be located within proximity of the Makai Section; this section overlaps the archaeologically rich Coastal Zone and has experienced relatively thorough (and in places, recent) previous archaeological coverage. The area adjacent to Old Kona Airport Park contains numerous large site complexes; correlation of features observed during the field inspection with these sites proved difficult. Of the 73 previously documented sites indicated within 100 m of the Makai Section, 21 were confirmed with confidence, and features possibly belonging to seven more sites previously recorded by Donham (1990c) were identified.

- A total of 34 previously documented sites were indicated within 100 m of the Mauka Section of the project area; of these, eight were confirmed and a section of one other site (SIHP # -23023, trail) was possibly confirmed.
- One previously documented site was confirmed in the immediate vicinity of the Northern Section (SIHP # -10714 Feature A); the other 11 sites in this area are located well outside the project area. Of the previously documented sites indicated near the project area that were not confirmed, 17 may have been destroyed by prior developments, and the remainder are likely located well outside the current project area.

Additionally, archaeologists documented 16 newly identified archaeological features or clusters of features during the field inspection (CSH-01 through CSH-16). The newly identified features were similar in nature to previously documented sites in the area. The majority of these features/feature complexes (12 total; CSH-04 through CSH-10, and CSH-12 through CSH-16) were located in the Northern Section of the current project area, in areas with only minimal previous archaeological coverage. The newly recorded features in the Northern Section included rock mounds, *pāhoehoe* excavations, a stepping-stone trail, other modified lava features, a lava tube that may contain modifications, and a modern quarrying complex. Three newly identified sites were located in the Makai Section (CSH-01, *ahu*; CSH-02, modified outcrop complex; and CSH-03, circular alignment complex). In the Northern Section, archaeologists documented a newly identified complex of circular alignments (CSH-11).

6.2 Recommendations

In general, efforts to minimize potential effects on historic properties is recommended in the project design phase. Such efforts could include limiting ground disturbance within previously undisturbed areas as much as possible (e.g., propose installation of transmission lines within existing roadbeds or graded areas). Some portions of the project area are of potentially higher sensitivity given their known archaeological content:

- A section of the Māmalahoa Trail (SIHP # -00002) runs parallel to Queen Ka‘ahumanu Highway within the Mauka Section in the vicinity of the proposed SAT facility. A portion of this historic property within the project area has existing mitigations in place associated with the ongoing Queen Ka‘ahumanu Highway Widening Phase 2 project. Impact to the Māmalahoa Trail should be avoided if possible by routing pipelines or other infrastructure through existing breaches along the trail.
- The portion of the Mauka Section relating to the Future Elevated Storage Tank has not been subjected to recent archaeological survey, and was found during the field inspection to contain several previously unrecorded archaeological features and lava tube openings. Lava tubes in this area commonly contain cultural modifications and/or deposits including but not limited to human burials.
- The section of the Initial Phase R-1 Transmission Line approaching the Old Kona Airport Park (Kailua Park) within the Makai Section is in direct proximity to several extensive previously identified site complexes. While many of these features are likely located a safe distance from the current project area, some are directly adjacent and could potentially be impacted. Difficulties in correlating present findings with the previously recorded sites—and the discovery of previously unrecorded features—highlight potential concerns with the existing body of archaeological coverage in this area.

Consultation with the SHPD is recommended regarding project historic preservation requirements. Given the high number of previously identified historic properties, presence of newly documented archaeological features within and in the vicinity of the project area, and likelihood that the project would have an effect on some of these sites, SHPD may require an AIS and/or other form(s) of mitigation.

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Appendix A Site Descriptions

7.1.1 50-10-27-00002 (Māmalahoa Trail) (Wilkinson et al. 2017:19–24; Figure 108)

Monahan et al. (2012) described SIHP # -00002 (the Māmalahoa Trail) as follows:

> SIHP # 50-10-27-00002, the well-known Māmalahoa Trail or Road, extends for miles outside of, and north and south of, the project area .... In its 1995 report, CSH (Walsh and Hammatt 1995) describe this site in general and project-specific terms:
>
> > Site 00002 is an historic cross-*ahupua'a* road commonly referred to as the Mamalahoa Trail. The construction of the road is dated to 1836-1855. It is considered to have been the major seaward road through the region between its construction and 1888, when use of the road became infrequent (Cordy 1991:403, 406). The road, in general, is described as a remarkably straight curb-lined path – typically 2.0 to 3.0 m. wide. In some areas the road surface is raised, with low points in the terrain filled in and leveled with stone.
> >
> > The trail has been used sporadically in late historic and modern times and some parts of the road show evidence of vehicular use. The road has been breached in numerous places between Kailua-Kona and the Keahole Airport in modern times. As a result, the trail exists as a series of discontinuous segments in varying conditions. (Walsh and Hammatt 1995:30)
>
> The portion currently located within the project area was described by CSH in 1995 as follows:
>
> > At Honokohau, Queen Kaahumanu Highway breaches the Mamalahoa Trail and two sections lie within the present project area. On the eastern side of the highway, one 30-40 foot (10 m.) section remains within the project area. It consists of a short ramp section below the present power line. The area surrounding this section has been cleared, presumably during the construction of the present highway. On the western side of the highway, an approximately 490 foot (149 m.) sections lies within the project area . . . This section begins 30 feet (9 m.) west of the present highway pavement edge and extends through the project area at 147 degrees T.N. [true north]. The road continues at the angle beyond the project area boundary and into the Kaloko-Honokohau National Park. This section does not appear to have been previously recorded. (Walsh and Hammatt 1995:32)
>
> The site was revisited during the current [2012] archaeological inventory survey and found to be in the same general physical condition. . .; however, in its current configuration, the Māmalahoa Trail is no longer within the project area on the east, or *mauka*, side.
>
> This trail is subject to protection and preservation under the Highways Act of 1892 (HRS Chapter 264-1(b)) (Na Ala Hele 2008). [Monahan et al. 2012:185–186]

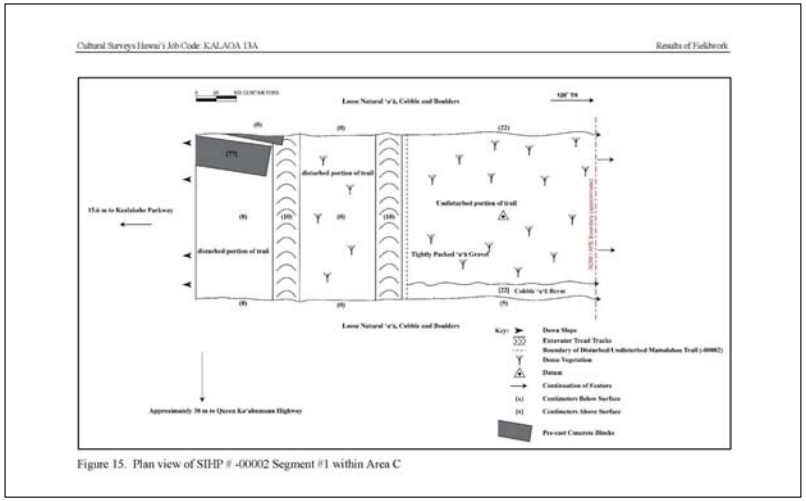


Figure 108. Plan view map of a portion of SIHP # -00002 at Kealakehe Parkway (Segment #2 within Area C, Wilkinson et al. 2017:25)

…SIHP # -00002 is oriented north-south and runs roughly parallel with Queen Ka‘ahumanu Highway within the east or *mauka* side at Area C. This historic property is segmented by the existing Kealakehe Parkway, which runs east to west or *mauka-makai*. Two sections of the historic property are present in Area C. Segment #1 of SIHP # -00002 in Area C is on the south side of the Parkway [within the Mauka Section of the current project area], entering the project area from the south across an *‘a‘ā* flow, oriented parallel to Queen Ka‘ahumanu Highway and perpendicular to Kealakehe Parkway... There is approximately 7 m (23 ft) of the trail segment within Area C of the project area. It is approximately 3.0 m wide. The trail is cut off approximately 2 m (3.2 ft) south of the top of the graded embankment on Kealakehe Parkway’s south shoulder; i.e., SIHP # -00002 has been destroyed from this point to Segment #2 to the north by the creation of the Kealakehe Parkway. A 3.5 m (11.48 ft) section of the trail south of the embankment and within Area C has been disturbed by a tracked machine driven in a perpendicular direction across the trail segment… Pre-cast concrete blocks are present adjacent to and slightly atop the disturbed northeast corner of this segment … The trail has a low cobble and small boulder berm on the *makai* side … No cultural materials were found within Segment #1.

Segment #2 of SIHP # -00002 in Area C is north of the Kealakehe Parkway’s graded shoulder in *‘a‘ā* lava, between the road shoulder and the graded construction base yard at the northeast corner of the Kealakehe Parkway and Queen Ka‘ahumanu Highway intersection … This is a short remnant section of SIHP # -00002, approximately 9 m (29.93 ft) long and 2.5 m (8 ft) wide between the two construction areas, and is bounded by bulldozer push piles at either end ... Directly north of Segment #2, SIHP # -00002 has been demolished by preproject grading within the construction base yard and other development further north. Directly south of Segment #2, SIHP # -00002 is cut by Kealakehe Parkway. The surface of Segment #2 is raised about 30 cm above the surrounding *‘a‘ā* ground surface on the mauka side and is lined with a low cobble and small boulder edging on the *makai* side … A horse shoe fragment (not collected) was observed at the north end of the Māmalahoa Trail Segment #2 …

Both trail segments within supplemental Area C consist primarily of a bed of tightly packed and slightly rounded *‘a‘ā* pebbles and small cobbles edged on the makai side with unhewn rough large cobbles and small boulders of *‘a‘ā*.

7.1.2 50-10-28-05011/21756 (Donham 1990a:A-52)

PHRI: T-94
SITE TYPE: Wall
TOPOGRAPHY: Aa and pahoehoe lava flows sloping to the southwest
VEGETATION: Christmas-berry, koa-haole, lantana, akia. grasses, lauae and scrub brush.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric/historic
FUNCTIONAL INTERPRETATION: Land division
DIMENSIONS: 2220.00 m by 0.70 m by 1.50 m average height.
DESCRIPTION: This wall follows the ahupuaa boundary between Kealakehe and Keahuolu. It consists of aa and pahoehoe, small to medium boulders and small to large cobbles. The wall is bifaced and core-filled. The wall is oriented an average

of c. 220/40 degrees Az. and has a few bends in the eastern section. The east and west ends are currently defined by the boundaries of developed areas, and do not represent the original ends of the wall.

7.1.3 50-10-27-06531 (Reeve et al. 2012:115-116)

Field Number: T-153
Site Type: Complex
Possible Age: Traditional
Possible Function: Habitation/Marker
Description: Site 50-10-27-6531 (T-153) consists of a complex of features including a stone mound (Feature A) and a C-shaped wall (Feature B). The site is located toward the northern boundary of the survey area and north of the east to west running ridge that is the focus of human activity in the area. No surface cultural material was noted at either feature. Both structures appear to have been built during the pre-Contact period, and while Feature A probably served as a marker, Feature B was most probably used as a temporary windbreak shelter.

Feature: A
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-6531 (T-153), Feature A is a badly disturbed stone mound constructed of *pāhoehoe* slabs.

Feature: B
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-6531 (T-153), Feature B is a C-shaped wall constructed of *pāhoehoe* slabs. It is situated c. 5 meters south of Feature A.

7.1.4 50-10-27-06532 (Reeve et al. 2012:116-117)

Field Number: T-197
Site Type: Stone Mound
Artifacts: None Observed
Midden: Present
Skeletal Remains: None Observed
Condition: Fair

Possible Age: Traditional
Possible Function: Burial
Description: Site 50-10-27-6532 (T-197) is a roughly rectangular mound. The site is located toward the northern boundary of the survey area along the northern edge of an east to west running ridge that appears to have been the focus of human activity in the area. The mound is constructed of loosely stacked *pāhoehoe* boulders and slabs. It is in fair condition. Fragments of branch coral were found in the immediate vicinity of the mound, and cowrie shell midden was noted on the ridge to west. Although it may have served as a marker, the presence of branch coral fragments suggest that this mound could possibly represent a burial monument. There are the remnants of what may be possible associated walls and pavings in the vicinity of the Site 50-10-27-6532 (T-197) mound, as well as areas of battering and a chiseled X. This suggests that the area was the local of both Traditional and Historic activity.

7.1.5 50-10-27-07704 (Haun & Henry 2006:96-98)

Site 7704 is a trail that extends across an area of uneven pahoehoe lava at elevations ranging from 38 to 41 ft. This trail was initially documented by Soehren (1980) who assigned it its current site designation. The portion of the site within the project area originates 15.0 m south of the large spoil pile located to the south of the harbor. The trail (Feature A) extends to the south a distance of 428.2 m to where it exits the project area at the boundary between Kealakehe and Keahuolu. The trail is marked by a series of 26 stone cairns (Features B through AA) with Feature B located at the north end and Feature AA located at the south. The trail extends to the south into the Land of Keahuolu an undetermined distance.

The Feature B through AA cairns are comprised of stacked cobbles and small boulders that range in length from 0.3 to 1.0 III (averaging 0.48 m long), in width from 0.19 to 0.95 m (averaging 0.37 m) and in height from 0.14 to 0.83 m (averaging 0.4 m). The individual characteristics of the 26 cairns are summarized in Table 70 and examples of these features are depicted in Figures 42 and 43. Of the 26 cairns, 20 contain fragments of waterworn coral (Features B-K, M, R, T-AA).

Site 7704 is interpreted as a north-south transportation route across the pahoehoe field. Soehren interpreted this site as a trail that, "appears to join the village and pond at Honokohau with the small settlement at Pawai in Keahuolu (1980:2). Donham's survey in Keahuolu did not identify a trail within her survey area; however, she did identify a complex of cairns, mounds, alignments wall and a boulder concentration (Site 13286) that is depicted on her site location map in a linear configuration of features that terminates inland of Pawai Bay (l990b: 16). It is possible that this site represents the southern end of Site 7704. According to Soehren:

It is delineated by coral pebbles ranging in size from one inch to six inches and spaced five to ten feet apart ... The trail appears to join the village and pond at Honokohau with the small settlement at Pawai in Keahuolu ... It was traced for

1600 ft across the natural basin in which the project is located; to the north it has been obliterated by the small boat harbor... The trail, or alignment of coral pebbles, is about as straight as a man on foot could make it, and pays little regard to irregularities in the terrain which make following it precisely rather difficult in places. In the absence of any abrasion of the lava surface, kerbstones, causeways over low places or other evidence of frequent use, it probably represents a "preliminary route selection" for a nineteenth century horse trail (Apple 1965) subsequently abandoned, perhaps in favor of the "Old Mamalahoa Trail" farther inland (1980:2).

The northern portion of the trail, north of the Feature B cairn has been buried beneath the large spoil pile that was created during the dredging of the harbor. The site is altered and in fair to good condition.

7.1.6 50-10-27-10714 A, B (Road to the Sea) (Monahan et al. 2012:258-260, 267-271) (Figure 109, Figure 110, Figure 111, Figure 112, Figure 113)

Feature A
Temp. Site No.: T-091010-4 (Monahan et al. 2011)
Site Type: Trail—Part of the Trail System "Road to the Sea"
No. of Features: 1
Functional Interpretation: Transportation
Probable Age: Pre-Contact with continued use in Historic Era
Overall Dimensions: Approximately 56.6 m long in the project area
Topography: Undulating *pāhoehoe* flow, level to slightly-sloping
Elevation: 75 ft (23 m) AMSL (in the project area)
Description: SIHP # 50-10-27-10714 (Feature A) is a trail located approximately 88 m northwest of the intersection of Hina Lani Street and the Queen Ka‘ahumanu Highway within the portion of the project area that is adjacent to the Kaloko-Honokōhau National Historical Park (…). The trail is roughly oriented E/W and measures 56.6 m long within the project area. Within the project area, the trail lacks any formal construction features such as stepping stones or curbing. The trail can be recognized within the project area by observing subtle wear-pattern / color variation on the lava flow [Figure 109, Figure 110].

Other previous archaeological studies such as Renger (1970), Cordy et al. (1991), Wolforth et al. (2005) and Bell et al. (2009), as well as consultation with trails specialists with the NPS, suggest this trail portion is part of a more extensive trail complex known as the "Road to the Sea," which generally follows the Kaloko/Kohanaiki *ahupua'a* boundary and extends from the Kohanaiki Homesteads (mauka) to Kaloko Fishpond (at the coast). *Mauka* of the project area, this trail has been designated SIHP # -10714 (by Wolforth et al. 2005), and the portion within the current project area is herein designated Feature A (specific to the current project).

This trail also connects within the national park with other trails segments designated SIHP #-2233 (D13-81) and SIHP # -2183.

. Photograph of SIHP # 10714 Feature A, view to southwest

Figure 109. Photos of SIHP #-10714 Feature A; views to the southwest (top) and west (bottom) (Monahan et al. 2012:259)

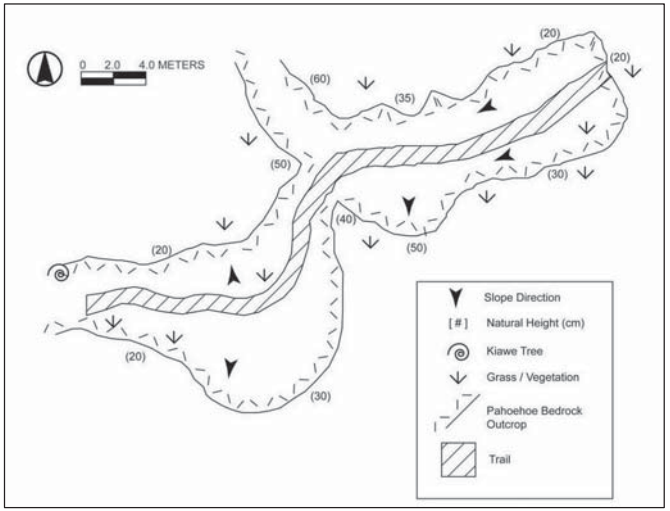


Figure 110. SIHP # -10714 Feature A plan view from Monahan et al. (2012:260)

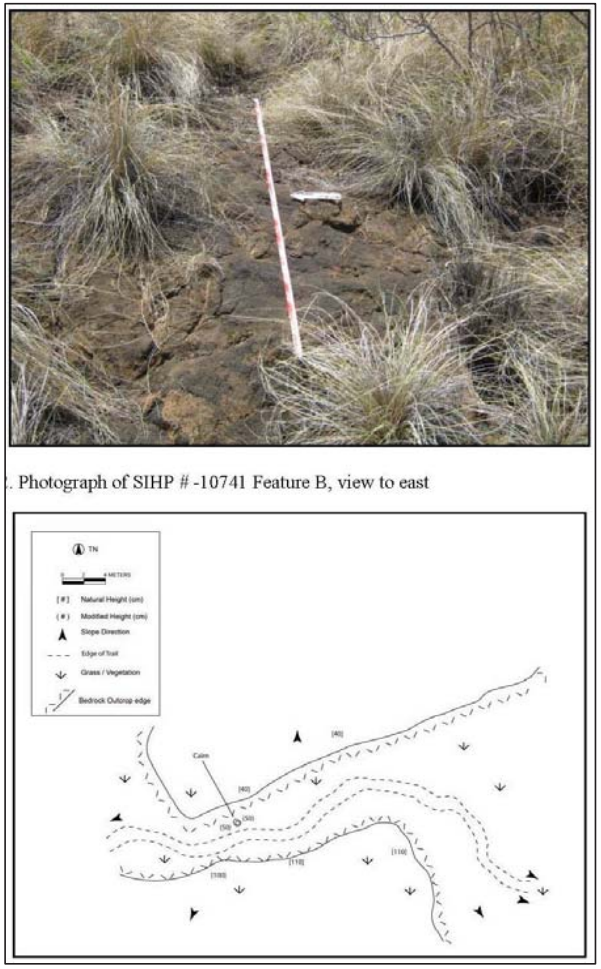
It is important to note that CSH has identified three portions of this “Road to the Sea Trail” within the project area. NPS trail specialists have suggested these three portions should all be considered part of SIHP # -10714, and CSH concurs with this recommendation. In the current report, these three trail portions are treated separately (although they are all given the same site number, with different feature numbers) in keeping with the south-to-north presentation and description of cultural resources.

This trail is subject to protection and preservation under the Highways Act of 1892 (HRS Chapter 264-1(b)) (Na Ala Hele 2008).

Previous significance evaluations for SIHP # -10714 by Wolforth et al. (2005) and Bell et al. (2009) have recommended this resource eligible for the Hawai‘i Register of Historic Places under Criteria D and E.

Feature B
Temp. Site No.: T-091010-5 (Monahan et al. 2011)
Site Type: Trail—Part of the Trail System “Road to the Sea”
No. of Features: 1
Functional Interpretation: Transportation
Probable Age: Pre-Contact with continued use in Historic Era
Overall Dimensions: Approximately 35.6 m long in the project area
Topography: Undulating pāhoehoe flow, level to slightly-sloping
Elevation: 75 ft (23 m) AMSL (in the project area)
Description: SIHP # 50-10-27-10714 (Feature B) is a trail located approximately 130 m northwest of the intersection of Hina Lani Street and the Queen Ka‘ahumanu Highway within the portion of the project area that is adjacent to the Kaloko-Honokōhau National Historical Park … The trail is roughly oriented E/W and measures 35.6 m long within the project area. Within the project area, the trail lacks any formal construction features such as stepping stones or curbing. The trail can be recognized within the project area by observing subtle wear-pattern / color variation on the lava flow [Figure 111]. Two stacked boulders located alongside (just north of) SIHP # -10714 Feature B may have served as a trail marker [Figure 111, Figure 112, Figure 113; former SIHP # -]. The two stacked *pāhoehoe* boulders are situated on top of a smooth, level *pāhoehoe* flow next to the trail and measure 0.4 m N/S by 0.3 m E/W with a maximum height of 0.5 m above the adjacent ground surface. A third boulder, located in the immediate vicinity, may have been displaced from the top of the mound.

Other previous archaeological studies such as Renger (1970), Cordy et al. (1991), Wolforth et al. (2005) and Bell et al. (2009), as well as consultation with trails specialists with the NPS, suggest this trail portion is part of a more extensive trail complex known as the “Road to the Sea,” which generally follows the Kaloko/Kohanaiki *ahupua‘a* boundary and extends from the Kohanaiki Homesteads (mauka) to Kaloko Fishpond (at the coast). *Mauka* of the project area, this trail has been designated SIHP # 10714 (by Wolforth et al. 2005), and the



. Photograph of SIHP # -10741 Feature B, view to east

Figure 111. Photo and plan view of SIHP # -10714 Feature B (Monahan et al. 2012:269)

Figure 112. Photo of marker along SIHP # -10714 Feature B (Monahan et al. 2012:270)

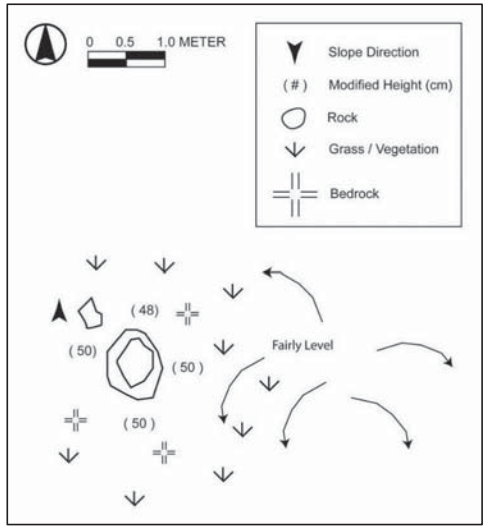


Figure 113. SIHP # -10714 Feature B plan view (Monahan et al. 2012:271)

portion within the current project area is herein designated Feature B (specific to the current project).

This trail also connects within the national park with another trail segment designated SIHP #2240 (D13-89).

It is important to note that CSH has identified three portions of this "Road to the Sea Trail" within the project area. NPS trail specialists have suggested these three portions should all be considered part of SIHP # 10714, and CSH concurs with this recommendation. In the current report, these three trail portions are treated separately (although they are all given the same site number, with different feature numbers) in keeping with the south-to-north presentation and description of cultural resources.

This trail is subject to protection and preservation under the Highways Act of 1892 (HRS Chapter 264-1(b)) (Na Ala Hele 2008). Previous significance evaluations for SIHP # -10714 by Wolforth et al. (2005) and Bell et al. (2009) have recommended this resource eligible for the Hawai'i Register of Historic Places under Criteria D and E.

7.1.7 50-10-27-13182 (Donham 1990a:A-6)

PHRI: T-8
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: On an exposed pahoehoe outcrop along a gentle, southwest-facing slope.
VEGETATION: 'Ilima, koa-haole, uhaloa, and fountain grass.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Marker-agriculture
DESCRIPTION: The overall dimensions of this site measure c. 12.0 m N-S by 12.0 m E-W. The site consists of a cairn and a pahoehoe excavation, No portable or cultural remains were observed.

FEATURE A: Cairn
FUNCTION: Marker
DIMENSIONS: 0.50 m by 0.50 m by 0.70 m
DESCRIPTION: The cairn consists of a loosely piled formation five courses high and made of pahoehoe cobbles. The cairn is situated on top of a pahoehoe outcrop and the area around it is paved with pebbles.

FEATURE B: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 4.50 m by 3. 70 m by 0.25 m
DESCRIPTION: Feature B is located 8 m from Feature A at 352 degrees Az. The excavation is generally cleared of rocks, but the area around the excavation may have been paved.

7.1.8 50-10-27-13194 (Walsh and Hammatt 1995:49–51)

State Site #: 13194
Site Type: Trail
Function: Transportation
Features (#): 1
***Ahupua‘a*:** Kealakehe
Description: Site 13194 is a stepping stone trail originally identified by PHRI in 1989 during the inventory survey for the Kealakehe Planned Community (Donham 1990[a]). The site was described as follows:

> The trail consists of a cleared and packed path through the aa with spaced pahoehoe slabs that are inset into the aa. Most of the slabs are a minimum of 0.20 m. and a maximum of 0.35 m in size. The rest of the slabs are small cobbles. The western end of the trail is cut off by the Queen Kaahumanu Highway. Efforts to relocate it on the west side of the highway were unsuccessful. To the east of the highway, the Mamalahoa Trail seems to have crossed over this trail. To the east of the Mamalahoa Trail, it has been broken by two different bulldozer paths over the aa. At the eastern end of the aa, the trail appears to make a sharp turn to the north. This turn may be an intersection of two trails; efforts to locate a continuation over the pahoehoe to the north and east were unsuccessful. (Donham 1990:A-14)

The trail was recommended for preservation with interpretive development and has since been included in two preservation plans (Jensen et a1. 1992, Borthwick and Hammatt 1992[b]).

A field check of the western end of the trail during the present survey confirmed that portion of the trail has been preserved as is. The trail begins 95 feet (29 m.) from the highway pavement edge and extends 85 feet (26 m.), where it intersects with the Mamalahoa Trail. The trail continues east of the Mamalahoa Trail for another 73 feet (22 m.) where it becomes obscured by a bulldozed path. The trail continues within or just adjacent to the bulldozed path for roughly 100 feet (30 m.), beyond which it was observed to continue inland apparently undisturbed.

7.1.9 50-10-27-13195 (Donham 1990a:A-14, A-16)

PHRI: T-22
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Slightly undulating pahoehoe flow; an aa flow c. 40.0 m to the north.
VEGETATION: Fountain grass, koa-haole and 'ilima
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Histone
FUNCTIONAL INTERPRETATION: Historic marker
DESCRIPTION: These cairns are located c. 9.0 m apart in a N-S line. They are possible survey markers.

FEATURE A: Cairn
FUNCTION: Historic marker
DIMENSIONS: 1.00 m by 0.80 m by 0.80 m
DESCRIPTION: This cairn is the northernmost of the two and consists of large aa cobbles, stacked with no apparent core fill. The cairn is pyramid shaped and circular at the base.

FEATURE B: Cairn
FUNCTION: Historic marker
DIMENSIONS: 1.10 m by 0.90 m by 0.70 m (approx.)
DESCRIPTION: This is the southernmost cairn; it consists of large aa cobbles and is pyramid shaped, with a circular base. The cairn is partially collapsed. This cairn appears to be located on the Mamalahoa Trail.

7.1.10 50-10-27-13253 (Burgett and Rosendahl 1992:A-28; individual feature descriptions not included)

SITE NO.: State: 13253
SITE TYPE: Complex (20 Features) [4 more documented by O‘Hare and Goodfellow 1994]
TOPOGRAPHY: The site is in a shallow ravine, at the base of a major a‘a flow to the south; a high pahoehoe slope to the north.
VEGETATION: Christmas-berry, fountain grass and other varieties of grass, *koa-haole*, and *‘ilima*.
SITE ELEVATION: [-]
CONDITION: Fair-good
INTEGRITY: Minor alteration to Feature A; Feature K bulldozed
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation/temp. habitation/burial
DESCRIPTION: The site complex consists of four platforms (Features A, B, J, and Q), thirteen terraces (Feature C–I, L, M, O, P, S, and T), one trail (Feature K), a modified outcrop (Feature N), and a modified sink (Feature R).

7.1.11 50-10-27-13253 Feature K (Donham 1990a: A-58)

FEATURE K: Stepping-stone trail
FUNCTION: Transportation
DIMENSIONS: 38.00 m by 0.8 maximum width
DESCRIPTION: The trail consists of a narrow corridor of crushed and packed aa clinkers with variously-spaced, inset pahoehoe slabs. The slabs average 0.30 m in diameter and are spaced from 0.40 to 2.00 m apart along the intact section of the trail. The western end of the trail is currently at the eastern edge of an extensive bulldozed area, 35.00 m from Feature A at 310 degrees Az. At the time of Soehren's survey (1975), the trail continued west to the coastal ponds at Honokohau (Soehren 1977:2).

The intact portion of the trail follows a generally east-west orientation, while following the upper, northern edge of the aa flow. At the west end, orientation is c.

50 degrees Az., then shifts to 80 degrees near the eastern end, at Feature I. Along the course of the trail, there are two branches that cut north, down the face of the flow to Features E, F and G. These branches do not have stepping-stones. There is an unmarked survey datum pipe in the center of the trail, above Feature E.

7.1.12 50-10-27-13284 (Donham 1990c:A-30)

PHRI: T-32
SITE TYPE: Complex (4 Features)
TOPOGRAPHY: Small ridge of smooth and ropy pahoehoe.
VEGETATION: Thick to moderate density of grass, small 'ilima and koa-haole and kiawe bushes.
ELEVATION: c. 9-20 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Possible agriculture
DESCRIPTION: Overall site complex area measures c. 55.0 m (N-S). It consists of pahoehoe slabs and blocks placed in four concentrated areas.

FEATURE A: Rock concentration
FUNCTION: Possible agriculture
DIMENSIONS: 1.27 m by 1.20 m by 0.40 m
DESCRIPTION: Feature A consists of seven pahoehoe slabs with surface cortex and eight pahoehoe blocks. The blocks range in size from 15x11x3 to 42x28x17 cm. Some of the stones are placed on edge in a small concentrated area and stacked to two courses high.

FEATURE B: Rock concentration
FUNCTION: Possible agriculture
DIMENSIONS: 2.90 m by 2.80 m by 0.30 m
DESCRIPTION: A rock concentration consisting of 20+ pahoehoe slabs stacked one to two courses high on top of smooth pahoehoe surface. The slabs range in size from 16x13x4 cm to 60x27x6 cm. No obvious form or pattern is evident. This feature is located 46.80 m from feature A at 12 degrees Az.

FEATURE C: Rock concentration
FUNCTION: Agriculture
DIMENSIONS: 2.60 m by 2.10 m by 0.52 m
DESCRIPTION: Feature C is a pile of 20 pahoehoe slabs situated on the northeast slope of a ridge. It lies on smooth, ropy pahoehoe and is surrounded by fountain grass 'ilima, kiawe trees and an unidentified weed. The dimensions of the slabs range from 17x 10x4 cm to 88x42x 11 cm. This feature is located 53.5 m from Feature A at 348 degrees Az.

FEATURE D: Rock concentration
FUNCTION: Possible marker
DIMENSIONS: 1.70 m by 1.50 m by 0.30 m

DESCRIPTION: Amorphous in plan view, it is constructed with pahoehoe blocks and slabs.

7.1.13 13286 (Donham 1990c:A-30-A-32)

PHRI: T-34
SITE TYPE: Complex (10 Features)
TOPOGRAPHY: Smooth pahoehoe ridge oriented c. NE-SW.
VEGETATION: Moderate density of fountain grass, small 'ilima and koa-haole bushes.
ELEVATION: c. 13-17 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Indeterminate/ markers/possible agriculture
DESCRIPTION: Overall complex area measures c. 31.0 m (NE-SW) by 74.0 m (NW-SE). The site consists of an alignment of four cairns (Feature A), a mound (Feature B), an alignment (Feature C), a rock concentration (Feature D), a mound (Feature E), a wall (Feature F), and four concentrated areas of boulders, slabs and stacked pahoehoe slabs (Features G to J).

FEATURE A: Alignment of cairns
FUNCTION: Possible marker
DIMENSIONS: 2.14 m by 0.64 m by 0.40 m
DESCRIPTION: Feature A consists of four short stacks or piles of pahoehoe slabs in an alignment that is oriented c. SE-NW. The cairns are single stacked to five courses high. The slabs of pahoehoe are fairly uniform in size and are placed on top of smooth pahoehoe. The stacks range in dimensions from 30x28x16 cm to 77x50x40 cm.

FEATURE B: Mound
FUNCTION: Possible agriculture/marker
DIMENSIONS: 8.25 m by 2.10 m by 0.21 m
DESCRIPTION: This feature lies on top of a small ridge. It consists of a circular pile of pahoehoe slabs on an area of smooth pahoehoe. Twenty-five pahoehoe slabs have been moved from an unknown area and placed in a nearly circular form on top of a small ridge. The northwest side of the feature is double stacked and the southeast side of the feature is single stacked. The smallest pahoehoe slab measures c. 9x5x2 cm and the largest pahoehoe slab measures c. 30x39x6 cm. This feature could possibly be a collapsed cairn. It is located 12.20 m from Feature A at 323 degrees Az.

FEATURE C: Alignment/low wall
FUNCTION: Indeterminate
DIMENSIONS: 1.36 m by 0.62 m by 0.26 m
DESCRIPTION: A small semicircular alignment of pahoehoe slabs, single to three slabs high. It consists of two single slabs of pahoehoe placed next to each

other with a stack of three slabs on one end. The slabs range in size from 36x25xl0 cm to 55x50x6 cm. Located 5.70 m from Feature A at 28 degrees Az.

FEATURE D: Rock concentration
FUNCTION: Possible marker
DIMENSIONS: 0.50 m by 0.38 m by 0.17 m
DESCRIPTION: A concentration of six small pahoehoe slabs, four of which arc in a single stack. Located 5.70 m northeast from Feature C.

FEATURE E: Mound
FUNCTION: Marker/indeterminate
DIMENSIONS: 3.40 m by 2.15 m by 0.31 m
DESCRIPTION: Two small stacks of pahoehoe slabs c. 1.65 m apart with other scatter of slabs in the surrounding area. The south stack is c. 20+ small pahoehoe slabs arranged in a low circular pile measuring c. 1.0 m (N-S) by 0.75 m (E-W) with other slabs scattered to the south. The north stack consists of four pahoehoe slabs one on top another and measuring c. 0.4 7 m (E-W) by 0.40 m (N-S). Three additional slabs are to the southeast. Feature E is constructed on top of smooth, fairly flat pahoehoe, and located 13.60 m from Feature A at 60 degrees Az.

FEATURE F: Wall
FUNCTION: Indeterminate
DIMENSIONS: 2.85 m by 0. 70 m by 0.60 m
DESCRIPTION: Stacked pahoehoe blocks on the lip of a sinkhole. The wall is constructed with single stacked pahoehoe blocks stacked c. 3-4 courses high. The wall is oriented E-W. The height on the west side is c. 0.60 m and on the east side it is c. 0.30-0.50 m high. The average block measures c. 28x22x 12 cm. It is located 45.30 m from Feature B at 296 degrees Az.

FEATURE G: Boulder concentration
FUNCTION: Possible agriculture
DIMENSIONS: 6.30 m by 5.10 m by 1.20 m
DESCRIPTION: A concentration of angular boulders partially filling a sinkhole which contains an overhang along the north rim. A small cleared area is situated at the opening of the overhang. The boulders are randomly placed in the sinkhole, with the average size of the angular boulders measuring c. 50 x 30 x 30 cm. Located 23.10 m from Feature F at 354 degrees Az.

FEATURE H: Stacked pahoehoe
FUNCTION: Possible marker
DIMENSIONS: 0.88 m by 0.52 m by 0.31 m
DESCRIPTION: Four slabs of pahoehoe stacked one on top of another atop flat, smooth pahoehoe blister. No vegetation within 2.0 m of the feature. Fountain grass and small 'ilima comprise the vegetation.

FEATURE I: Stacked pahoehoe
FUNCTION: Possible marker
DIMENSIONS: 2.60 m by 1.72 m by 0.21 m

DESCRIPTION: Feature I consists of three columns of stacked pahoehoe slabs. The west column consists of two single slabs. The middle column consists of four slabs, one to three courses high. The east column consists of four slabs, one to two courses high. The slabs range in size from 30x26x5 cm to 74x65x6 cm. The feature is located 12.80 m northeast from Feature F.

FEATURE J: Stacked pahoehoe
FUNCTION: Indeterminate
DIMENSIONS: 1.20 m by 0.95 m by 0.28 m
DESCRIPTION: Feature J consists of two columns of pahoehoe slabs stacked on top of a smooth pahoehoe surface. The NE column consists of two stacks, stacked two slabs high. The SW column consists of three stacks, stacked one-two slabs high. All slabs measure c. 37x28x4 cm.

7.1.14 50-10-27-13288 (Donham 1990c:A-34)

PHRI: T-37
SITE TYPE: Retaining wall/terrace
TOPOGRAPHY: Undulating pahoehoe and aa lava flows. 1-2% slope to the south. Bedrock outcrop immediately adjacent to the northwest.
VEGETATION: Christmas-berry, kiawe, fountain grass, 'ilima, and noni.
ELEVATION: c. 22 feet
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Loading ramp
DIMENSIONS: 11.50 m by 1.00 m by 1.30 m
DESCRIPTION: A stacked wall constructed with basalt boulders and cobbles. It is oriented NE-SW and built on the southeast side of a bedrock outcrop. The wall is stacked three to six courses high and c. 0.80-1.0 m wide. A terrace abuts the bedrock and is c. 6.0-6.25 in wide. The surface of the terrace is flat and roughly level with areas of asphalt paving. There is a bulldozed slope oriented to the northeast from the terrace for c. 15.0 m to a jeep road. One short section of this slope also has a faced retainment oriented N-S. 2.9 m wide, one to three courses high for a height range of 0.25-0.5 m. The terrace and the bulldozed slope may have been used for dumping or for asphalt tar preparation. Immediately adjacent to the southwest end of the terrace is a large pile of metal tar barrels. Other historic rubbish is in the immediate area.

7.1.15 50-10-27-13289 (Donham 1990c:A-34-A36)

PHRI: T-38
SITE TYPE: Complex (15 Features)
TOPOGRAPHY: Undulating field of smooth and ropy pahoehoe with numerous natural crevices.
VEGETATION: Moderate density of grass, small 'ilima, and lantana bushes, some kiawe, and small Christmas-berry trees.

ELEVATION: c. 9-10 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Quarry/possible agriculture
DESCRIPTION: Overall complex area measures c. 49.75 m (N-S) at 358 degrees by 27.14 m (E-W). The site consists of 15 quarried holes with associated excavated blocks. The blocks range in size from 9x6x4 cm to 78x3lx28 cm. Thin soil deposits are in Features I and J. Four waterworn basalt cobbles and one piece of coral are present.

FEATURE A: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.01 m by 0.92 m by 0.45 m
DESCRIPTION: This square-shaped excavation is in a large cracked blister. The floor interior is cleared and all faces are excavated. The thickness of the excavated faces ranges from 0.27-0.33 m. The excavated blocks are north, east, and south of the excavation. One piece of waterworn coral is located c. 2.24 m from the southwest comer of Feature A.

FEATURE B: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 5.65 m by 3.14 m by 0.55 m
DESCRIPTION: A large L-shaped excavated area quarried in a large cracked blister. Excavated in smooth and ropy pahoehoe with the quarried blocks inside of the excavated hole and around all edges. The thickness of the excavated face is 0.17-0.31 cm with the depth ranging from 0.32 m to 0.55 m below surface.

FEATURE C: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.68 m by 1.05 m by 0.41 m
DESCRIPTION: A small excavation with a partially cleared floor quarried into a large pahoehoe blister. The excavated blocks are piled to the east and south of the excavation. The thickness of the excavated face is 0.16 m and the depth ranges from 0.13 m to 0.41 m below surface.

FEATURE D: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 2.04 m by 0.95 m by 0.42 m
DESCRIPTION: Oblong shape in plan, the interior is cleared except for a few angular cobbles. The quarried blocks are placed exterior of and along the western half of the feature. A waterworn cobble/boulder with one battered end lies on the southeast floor of the feature. It measures c. 19x 12x8 cm. The thickness of the excavated face ranges 18-20 cm. Old pahoehoe is visible as the interior floor surface.

FEATURE E: Pahoehoe excavation
FUNCTION: Quarry

DIMENSIONS: 0.54 m by 0.39 m by 0.48 m
DESCRIPTION: Triangular shape in plan it is mostly cleared of quarried material. The quarried material is placed north of the feature. The thickness of the excavated face is 19-23 cm.

FEATURE F: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.30 m by 1.17 m by 0.45 m
DESCRIPTION: A fully excavated and cleared pahoehoe blister. Quarried blocks form a semicircular shape on the southwest side of the pahoehoe excavation. There are blocks within the feature that are possibly natural. The thickness of the excavated face ranges from 17 cm to 29 cm.

FEATURE G: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 0.80 m by 0.30 m by 0.49 m
DESCRIPTION: Feature G consists mostly of a natural crack along a blister from which rocks were removed. The quarried blocks were removed and placed on the southwest and west side of the feature. The thickness of the excavated face is c. 23 cm.

FEATURE H: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 0.65 m by 0.60 m by 0.23 m
DESCRIPTION: A small excavated crack with a cleared floor. The quarried blocks are placed south, east, and west of the excavation. The maximum depth of the hole is c. 0. 7 m. A small waterworn pebble is present c. 1.87 m at 193 degrees from the south comer of Feature H.

FEATURE I: Pahoehoe excavation
FUNCTION: Quarry/possible agriculture
DIMENSIONS: 0.90 m by 0. 76 m by 0.20 m
DESCRIPTION: Roughly rectangular shape in plan, with quarried blocks placed c. 0.50 m to the northwest. The thickness of the excavated face is c. 15-20 cm. A deposit of brown, gravelly soil loam, c. 0.05 m thick, occurs in the interior floor of Feature I.

FEATURE J: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.88 m by 1.00 m by 0.38 m
DESCRIPTION: A rectangular shaped collapsed blister with three faces excavated and with some displacement of broken cobbles. The floor interior is fairly cleared of quarried material. The thickness of the excavated face is 0.14-0.22 m. The depth ranges from 0.22-0.38 m below surface. One waterworn basalt hammerstone measuring c. 22x23x17 cm with two battered comers is in the southeast comer of Feature J.

FEATURE K: Pahoehoe excavation

FUNCTION: Quarry
DIMENSIONS: 2.69 m by 1.14 m by 0.22 m
DESCRIPTION: Rectangular shape in plan, all faces are excavated. The floor interior is fairly cleared with blocks placed east and west of the excavation. The depth of the feature ranges between 0.45-0.63 m below surface. Two layers of pahoehoe area are excavated and the thickness of the excavated face averages 0.22m.

FEATURE L: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 2.22 m by 1.15 m by 0.43 m max. depth
DESCRIPTION: A collapsed blister with three excavated faces. The floor interior is cleared with the quarried blocks placed along the north and southwest edges. The thickness of the excavated faces are 0.9-0.28 m. The range of depth is 0.15-0.43 m below surface. One waterworn basalt hammerstone measuring c. 35x28x 18 cm is present c. 1.45 m southeast of Feature L. It shows evidence of battering on one end.

FEATURE M: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 2.34 m by 2.20 m by 0.62 m maximum depth
DESCRIPTION: Generally rectangular shape in plan with all faces excavated. The floor is partially cleared with quarried blocks in the hole and around the edges. The thickness of the excavated face is 0.21 to 0.37 m. The depth range is 0.40 to 0.62 m below surface. It is situated within a small outcrop of pahoehoe blister that consists of slight faulting and cracks at the north end of the site. One mammal bone fragment is present in the southeast comer of the excavated hole.

FEATURE N: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 0.36 m by 0.00 m by 0.31 m
DESCRIPTION: A small collapsed area with one face excavated. The excavated blocks are removed and the floor interior is clear of material. The thickness of the excavated face averages 0.22 m. It is situated on a small outcrop of pahoehoe at the north end of the site.

FEATURE O: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 0.46 m by 0.00 m by 0.32 m
DESCRIPTION: A small cracked and partially collapsed blister with an excavated face along the NW side of the collapse. Quarried blocks occur inside the excavation. Thickness of the excavated face averages 0.16 m.

7.1.16 50-10-27-13290 (Donham 1990c:A-36-A-38)

PHRI: T-39
SITE TYPE: Complex (6 Features)
TOPOGRAPHY: The site is situated on uneven pahoehoe flow with collapsed blisters, cracks and faulted areas.

VEGETATION: Moderate density of grass, small lantana, and 'ilima bushes.
ELEVATION: c. 9-10 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Quarry/agriculture
DESCRIPTION: The overall complex area measures c. 35.9 m at 160 degrees by 7.45 m. The quarried blocks range in size from 12x9x5 cm to 42x36x29 cm and are either in the excavations or around the perimeters. A large waterworn basalt hammerstone is present on the site; no soil was observed in the excavations.

FEATURE A: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.83 m by 1.72 m by 0.48 m
DESCRIPTION: Feature A is a blister with all faces excavated and with the quarried blocks placed along the northeast edge. There are also a few blocks on the feature floor. The thickness of the excavated face is 0.29 m.

FEATURE B: Pahoehoe excavation Figure A-13
FUNCTION: Quarry
DIMENSIONS: 2.53 m by 0.47 m maximum depth
DESCRIPTION: Feature B consists of an excavation along a faulted face, 2.79 m southeast from Feature A. Thickness of the excavated pahoehoe face is 0.24 m. The quarried blocks are in a concentrated area east of the excavation.

FEATURE C: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.78 m by 0.85 m by 0.74 m
DESCRIPTION: Feature Cis situated at the south end of a small pahoehoe ridge, 14.1 m south from Feature A. All faces are mined with the associated blocks concentrated to the east. The floor is partially cleared of excavated blocks. The thickness of the excavated face is 0.39 m.

FEATURE D: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 0.82 m by 0.51 m by 0.33 m
DESCRIPTION: Feature 0 is a blister excavation, 30.93 m south from Feature A. It shows evidence of all faces being quarried with the associated blocks located around the excavated hole. The thickness of the excavated face is 0.22 m. One waterworn basalt measuring c. 29x 19x 17 cm with some evidence of battering is present 0.93 m north of Feature D. It is located on the north to west side of a large collapsed blister.

FEATURE E: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.35 m by 1.00 m by 0.63 m
DESCRIPTION: Feature E consists of a blister excavation. 30.35 m southeast from Feature A. It shows evidence of all faces being quarried and has been cleared

of loose rubble. The associated blocks are located around the excavated hole. The thickness of the excavated face is 30 cm. The depth ranges from 0.5 Ito 0.63 m below surface. It is located on the north to west side of a large collapsed blister.

FEATURE F: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 3.96 m by 1.40 m by 0.47 m
DESCRIPTION: A blister excavation with evidence of all faces being quarried. The associated blocks are located around the perimeter of the excavated hole. The thickness of the excavated face is 0.20 to 0.24 m. The depth of the hole ranges from 0.34 to 0.47 m below ground surface. It is located on the north and west side of a large collapsed blister, 31.93 m southeast from Feature A.

7.1.17 50-10-27-13291 (Donham 1990c:A-38)

PHRI: T-40
SITE TYPE: Complex (6 Features)
TOPOGRAPHY: Gently undulating smooth and ropy pahoehoe with natural cracks. The surface area is littered with pahoehoe pebbles.
VEGETATION: Moderate thick density of grasses, small 'ilima, kiawe bushes, and two small Christmas-berry trees.
ELEVATION: c. 9 feet
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Quarry
DESCRIPTION: Overall complex area measures c. 14.0 mat 272 degrees by 17.5 m. The site consists of six pahoehoe excavations (Features A-F). No soil or cultural deposits were observed in or around the excavations. A single piece of waterworn coral is present near Feature A. There appears to be some bulldozer activity to the southeast of the site area. c. 10-20 m. It is probably associated with a nearby roadway.

FEATURE A: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 4.43 m by 2.44 m by 0.47 m
DESCRIPTION: Feature A is an excavated pahoehoe blister. It is roughly rectangular shape in plan with associated blocks piled along the edge to the south. Some blocks are present on the floor surface. The overall feature, including the quarried block pile, measures c. 7.37 mat 115 degrees by 4.84 m. The thickness of the excavated face is 0.33 m. The excavated blocks average size measures c. 36x20x16 cm. One piece of waterworn coral is present.

FEATURE B: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.36 m by 1.22 m by 0.54 m
DESCRIPTION: Generally rectangular shape in plan, Feature B consists of an excavated pahoehoe blister. The excavated blocks are piled along the southern edge

and scattered on the floor interior. The thickness of the excavated face is 0.21 m on the southeast side and 0.25 m on the northwest side. The maximum depth ranges from 0.46 to 0.54 m below surface. This excavation is 0.52 m east from Feature A.

FEATURE C: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 3.12 m by 2.00 m by 0.45 m
DESCRIPTION: Feature C consists of an excavated pahoehoe blister, 5.62 m east from Feature B. It is roughly rectangular shape in plan, and all faces show evidence of quarrying. The associated quarried blocks are piled along the northern and the western edge. The total area including the excavated hole and the quarried block piles measures 4.73 m at 74 degrees by 5.49 m. The thickness of the excavated face measures 0.32 m. The average quarried block size is 35xl9xl5 cm.

FEATURE D: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 2.1.8 m by 1.35 m by 0.46 m
DESCRIPTION: Feature D is an excavated pahoehoe blister, 5.6 m southeast from Feature A. It is generally rectangular shape in plan, and excavated blocks are stacked on all sides of the excavated area. The average block size measures c. 20x 16 x27 cm. The thickness of the excavated face is 0.26 m.

FEATURE E: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.90 m by 1.12 m by 0.47 m
DESCRIPTION: Feature E is an excavated pahoehoe blister located adjacent 10 Feature D. It is generally rectangular shape in plan, with an excavated face thickness of 0.30 m. The average block size measures 20xl6x27 cm.

FEATURE F: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 2.75 m by 1.06 m by 0.48 m
DESCRIPTION: An excavated crevice, it is in an area of natural collapse in which large and small angular rocks were removed and placed northwest of the feature. Feature F contains three faces that are excavated with three to four large rocks within the excavation. It is located 2.10 m northwest from Feature A.

There are small angular blocks to the east that may have naturally collapsed into the feature interior. There are c. 100+ excavated blocks in and around the feature. The average size of the blocks is 27x22x18 cm. The overall feature dimensions including the scattered blocks measures c. 5.68 m (E-W) by 3.85 m (N-S).

7.1.18 50-10-27-13292 (Donham 1990c:A-39)

PHRI: T-41
SITE TYPE: Complex (18 Features)
TOPOGRAPHY: Terrain consists of a ridge of faulted and cracked smooth and ropy pahoehoe that is oriented c. N-S.

VEGETATION: Sparse fountain grass, a few small lantana and 'ilima bushes, and two Christmas-berry trees on the a ridge.
ELEVATION: c. 9 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Quarry/possible agriculture
DESCRIPTION: The overall site complex consists of 18 pahoehoe excavations. The total area measures c. 5290 m (N-S) by 17.5 m (E-W). The excavated areas range in size from c. 0.66-4.60 m x 0.4-1.82 m with face thicknesses of c. 0.10-0.32 m and total depths of c. 0.54-0.61 m below surface. The pahoehoe excavations consists of eight fault excavations, six blister excavations, three crevices and one collapsed blister excavation.

The pahoehoe excavation complex contains c. four excavated faces per feature. Six of the features have totally cleared floors and within four of these there are no associated blocks present. The remaining features have quarried blocks within the excavations or in close proximity to the excavated edges. The blocks range in size from 8x7x9 cm to 55x42x26 cm. One waterworn basalt with evidence of battering marks was present along the southeast boundary of the site. Three Cypraeidae shell fragments were also observed scattered on the site surface. No soil was observed in the excavations.

7.1.19 50-10-27-13293 (Donham 1990c:A-39)

PHRI: T-42
SITE TYPE: Complex (9 Features)
TOPOGRAPHY: Situated between two low ridges of pahoehoe, the terrain is of undulating pahoehoe flow consisting of small cracks and natural faulting.
VEGETATION: Moderate to thick grass, small 'ilima and koa-haole bushes; Christmas-berry, and kiawe trees.
ELEVATION: c. 9 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Quarry/possible agriculture
DESCRIPTION: The overall complex area measures c. 23.8 m at 26 degrees by 13.8 m. This site consists of a rock alignment (Feature A) and eight pahoehoe excavations. No soil or portable remains were observed.

FEATURE A: Alignment
FUNCTION: Indeterminate
DIMENSIONS: 2.25 m by 1. 70 m by 0.35 m
DESCRIPTION: An area of smooth pahoehoe and natural collapse which features a C-shape alignment of pahoehoe blocks. There are c. 15+ angular pahoehoe rocks and slabs placed in a single stacked C-shape alignment The blocks range in size

from 15xl3x8 cm to 31x26x28 cm. Some of the rocks were scattered around the alignment. The interior measures 1.12 m (N-S) by 1.05 m (E-W).

FEATURE: Pahoehoe excavation (8)
FUNCTION: Quarry/possible agriculture
DESCRIPTION: This area consists of eight pahoehoe excavations: six blister type excavations and two crevice type excavations. Three of these have cleared floors. All excavations exhibit at least one to four excavated faces with only one layer of pahoehoe quarried. The floors are the exposed second layer of pahoehoe.

The quarried basalt blocks are either on the floor of the excavations or along the perimeters in circular alignments. The average block size is c. 28x18x 12 cm: the average excavated area is c. 1.97 m by 0.66 m: the excavated face thickness ranges from 0.11 to 0.34 m and the depth of the excavations range from 0.26 to 0.81 m be/surface.

7.1.20 50-10-27-13294 (Donham 1990c:A-39—A-43) (Figure 114)

PHRI: T-43
SITE TYPE: Complex (73 Features)
TOPOGRAPHY: Relatively level pahoehoe with an adjacent aa finger flow. There are collapsed tubes in the area and modified shallow blisters.
VEGETATION: Fountain grass, noni trees, kiawe, koa-haole, 'ilima, some Christmas-berry, and lantana. Approximately 30% of the surface area is covered with vegetation. The remaining portions are bare.
ELEVATION: c. 9 feet
CONDmON: Good
INTEGRITY: Unaltered
PROBABLE AGE: Indeterminate/prehistoric-historic
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall complex area measures c. 110.0 m (E-W) by 84.0 m (N.S). The site complex is divided into four quads for counting the pahoehoe excavations. A 20.0 by 20.0 m sample area in the SE corner of the SW quad was mapped. and individual features (A through F) were recorded [Figure 114]. Features recorded and/or counted include a cairn (Feature A), an alignment (Feature B), a pile of pahoehoe blocks (Feature F), and 70 pahoehoe excavations Features C-E, G-1, and 64 additional excavations. The site is affected along the SW and S side by airport construction and a service road and was possibly larger.

Soil deposits were observed in Features G, H, and I, and portable remains observed include waterworn pebbles, cobbles, and boulders, stoneware pottery sherds, and modem bottle glass.

FEATURE A: Cairn
FUNCTION: Marker
DIMENSIONS: 2.52 m by 2.34 m by 0.64 m
DESCRIPTION: The cairn is situated on a natural outcrop of aa at the southwest end of the site. Feature A is constructed with piled pahoehoe blocks at the bottom

Figure 114. SIHP # -13294 plan view (Donham 1990c:A-40)

and with aa rocks at the top. There are c. l00+ rough aa boulders and cobbles and c. 20+ pahoehoe blocks. Presently, it is in a collapsed condition.

A waterworn cobble hammerstone with two battered ends lies on top of the eastern side of the cairn. In addition, there are three small coral fragments and a small waterworn cobble 1.2 m west of Feature A.

FEATURE B: Alignment
FUNCTION: Indeterminate
DIMENSIONS: 3.37 m by 2.48 m by 0.45 m
DESCRIPTION: A roughly U-shaped alignment, 2-3 courses wide and 1-3 courses high. It is constructed with blocks of pahoehoe and aa. Clinker size pieces of pahoehoe and aa are on top of the feature and in portions around the alignment. Two waterworn basalt fragments and broken glass are present Feature B is situated at the far SW comer of the site, near the fence line along the old airport runway.

FEATURE C: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 12.35 m by 3.40 m by 0.39 m
DESCRIPTION: Feature C is situated at the southwest comer of the site, adjacent to Feature B. It consists of a quarried blister with a partially cleared floor. A second layer of pahoehoe is exposed. There are c. 16 blocks located to the SW of the excavated area. and one small pile of aa and pahoehoe cobbles located on the NW edge of the excavated area. This small pile of cobbles measures c. 1.22 m (N-S) by 0.98 m (E-W). It is piled 2-3 courses high and is c. 0.34 m above the ground surface. The thickness of the excavated face ranges from 0.14-0.37 m and the depth ranges from 0.14-0.39 cm below surface. No soil is present.

The portable remains consists of *Cellana*, rock oyster, and *Cypraeidae* shell fragments, two pieces of coral, one waterworn basalt, glass sherds, and tin cans.

FEATURE D: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 9.50 m by 4.00 m by 0.30 m
DESCRIPTION: Feature D is located immediately south of Feature B. The main portion of the pahoehoe excavation is roughly circular in plan and measures c. 2.90 m in diameter. It is a broad, shallow hole with a slightly sloping rough floor. Most of the blocks were removed from the excavation, which is possibly the source for the Feature B alignment.

There are extensions along crevices from the east side and the northwest side of the excavation. Both extensions are 3.2 m in length and are 0.6 to 1. 7 m wide. They contain the same flat, rough and cleared floor. The mined basalt is uniform vesicular with no air pockets. Only one layer was mined. A thin pocket of reddish-brown soil is present in the lowest point of the excavation near the center. One waterworn coral pebble, two pieces shatter from a basalt hammerstone, and brown bottle glass are present. The hammerstone shatter pieces were broken from the hammerstone currently located at Feature E.

FEATURE E: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 4.50 m by 3.80 m by 0.23 m
DESCRIPTION: Feature E is located 2.00 m east from Feature D. It is a broad, roughly circular, shallow hole with a flat rough floor. All faces were excavated except the SE side. Most of the excavated blocks were removed, however there are c. 12 large blocks remaining in the excavation. Some of the blocks are scattered on the aa flow to the east and a few to the north. The overall feature dimensions including the scatter is c. 6.8 m (N-S) by 5.7 m (E-W).

A large basalt boulder hammerstone is present inside the excavation, against the west wall. It has several flakes removed from it and appears to be the source for flakes observed scattered in the area of Features A-F.

FEATURE F: Block pile
FUNCTION: Quarry
DIMENSIONS: 2.60 m by 1.40 m by 0.40 m
DESCRIPTION: Feature F is located 2.20 m northwest of Feature D. It is a roughly curved pile of large excavated blocks, some of which are loosely stacked to two courses high. It is constructed with c. 50 pahoehoe blocks with three large aa cobbles. One broken waterwom boulder and one large flake from the Feature E hammerstone were also present. Feature D may be the possible quarry source for this rock pile.

FEATURE G: Pahoehoe excavation
FUNCTION: Possible agriculture
DIMENSIONS: 2.40 m by 1.90 m by 1.00 m
DESCIRPTION: Feature G consists of an excavated blister and edge of finger. The overall feature area is c. 4.1 m (E-W) by 3.5 m (N-S). Two pahoehoe layers were excavated, however, the upper layer is broken off in a wider area than the lower, forming a shelf along the SW side of the hole. The upper layer of lava is 0.32 m thick and the lower layer is 0.27 m thick.

Broken and excavated blocks are loosely stacked on the north side of the excavation, forming a C-shaped perimeter around the depression. The base of the hole is filled with broken pieces of pebble size basalt. Brown soil mixed with pebble and gravel size pieces is also visible at the bottom of the hole.

FEATURE H: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 3.50 m by 1.60 m by 0. 70 m
DESCRIPTION: The overall feature measures c. 6.5 m (N-S) by 5.5 m (E-W). Excavated blocks are used to make two compartments inside of the excavated blister and as perimeter around the lower north side.

Large naturally collapsed slabs were moved out of the hole. They measure c. l.0x0.8x0.25 m. Other blocks were knocked off and arranged in a semicircle around

the western compartment and encircle the eastern compartment. All are haphazardly stacked two courses high.

The east side of the western compartment has a cleared floor and the west side has pebbles and soil. A small overhang is situated at the west end of the western compartment. The western compartment measures c. 1.70 m (E-W) by 0.70 m (N-S). The eastern compartment is all pebbles and soil fill with some slabs set on edge around the perimeter. The eastern compartment measures c. 1.0 m (N-S) by 0.57 m (E-W). A small overhang is also present at the east end.

Two layers of pahoehoe were excavated. The upper layer is 0.25 m thick and the lower layer is 0.23 m thick. Feature H is located 3.70 m east of Feature G, and is on the same pahoehoe finger.

FEATURE I: Pahoehoe excavation
FUNCTION: Possible agriculture
DIMENSIONS: 7.40 m by 4. 70 m by 0.40 m
DESCRIPTION: Feature I is c. 6. 7 m east of Feature H. Very large blocks are removed from an excavated blister to form a crude enclosure around the excavation. The aligned debris goes around the west, north and east sides. There is a slight break in the center on the north side. The interior measures c. 3.5 m (E-W) by 2.5 m (N-S) and averages c. 0.9 m wide. Most of the excavation is loosely filled with blocks except for a small hole that contains pebbles and soil.

At the SE end is a filled crevice that has a relatively level surface. It measures c. 1.8 m (N-S) by 1.2 m (E-W) and goes under an overhang with a ceiling heightof0.4 m above the top of the rock fill. The overhang is c. 1.4 m wide and 0.6 m deep. The depth of the fill appears to be at least three layers of blocks.

At the east end, mixed with small pieces of debris, on top the pahoehoe surface at the base of the slope, are several pieces of broken branch coral and basalt hammerstone shatter and flakes.

FEATURE - : Pahoehoe excavation (35)
FUNCTION: Quarry/agriculture
DESCRIPTION: The northeast quadrant of the site contains at least 35 pahoehoe excavations, including 15 excavated blisters, 13 crevices and seven faults.

Of these 35 features, 19 have totally or partially cleared floors. Five of these features have an absence of excavated blocks. In the other cases, most blocks are either in the excavated holes and or in close proximity to the edges. For most cases, only the top layer of pahoehoe has been excavated and the floor is fairly level exposing the second layer of pahoehoe.

The excavated areas range in size from c. 0.90 m (NE-SW) by 0.38 m (NW-SE) with excavated face thickness of c. 0.33 m and a total depth of c. 0.52 m below surface, to c. 3.55 m (NE-SW) by 1.83 m (NW-SE) with an excavated face thickness of c. 0.13-0.28 m and a total depth of c. 0.28-0.61 m below surface.

There is a moderate density of recent garbage in the area, various marine shell, coral and two waterworn basalt boulders, the larger of which contains battering on one end. Sparse soil deposits have also collected in the cracks.

FEATURE - : Pahoehoe excavation (3)
FUNCTION: Quarry/possible agriculture
DESCRIPTION: The southeast quadrant of the site contains three pahoehoe excavations. Two of these features are single-faced excavations between boundaries of pahoehoe and aa flows. Their floors are partially cleared, but contain many cobble-sized aa pieces. The third feature is a blister excavation, which is also near the aa and pahoehoe boundary. The average excavated face length is 2.25 m and the average thickness of the excavated face is c. 0.18 m. The three excavations range in depth from 0.26 to 0.64 m below surface.

Most of the excavated blocks are absent from the area. Some larger blocks are strewn c. 6.0 m to the south of the two single faced excavations. A few of the blocks are also located in the third excavated blister floor and along the SE face.

Historic garbage consisting of wood, nails, broken beer bottles are scattered throughout the quad. Near the roadway, much midden scatter and the evidence of bulldozer activity was visible. Coral fragments and shell fragments occur near the aa flow edge.

FEATURE - : Pahoehoe excavation (23)
FUNCTION: Possible agriculture
DESCRIPTION: The northwest quadrant consists of 23 excavated areas and one alignment. Formal variants include eight totally cleared shallow crevices, six deep, narrow crevices with pebble fill and three to four backfilled crevices.

The northern boundary is very indistinct and abuts SIHP Site No. 13386. Across the south half, and extending E-W is a raised finger with several excavations. To the north is a low area of broken pahoehoe and some aa. Features G, H, and I are situated along north face of the finger. They appear to be possible planting areas based on morphology, presence of soil, pebble fill, depth and exposure.

A circular alignment of odd-shaped blocks is situated on the flat at the northern end. The interior dimensions are c. 1.3 by 1.2 m and contains a flat and cleared surface. Portable remains consists of a basalt hammerstone flake, waterworn coral and basalt, shell midden, basalt shatter, and stoneware sherds.

FEATURE -: Pahoehoe excavation (12)
FUNCTION: Quarry
DIMENSIONS: 50.00 m by 42.00 m
DESCRIPTION: The southwest quadrant contains at least 12 features. There are three excavated crevices along an up thrust of ropy pahoehoe at the west boundary. Two broad shallow excavations are at the northeast comer of the quadrant, the smaller of which is backfilled with blocks and the larger one which is empty. Also, an excavated blister is visible just southwest of the area. An excavated crevice at the western boundary of the site contains broken pebble-size pieces of pahoehoe

and two waterworn cobbles, one of which is ground. It is a moist crevice with a small overhang on the south side. It measures c. 0.6 m deep with an opening of c. 0.8 m by 0.15 m and a ceiling height of c. 0.35 m. Blocks are scattered along the sides of the excavation.

The western boundary of the site is c. 10.0 m from SIHP Site No. 13353, a complex consisting of modified anchialine pools and petroglyphs.

7.1.21 50-10-27-13295 (Donham 1990c:A-43–A-44)

PHRI: T-44
SITE TYPE: Complex (10 Features)
TOPOGRAPHY: A small ridge of smooth and ropy pahoehoe oriented roughly E-W.
VEGETATION: Moderate grasses, small 'ilima and lantana bushes, and small Christmas-berry trees.
ELEVATION: c. 9-10 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Quarry
DESCRIPTION: Site complex consists of quarried faces of pahoehoe with blocks either closely associated around the excavation or in the hole. Two pieces of coral are present at Features H and I.

FEATURE A: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.51 m by 1.39 m by 0.48 m
DESCRIPTION: Generally rectangular shape in plan with associated blocks placed on the east and southeast edges of the hole. The floor is partially cleared of excavated blocks. The overall feature including the scattered blocks measures 2.98 m (NW-SE) by 2.25 m (NE-SW). The thickness of the excavated face is 0.21 m.

FEATURE B: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 0.98 m by 0.88 m by 0.52 m
DESCRIPTION: Feature B is a pahoehoe excavation blister, located 2.25 m west from Feature A. A few excavated blocks are to the southeast of the excavation and many blocks are inside: The total feature area including the excavated material measures c. 1.83 m at 232 degrees by 2.37 m. The thickness of the excavated face is c. 0.25 m.

FEATURE C: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 4.14 m by 0.96 m by 0.68 m
DESCRIPTION: An excavated fault in which both faces were excavated. The floor is cleared of quarried material, some of which appear to be downhill to the east and south. The total area measures 4.19 mat 150 degrees by 6.05 m. The

thickness of the excavated face is c. 0.39 m. Feature C is 2.90 mat 150 degrees Az. from Feature A.

FEATURE D: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 3.82 m by 0.45 m by 0.54 m
DESCRIPTION: Feature D is an excavated crevice situated 4.6 m from Feature A at 208 degrees Az. The excavation is generally cleared of rubble, which is concentrated to the southeast of the crevice. The overall feature area including the quarried material measures 3.82 mat 80 degrees by 5.74 m. The thickness of the excavated face is 0.27 m.

FEATURE E: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 2.96 m by 0.69 m by 0.37 m
DESCRIPTION: Feature E is an excavated blister and fault situated on top of smooth and ropy pahoehoe on the north edge of a small depression. It is 7.11 m at 248 degrees Az. from Feature A. It consists of a square hole excavated through a blister, and an excavated face along a small fault adjacent the blister. Quarried blocks are located to the southwest and northeast of the excavated area. The overall feature area measures 4.31 m at 284 degrees by 4.51 m. The thickness of the excavated face ranges from 0.08-0.27 m. The depth ranges from 0.08-0.37 m below surface. Thick grass is growing in the excavation.

FEATURE F: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.15 m by 0.64 m by 0.43 m
DESCRIPTION: Feature F is an excavated blister located 15.05 mat 263 degrees Az. from Feature A. All faces of the feature are excavated and the floor is partially cleared of loose rubble. Quarried blocks are placed on the seaward (west) side of the excavation. The thickness of the excavated face is 0.24 m.

FEATURE G: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 132 m by 0.91 m by 0.53 m
DESCRIPTION: Feature G is an excavated blister located 17.71 m from Feature A at 265 degrees Az. All faces of the feature are excavated and the floor is partially cleared of rubble. Quarried blocks are placed on the seaward (west) side of the excavation. The excavated pahoehoe face here is 0.30 m thick.

FEATURE H: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.59 m by 1.19 m by 0.47 m
DESCRIPTION: Feature H is an excavated blister located 19.22 m at 269 degrees Az. from Feature A. All faces of the feature are excavated and the floor is partially cleared of loose rubble. Quarried blocks are placed on the seaward (west) side of the excavation. Thickness of the excavated pahoehoe layer is 0.28 m. One piece of coral was located 1.84 m to the northwest of Feature H.

FEATURE I: Pahoehoe excavation
FUNCTION: Quarry
DIMENSIONS: 1.17 m by 1.12 m by 0.46 m
DESCRIPTION: Feature I is another excavated blister located 17.54 m from Feature A at 270 degrees Az. All faces of this feature are excavated and the floor is partially cleared of loose rubble. Quarried blocks are placed on the seaward (west) side of the excavation. Thickness of the excavated pahoehoe layer here is 0.29 m. One piece of waterworn coral is located l.74 m to the north of Feature I.

FEATURE J: Displaced quarried rocks
FUNCTION: Possible quarried material
DIMENSIONS: 9.65 m by 5.82 m by 0.22 m
DESCRIPTION: Feature 1 is situated c. 25.48 m at 183 degrees from Feature A. It is a displacement of cracked and broken ropy pahoehoe, located west of the major portion of this site. Slabs of pahoehoe are flipped over and moved from their original position. The slabs and blocks range in size from 6x3x6 cm to 80x73x21 cm.

7.1.22 50-10-27-13297 (Donham 1990c:A-44, A-46)

PHRI: T-47
SITE TYPE: Complex (9 Features)
TOPOGRAPHY: Undulating smooth and ropy pahoehoe flow with natural cracks and faulting.
VEGETATION: Moderate to thick density of grass, small 'ilima and koa-haole bushes, Christmas-berry, and kiawe trees and bushes.
ELEVATION: c. 17.5 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Quarry/possible agriculture
DESCRIPTION: This site consists of nine pahoehoe excavations within an area 42.73 m by 38.40 m. Formal variants observed include excavated blisters, crevices and faults. One to four faces are excavated per feature, with the average excavation measuring 1.68 m by 1.15 m. Thickness of the excavated pahoehoe layer averages 0.26 m and the average depth is 0.36 m below surface. Two of the excavations have cleared floors. The remaining have excavated blocks closely associated with the features in addition to a couple of isolated block scatters. The average block size is 31x12x28 cm. Ten stoneware pottery sherds are located c. 25.68 mat 12 degrees from the site datum.

7.1.23 50-10-27-13298 (Donham 1990c:A-46-A-47) (Figure 115, Figure 116)

PHRI: T-48
SITE TYPE: Complex (7 Features)
TOPOGRAPHY: Depression between pahoehoe ridges oriented NW-SE.
VEGETATION: Thick grass, kiawe, koa-haole, lantana, purple flowering vines, and 'ilima in depression.

ELEVATION: c. 20 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Quarry/agriculture/temporary habitation
DESCRIPTION: The site complex consists of a cairn (Feature A), a rubble concentration (Feature B), two linear mounds (Features C and F), a modified crevice (Feature D), a pahoehoe excavation (Feature E) and a modified fault (Feature G). The features are relatively dispersed over an area of at least 1000.00 sq m.

FEATURE A: Cairn
FUNCTION: Indeterminate marker
DIMENSIONS: 0.34 m by 0.30 m by 0.77 m
DESCRIPTION: The cairn is constructed with four pahoehoe blocks of similar shape and size stacked one on top of another. It is built on top of naturally cracked pahoehoe, situated on the southwest side of and below large ridge of pahoehoe.

FEATURE B: Rubble concentration
FUNCTION: Quarry
DIMENSIONS: 7.20 m by 4.50 m by 0.27 m
DESCRIPTION: Feature B is located 2.44 m south from Feature A. It consists of pahoehoe cobbles and boulders concentrated near an overhang at the base of a ridge. The cobbles and boulders range in size from 13xl0x5 cm to 62x34x27 cm. They are concentrated in front of the overhang and were probably removed from the overhang area. No deposits or portable remains are present inside the overhang. A vesicular basalt abrader occurs on the rock concentration; it measures 12x12x10 cm.

FEATURE C: Linear mound [Figure 115]
FUNCTION: Possible temporary habitation/agriculture
DIMENSIONS: 3.55 m by 1.68 m by 0.86 m
DESCRIPTION: A linear mound roughly oriented N-S parallel to small the major axis of an adjacent overhang. The mound is partially faced on the west side and is constructed with crudely stacked angular pahoehoe cobbles and boulders. The rock size ranges from 10x9x7 cm to 54x47x12 cm. A waterworn basalt hammerstone with battering marks on two ends, is present between the linear mound and the overhang.

A 1.80 by 1.00 m test trench was excavated across the narrow axis of the mound, at the center, in order to determine if subsurface features were buried beneath the rocks. The rock fill was found to be overlying a depression in the pahoehoe surface, and continued to 0.94 m below the top of the mound. At the base of the rock fill, which was a uniform deposit of large cobbles and small boulders, a bedrock surface with narrow, soil-filled crevices was encountered. The soil deposits were up to 0.13 cm thick in the crevices and consists of very rich, black loam. No portable remains were observed. A sample of the soil deposit was obtained for additional analysis …

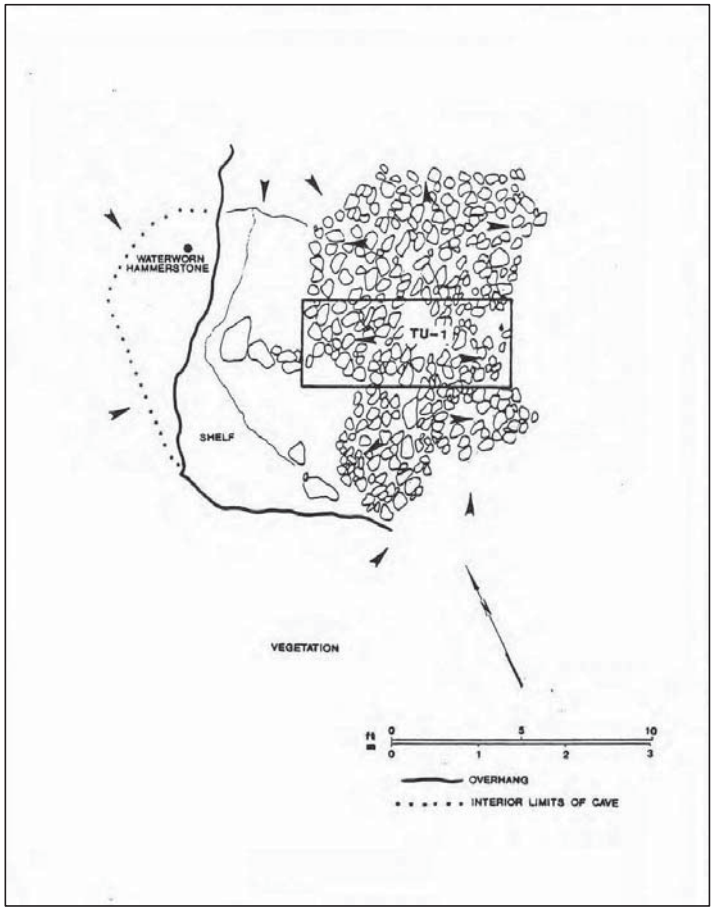


Figure 115. SIHP #-13298 Feature C plan view (Donham 1990c:A-48)

FEATURE D: Modified crevice
FUNCTION: Possible water catchment/agriculture
DIMENSIONS: 5.00 m by 2.20 m by 0.85 m
DESCRIPTION: Feature D is located 25.4 m from Feature B at 201 degrees Az. It consists of piled and stacked boulders and cobbles in a natural crevice between an aa flow and an overhang. The feature is situated along the southwest edge of the site at the southeast base of a pahoehoe ridge. The ends of the crevice, and a small area in front of the overhang are filled with slabs and blocks of pahoehoe, leaving a central area clear of cobbles. This central area has the appearance of a walled hole. The hole area measures c. 2.05 m at 228 degrees by 0.85 m. A large waterworn basalt hammerstone measuring c. 23x23x17 cm with battering on two ends is located in the NE wall.

FEATURE E: Pahoehoe excavation
FUNCTION: Quarry/possible agriculture
DIMENSIONS: 2.50 m by 1.30 m by 0.28 m
DESCRIPTION: Modified pahoehoe excavation, located 11.00 m south from Feature D. The excavation is rectangular in plan, and quarried blocks are stacked 1-2 courses high, directly on the edges of the excavation. Two layers of pahoehoe are excavated through. The hole is cleared, with the exception of a few blocks. The excavated hole measures c. 1.8 mat 210 degrees by 0.62 m. The hole depth is c. 0.78 to 1.2 m below surface.

FEATURE F: Linear mound
FUNCTION: Indeterminate
DIMENSIONS: 4.66 m by 1.58 m by 0.52 m
DESCRIPTION: This linear mound is situated on the top of a linear pahoehoe ridge, and is oriented northeast/southwest. It is constructed with thin slabs of pahoehoe and has a long rectangular shape. The slabs range from 16x10x3 cm to 96x46x6 cm. The area surrounding Feature F consists of broken pahoehoe slabs that cover the top of the ridge.

FEATURE G: Modified crevice [Figure 116]
FUNCTION: Possible water catchment
DIMENSIONS: 4.20 m by 1.15 m by 1.55 m maximum depth ·
DESCRIPTION: This feature is located 24.10 m west from Feature B. It consists of a large crevice/fault area with two faced walls oriented across and perpendicular with the long axis of the crack. The walls are 0.66 m high, and are filled behind with small cobbles, creating a cleared, vertical-sided depression between the walls. This open depression measures 1.40 mat 88 degrees by 0.96 m. Maximum depth of the hole from the natural faulted surface is 1.55 m.

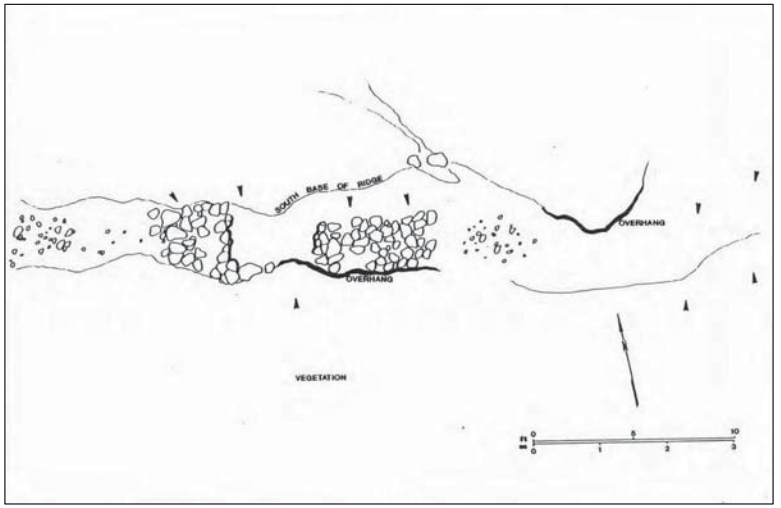


Figure 116. SIHP # -13298 Feature G plan view (Donham 1990c:A-49)

7.1.24 50-10-27-13315 (Donham 1990c:A-59)

PHRI: T-68
SITE TYPE: Rubble wall
TOPOGRAPHY: The site is on a fairly flat pahoehoe blister that slopes slightly toward the WNW.
VEGETATION: The site is surrounded by koa-haole, fountain grass, kiawe, and Christmas-berry.
ELEVATION: c. 88 feet
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-historic
FUNCTIONAL INTERPRETATION: Indeterminate
DIMENSIONS: 2.95 m by 0.95 m by 0.32 m
DESCRIPTION: A rubble wall of pahoehoe blocks and slabs occurs in an area of natural collapse and high density of vegetation. The wall width ranges from 0.24-0.95 m and the height from 0.12-0.32 cm. The types of rocks consists of surface blocks and slabs of both smooth and ropy pahoehoe, and aa cobbles. The wall is along the edge of a naturally collapsed blister. There are c. 30 blocks and/or slabs present.

7.1.25 50-10-27-13321 (Donham 1990c:A-61) (Figure 117)

PHRI: T-74
SITE TYPE: Boulder concentration
TOPOGRAPHY: A collapsed pahoehoe blister.
VEGETATION: Moderately thick fountain grass, lantana, 'ilima, koa-haole, kiawe, and Christmas-berry.
ELEVATION: c. 110 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DIMENSIONS: 16.95 m by 5.08 m by 0.59 m
DESCRIPTION: The site consists of a boulder mound and concentration, located in a collapsed blister. The concentration consists of large angular cobbles and boulders, some of which appear to be excavated from sections around the rim of the blister. The blocks range in size from 9x4x6 cm to 94x52x37 cm. The mounded area of the concentration is oriented N-S, across the short axis of the blister, at the west end. It is 5.00 m long and 1.50 m wide, with a narrow 5.00 m long extension to the east. Average height is 0.50 m. A curved low rubble wall adjoins the west side of the mound, forming a 2.00 by 0.70 m enclosed area.

To the east of the mound is a 10.00 by 3.00 m area of rubble paving, which is slightly mounded in the center. The paving follows the northern perimeter of the blister and extends into the center, within 1.50 m from the south perimeter. A

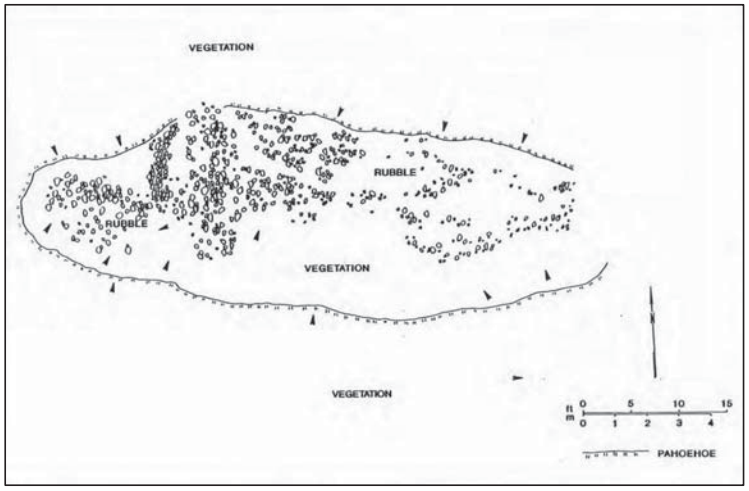


Figure 117. SIHP # -13321 plan view (Donham 1990c:A-62)

second smaller area of rubble occurs at the eastern end of the blister. No soil was observed in the blister, however, deposits could be present beneath the rubble fill.

7.1.26 50-10-27-13326 (Donham 1990c:A-63) (Figure 118)

PHRI: T-85
SITE TYPE: Platform
TOPOGRAPHY: Smooth and ropy pahoehoe flow sloping gently from the northeast
VEGETATION: Thick grass, koa-haole, kiawe, and Christmas-berry.
ELEVATION: c. 189 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DIMENSIONS: 2.99 m by 1.97 m by 0.81 m maximum height
DESCRIPTION: This small, amorphous platform is constructed from small to medium-size angular pahoehoe cobbles, with a perimeter of large blocks and slabs set on edge. It is built on smooth pahoehoe, near a partially collapsed blister.

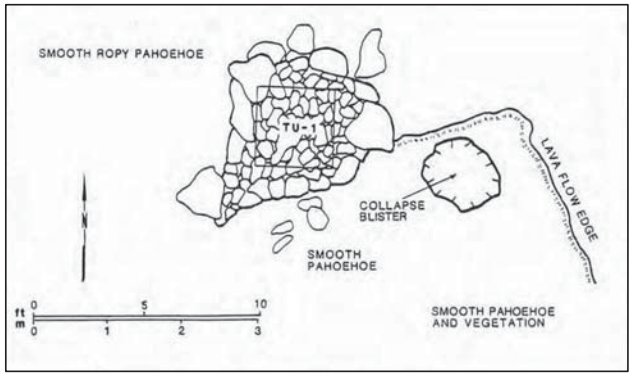


Figure 118. SIHP #-13326 plan view from Donham 1990c:A-65

The platform is raised on all four sides, with heights ranging from 0.23 to 0.81 m. The pahoehoe blocks used for the perimeter average 48x45x13 cm. No pavement is present, and the surface is somewhat irregular.

A 1.00 by 1.00 m square test unit was excavated into the feature, in order to ascertain whether it contained a subsurface feature, such as human skeletal remains. The test unit revealed a fill layer of 0.43 m thick, which exhibited no evidence of size or material sorting. A few Echinoidea fragments were located, scattered in the fill. At the base of the fill was a small opening in the pahoehoe surface which contained soil and additional midden remains (one Cypraeidae shell fragment, one *Brachidontes c*. valve, one Isognomonidae valve, and several Echinoidea fragments. The soil deposit was 0.04 m thick and occurred only in the pahoehoe opening. A sample of the soil was collected for further analysis …

Two pahoehoe excavations with associated blocks are located c. 10.0 m east of the platform.

7.1.27 50-10-27-13327 (Donham 1990c:A-63, A-65)

PHRI: T-88
SITE TYPE: Pahoehoe excavation
TOPOGRAPHY: A ridge top that is oriented c. inland/seaward. Smooth and ropy pahoehoe with natural cracks and breakage.
VEGETATION: Moderate amounts of grass, kiawe, koa-haole, and small 'ilima bushes.
ELEVATION: c. 191 feet
CONDITION: Good

INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Quarry
DIMENSIONS: 6.30 m by 5.35 m by 0.56 m
DESCRIPTION: This site consists of two small areas on a blister with excavated faces. One excavation measures 1.60 by 1.30 m and one measures 1.40 by 0.92 m. Average thickness of the excavated pahoehoe layer is 0.19 m, and average depth is 0.56 m.

The quarried blocks are concentrated to the southeast and range in size from 14x11x9 cm to 35x24x12 cm. The floor areas of the excavations are covered with a few of the quarried blocks.

7.1.28 50-10-27-13328 (Donham 1990c:A-65)

PHRI: T-89
SITE TYPE: Cave
TOPOGRAPHY: Located on the northeast side of a large collapsed blister.
VEGETATION: Koa-haole, kiawe, and fountain grass.
ELEVATION: c. 214 feet
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation
DIMENSIONS: 8.38 m by 6.52 m by 2.65 m
DESCRIPTION: The entrance to the cave faces southwest at 240 degrees Az. It is 2.25 m wide and has a ceiling height of 1.7 m. Directly south of the cave entrance is a collapsed tube which extends for an indeterminate distance (inaccessible due to ceiling collapse). The north corner of the cave contains a crawlspace which extends 3.0 m from the main chamber.

Most of the cave floor is covered with a layer of pahoehoe which collapsed from a shelf 0.24 to 0.66 m above the cave floor. The shelf is present around the perimeter of the cave, and protrudes 0.50 to 2.50 m from the side walls. The center of the cave floor consists of large scattered boulders and cobbles from ceiling collapse.

A 3.05 by 2.80 m area of concentrated midden, soil and ash occurs near the center of the cave. Portable remains observed on the surface include eight Cypraeidae fragments, 50+ *Nerita picea*, four Echinoidea fragments, fishbone, and scattered goat bones. A 0.06 m thick ash deposit with small pieces of charcoal is also present.

7.1.29 50-10-27-13353 (Donham 1990c:A-91–A-92)

PHRI: T-128
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: Upthrusted and faulted pahoehoe.
VEGETATION: Sparse grass, 'ilima, red flowering plants, and Christmas-berry trees.
ELEVATION: c. 9 feet

CONDITION: Good
INTEGRITY: Unaltered-except for bulldozer activity around Feature C.
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Rock art-aquaculture-bathing
DESCRIPTION: The overall complex area measures 22.5 mat 256 degrees Az. by 19.0 m. The site consists of petroglyphs (Feature A) and two modified anchailine pools (Features B and C).

FEATURE A: Petroglyph
FUNCTION: Rock art
DIMENSIONS: 13.00 m by 5.00 m
DESCRIPTION: Feature A consists of three panels of petroglyphs that are concentrated in an area of natural collapsing pahoehoe. The petroglyphs are situated on an upthrust of smooth pahoehoe with an average thickness of 0.25 m. The panel of petroglyphs face northeast, northwest and southeast, respectively.

On the northeast-facing panel, there are at least nine human stick figures and six other geometric shapes or symbols. This panel is at a 45 degree angle and measures 5.15 m in length by 2.8 m in height.

The northwest-facing panel contains two human stick figures and two geometric shapes or symbols. This panel is at a 45 degree angle and measures 4.5 m in length and 0.80 m in height.

The southeast-facing panel contains at least one human stick figure and six other geometric shapes or symbols. This panel measures 3.15 m in length and 1.8 m in height.

There are two waterworn basalt cobbles and a waterworn coral cobble in front of the panels.

FEATURE B: Modified tide pool
FUNCTION: Aquaculture/bathing/water source
DIMENSIONS: 6.50 m by 2.60 m by 0.75 m
DESCRIPTION: Feature B is 9.80 m west from Feature A. It consists of an oblong opening in the surface pahoehoe layer which provides access to a small tidal pool. The feature is bordered by natural fault lines on the northwest and southeast sides, and by two walls of stacked angular cobbles and boulders on the northeast and southwest sides. The access opening between the fault lines and the two cobble walls measures 1.4 m (NE-SW) by 1.14 m (NW-SE). A few angular cobbles are piled behind the lip of the southeastern fault.

The water level of the pool appears to rise and fall with the tide. At the time of survey, it was 0.20 m deep, however a water line mark is visible at 0. 70 m above the bottom of the pool. The bottom of the pool is covered with small angular cobbles and contains red shrimp.

FEATURE C: Modified tide pool
FUNCTION: Aquaculture/bathing/water source
DIMENSIONS: 2.70 m by 2.70 m by 1.65 m

DESCRIPTION: This feature is along the fenceline between the project area and the old Kona airport 22.1 m west from Feature A. It consists of a tidal pool at the base of a collapsed blister that has been cleared. Surrounding all edges of the pond are angular cobbles and large boulders. The bottom of the pond is covered with small angular waterworn cobbles and sand. The pond extends under an overhang along the southwest rim of the blister. The water was 0.86 m deep at the time of survey, and red shrimp were observed. Coral and marine shells are also at the bottom of the pool. There is at least 2-3 meters of bulldozer push on the south and west sides of the pool. There has been much bulldozing activity in the area. Also, recent garbage is present around the pool

7.1.30 50-10-27-13482 (Donham 1990c:A-154)

PHRI: T-87
SITE TYPE: Pahoehoe excavation
ELEVATION: c. 194 feet
FUNCTIONAL INTERPRETATION: Quarry

7.1.31 50-10-27-13493 (Bell et al. 2008:44) (Figure 119)

FUNCTION: Transportation
SITE TYPE: Trail
TOTAL FEATURES: 1
DIMENSIONS: 46 m by 6 m (150.9 ft. by 19.7 ft.)
CONDITION: Good
AGE: Pre-contact
ELEVATION: 120 ft. a.m.s.l.
DESCRIPTION: Site 50-10-27-13493 is a stepping stone trail in good condition located on an undulating *ʻaʻā* flow in the southwest corner of the project area [Figure 119]. The trail was designated Site -13493 based on survey work within the adjoining water tank parcel (Rosendahl 1989). No soil is present on the flow and vegetation consists of sparse grasses. The trail crosses the *ʻaʻā* flow in a southwest/northeast direction for 46 m (150.9 ft). Flat *pāhoehoe* slabs (30-40 cm / 1-1.3 ft.) were set into *ʻaʻā* cobbles at evenly spaced intervals, creating an easily traveled and well constructed path across the *ʻaʻā* flow. Discoloration of the pāhoehoe slabs and small *ʻaʻā* cobbles as a result of bruising make this trail easily discernable from the surrounding *ʻaʻā*. Approximately 15 m (49.2 ft) of the trail is heavily discolored. The trail was not discernable on the *pāhoehoe* lava on either the east or west side of the *ʻaʻā* flow. Additionally, a bulldozer road has destroyed the northeast end of the trial [sic] along the edge of the *ʻaʻā* flow. No midden or artifacts were observed in association with the site. Excavation potential is considered poor. The function of the site is transportation. The site is one of many closely spaced and approximately parallel trails crossing a pronounced *ʻaʻā* flow from the northeast/southwest, suggesting a relatively high degree of traffic in the area.

Figure 119. Photo of SIHP # -13493; view to the north (Bell et al. 2008:45)

7.1.32 50-10-27-15329 (Bell et al. 2008:52) (Figure 120, Figure 121)

FUNCTION: Temporary habitation
SITE TYPE: Modified tumulus
TOTAL FEATURES: 1
DIMENSIONS: 27.0 m2 (290.5 ft2)
CONDITION: Fair
AGE: Pre-contact
ELEVATION: 100 ft. a.m.s.l.
DESCRIPTION: Site 50-10-27-15329 [Figure 120] is a modified tumulus with the modification consisting of a discontinuous piled rock alignment [Figure 121]. The terrain consists of *pāhoehoe* gently sloping *makai*, with sparse soil deposits, which support exotic grasses, *koa haole*, *kiawe*, *noni*, and some *klu*. The site is approximately 60 m (196.9 ft) northwest of the intersection of Hina Lani Street and Queen Ka‘ahumanu Highway.
An old site tag was discovered that reads: PHRI 92-1118 Site 1118-18.
The alignment is constructed of piled cobbles and small boulders on an exposed raised portion of the *pāhoehoe* tumulus. The piling is never more than 2 courses high with a maximum height of 0.2 m (0.7 ft), forming a discontinuous alignment

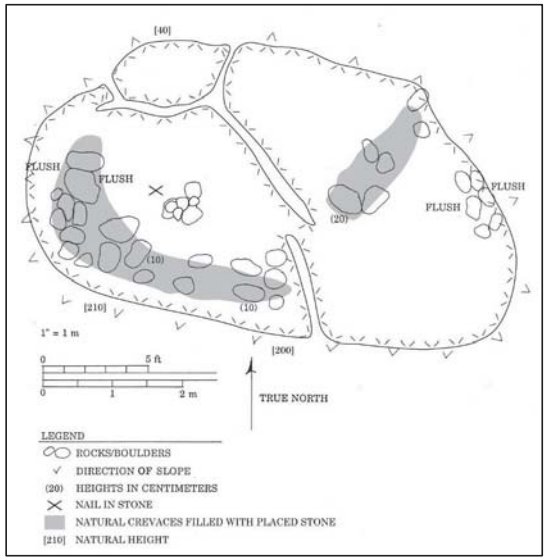


Figure 120. SIHP # -15329 plan view (Bell et al. 2008:53)

Figure 121. Photo of SIHP # -15329; view to the southeast (Bell et al. 2008:54)

with bare bedrock visible under the piled rocks. The upper surface of the tumulus is relatively level, and some of the cracks atop the tumulus are filled in while others are not.

A small cairn is in the center of the west side of the top of the *pāhoehoe* tumulus; this may be a previous survey marker. Next to the cairn is a nail driven into the bedrock.

The site's function is interpreted as a recurrent use site/shelter based on structural modifications. No artifacts or midden were observed and excavation potential of the site is poor due to the lack of construction and lack of soil deposits.

7.1.33 50-10-27-17167 (Borthwick and Hammatt 1992a:15, 17) (Figure 122, Figure 123)

(CSH1)
Site Type: Modified sink
Function: Habitation (temporary)
Features: 1
Dimension: 11.4 square meters (123.1 square feet)
Location: 4 + 50 (60 ft. E)
Elevation: 60 feet AMSL
Description: Cultural Surveys Hawaii site 1 consists of a small modified sink in terrain of undulating pahoehoe with minimal soil deposits. Christmas-berry is present at the site.

The sink is roughly oval in shape, with a shallow overhang just under the rim of the sink on all sides [Figure 122]. This overhang ranges from 0.1 to 3.0 m. (0.33 to 9.8 ft.) wide, with a maximum height of 1.4 m. (4.6 ft.). The sink itself is approximately 10.0 m. (33.0 ft.) long N/S by 6.0 m. (19.7 ft.) wide E/W, with a floor of pahoehoe rubble.

Modifications include an area of pavement constructed of pahoehoe slabs, 1 to 2 courses high, immediately under the overhang on the west side. The paved area measures 12.0 m. (39.4 ft.) long N/S by 1.0 m. (3.3 f.t) wide E/W, with a maximum height of 0.1 m. (0.33 ft.). Branch coral, *'opihi* (*Cellana* sp.), and sea urchin (*Echinoderm* sp.) were observed in this paved area.

A second area of rough pavement occurs on the south side of the sink, under the overhang. It measures 0.6 m. (2.0 ft.) by 1.0 m. (3.3 ft.). No artifacts or midden were observed in this area.

This site is interpreted as temporary habitation, indicated by the midden present. It's in good condition, with fair excavation potential in and near the paved areas.

A one-meter test trench was excavated within the slab pavement on the western side of the sink. The excavation yielded a small quantity of marine shell (4 *opihi*), one coral abrader, and some fragmented goat bones. The slab pavement was constructed over a loosely piled boulder fill. The boulders filled in a narrow crevice between the sink wall and the bedrock floor [Figure 123]. The fill had a maximum thickness of 70 cm. Below the fill in the narrow crevice was a soil layer of very fine loose aeolian deposited silt loam. No cultural material was observed in the soil,.

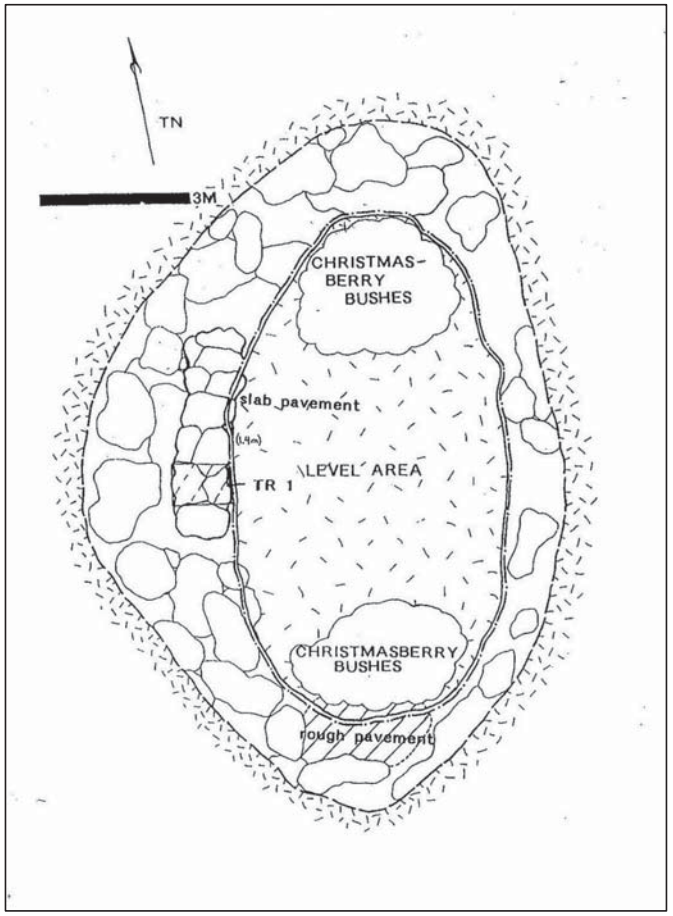


Figure 122. SIHP # -17167 plan view (Borthwick and Hammatt 1992a:16)

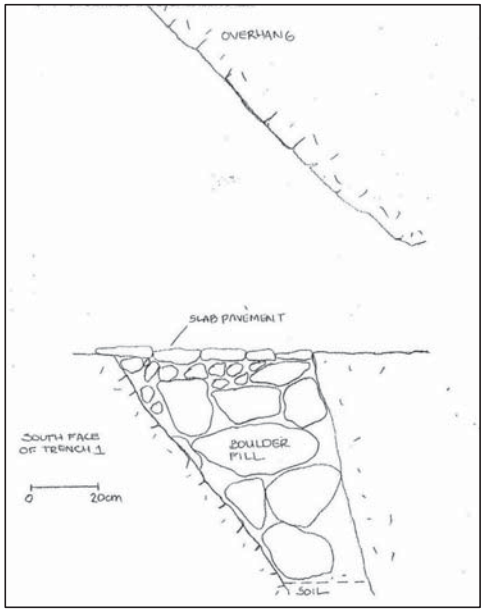


Figure 123. SIHP # -17167 Trench 1 profile (Borthwick and Hammatt 1992a:18)

which was up to 40 cm. deep, except on the surface of the soil where an *opihi* was recovered. The *opihi* was there as filtered material from the pavement and fill.

The soil stratigraphy consists of a very thin (1-3 cm. thick) layer that includes the *opihi*, the organic debris of Christmas berry leaves, and grass. Like the *opihi* the organic debris is filtered material through the loose matrix of the boulder fill. The loose aeolian deposited silt loam is dark yellowish brown (10 YR 3/4) granular with no structure. The soil stratigraphy observed indicates a single soil layer with the organic debris and *opihi* sitting on top. This is suggestive that the bulk of the soil was probably deposited prior to the construction of the slab pavement. The slab pavement has probably slowed the process of aeolian deposition.

No charcoal was observed within the excavation unit, though a full-scale excavation of the paving, fill, and soil layer would probably have produced a datable sample.

After taking notes, drawing a profile [Figure 123], and taking photographs, the trench was backfilled and the slab pavement reconstructed

7.1.34 50-10-27-17168 (Borthwick and Hammatt 1992a:19)

(CSH2)
Site Type: Modified sink
Function: Habitation (temporary); Possible agriculture
Features: 1
Dimension: 32.5 square meters (351.0 square feet)
Location: 34 + 100 (25.0 ft. E)
Elevation: 24 feet AMSL
Description: Cultural Surveys Hawaii site 2 is a modified pahoehoe sink with an overhang on the west side. The sink itself measures 12.0 m. (39.7 ft.) long NW/SE by 5.5 m. (18.0 ft.) wide SW/NE.

Modifications include a faced wall, a possible shelter area under the overhang, and a cleared and leveled area immediately outside of the overhang. The wall is constructed of a single course of boulders stacked 0.9 m. (3.0 ft.) high and approximately 3.5 m. (11.5 ft.) long E/W. The wall is situated in the southwest portion of the sink and extends a short distance under the overhang.

A leveled area which may represent a probable shelter is present under the overhang, adjacent to the boulder wall. It is approximately 1.5 m. long E/W by 1.0 m. (3.3 ft.) wide N/S.

An area of the sink, just east of the overhang, appears to have been cleared and leveled, possibly for planting. A large Christmas-berry tree is currently growing in this area.

Two rock concentrations occur on the rim of the eastern side of the sink. These resemble small collapsed ahu, consisting of pahoehoe slabs and cobbles, with no facing or stacking.

CHS site 2 is in fair to good condition, with poor excavation potential due to the lack of soil at this site. The area under the overhang may have functioned as a temporary shelter, while the cleared portion of the sink may represent a planting area.

7.1.35 50-10-27-17169 (Borthwick and Hammatt 1992a:21) (Figure 124)

(CSH3)
Site Type: Modified lava blister
Function: Possible temporary habitation
Features: 1
Dimension: 18.3 square meters (197.6 square feet)
Location: 34 + 00 (20.0 ft. W)
Elevation: 20 feet AMSL

Description: Cultural Surveys Hawaii site 3 is a lava blister with possible modifications, located along the north edge of a large pahoehoe sink. Terrain at the site is undulating pahoehoe covered with moderately dense fountain grass.

The modifications at this site are minimal, consisting of a possible cleared area, and a small crevasse which may have been filled with pahoehoe boulders and cobbles [Figure 124]. A small scatter of bone fragments was observed in the north portion of the blister, but were too small to identify, but are probably goat bone which is also present on the south side of the blister.

The site is in poor condition, with poor excavation potential due to a lack of soil deposits.

7.1.36 50-10-27-20722 (Bell et al. 2008:152) (Figure 125)

FUNCTION: Transportation
SITE TYPE: Trail
TOTAL FEATURES: 1
DIMENSIONS: 70 m (230 ft.) northwest/southeast
CONDITION: Fair
AGE: Pre-contact
ELEVATION: 100 ft. a.m.s.l.
DESCRIPTION: Site 50-10-27-20722 is a stepping stone trail located on *‘a‘ā* lava [Figure 125]. No soil is present and the area is virtually devoid of vegetation.

From the *makai* edge of the lava flow the trail is oriented in a north/south direction for approximately 13.1 m (43.0 ft) where it then forks, with one leg extending 41.0 m (134.5 ft) to the northwest, and the other leg extending 23.4 m (76.8 ft) to the northeast to the *mauka* side of the *‘a‘ā* flow. Numerous attempts were made to follow the trail on both sides of the *‘a‘ā* flow without success.

The trail is constructed of flat pāhoehoe slabs set into small *‘a‘ā* cobbles at evenly spaced intervals creating an easily traveled well-constructed path across the *‘a‘ā* flow. The fork in the trail is very pronounced; approximately ten *pāhoehoe* slabs were placed together to mark the fork. Some of the *pāhoehoe* slabs are set into *‘a‘ā* cobbles while others are set on top of cobbles. The south leg of the trail runs approximately 45 m (147.5 ft) between the south end of the trail and the fork. Paving stones vary in size from 5 cm to 30 cm (0.16 to 1 ft.) across. The northeast leg of the trail was cut off by a bulldozer.

The site’s function is interpreted as transportation. No midden or artifacts were observed. Excavation potential is considered poor.

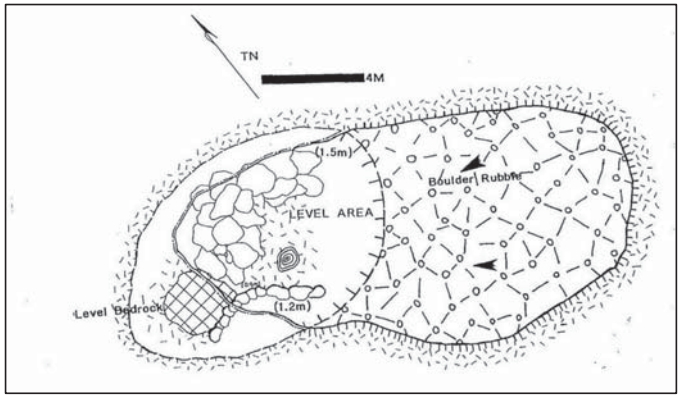


Figure 124. SIHP # -17169 plan view (Borthwick and Hammat 1992a:20)

Figure 125. Photo of SIHP # -20722; view to the northeast (Bell et al. 2008:153)

7.1.37 50-10-27-20726 (Bell et al. 2008:161) (Figure 126)

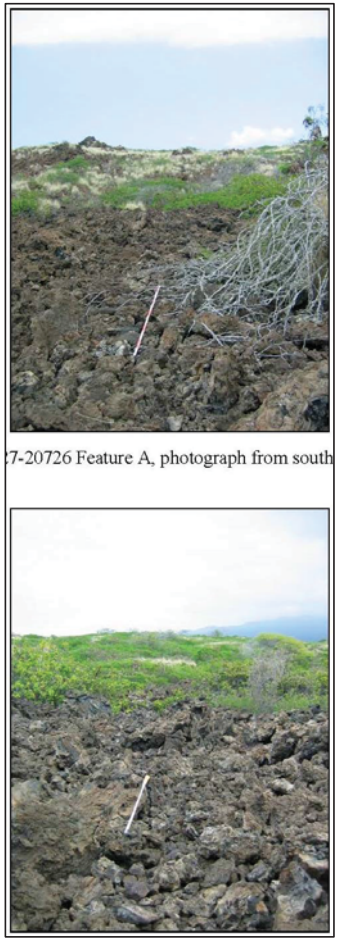
FUNCTION: Transportation
SITE TYPE: Trail
TOTAL FEATURES: 2
DIMENSIONS: Feature A – 45 m (147.6 ft.) north/south
Feature B – 40 m (131.2 ft.) northeast/southwest
CONDITION: Fair
AGE: Pre-contact
ELEVATION: 120 ft. a.m.s.l.
DESCRIPTION: Site 50-10-27-20726 consists of two trails (one stepping stone and one cobble), designated Features A and B, which are in good condition and located on ‘a‘ā lava.

Feature A is a stepping stone trail that crosses the *‘a‘ā* flow in a southwest/northeast direction for a total length of 16.7 m (54.8 ft) before it is no longer discernable [Figure 126]. The flow is somewhat undulating but relatively level. The overall *‘a‘ā* flow is relatively barren; there is more grass in the south and more dense *haole koa* in the north. Construction of the trail consists of flat *pāhoehoe* slabs set into *‘a‘ā* cobbles that are almost contiguous and generally have a diameter of 30 cm (1 ft.). At the trail’s north end are 3 or 4 constructed steps descending from the *‘a‘ā*. Vegetation in the immediate trail area includes *koa haole* and Christmas berry. More stepping stones are present on the northern section of the trail with the number of stepping stones decreasing significantly as the trail extends southward. Feature A crosses the west end of the generally east/west traversing flow in a north/south direction for approximately 80 m (262.47 ft).

Feature B is a worn (i.e. trodden path) cobble trail that extends for a measured length of approximately 60 m (196.8 ft) [see Figure 126]. The south end of Feature B is approximately 20 m (65.6 ft) *mauka* of the south end of Feature A. The trail is relatively free of cobbles and boulders and is discolored by bruising of foot traffic. The trail angles significantly more *mauka* than Feature A at 49 degrees. Vegetation in the immediate area is Christmas berry, otherwise the area is relatively barren. The site’s function is interpreted as transportation. No artifacts or midden were observed at the site. Excavation potential is considered poor.

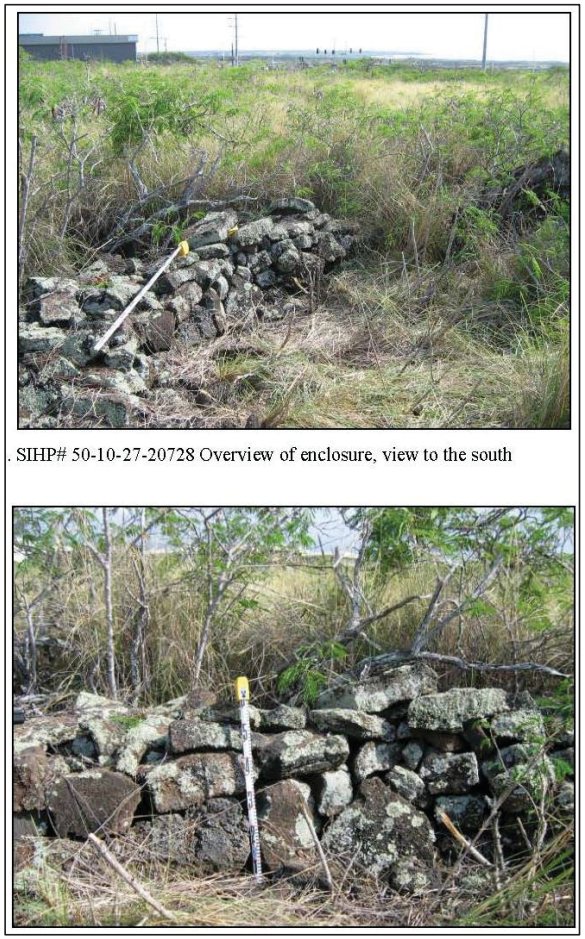
7.1.38 50-10-27-20728 (Bell et al. 2008:165) (Figure 127)

FUNCTION: Temporary habitation
SITE TYPE: Enclosure
TOTAL FEATURES: 1
DIMENSIONS: 18.2 m2 (195.8 ft2)
CONDITION: Fair
AGE: Pre-contact
ELEVATION: 110 ft. a.m.s.l.
DESCRIPTION: Site 50-10-27-20728 [Figure 127] is a semi-circular enclosure located on undulating *pāhoehoe* terrain and is located in the southwest portion of the parcel.



7-20726 Feature A, photograph from south

Figure 126. Photos of SIHP #-20726 Feature A (top) and Feature B (bottom); views to the north (Bell et al. 2008:162)



. SIHP# 50-10-27-20728 Overview of enclosure, view to the south

Figure 127. Photos of SIHP # -20728; views to the south (top) and southeast (bottom) (Bell et al. 2008:167)

The enclosure measures 3.4 m (11.1 ft) north/south by 5.3 m (17.3 ft) east/west. The eastern segment of the enclosure wall is well faced with a maximum height of 0.65 m (2.1 ft) with 3-5 courses of small boulders and larger cobbles [see Figure 127]. The south, north, and west sides of the enclosure are formed by a natural lip in the existing bedrock. The interior of the enclosure is bedrock with scattered boulders. Stones are covered with lichen, indicating that the structure has not been significantly disturbed in recent times. No artifacts or midden were observed at the site. The site's function is interpreted as a temporary habitation site based on the paucity of midden recovered from the test unit and the lack of other associated features. Based upon testing results, no further work is recommended for this site.

Testing Results

Subsurface testing was conducted at Site 20728 to aid in determining the site function, examine cultural deposits, and to attempt to collect datable charcoal for radiocarbon analysis. A 1.0 m by 1.0 m (3.3 ft by 3.3 ft) test unit was placed within the interior of the enclosure abutting the western portion of the faced wall. The unit was excavated to a maximum depth of 18 cm (0.6 ft.) below surface and excavation was terminated upon encountering bedrock. The bedrock at the base of the unit was covered by a 2-3 cm (0.06-0.1 ft.) layer of organic humus and rootlets. There was no soil layer present within the unit and only 7.5 g of *kukui* endocarp were recovered.

7.1.39 50-10-27-20744 (Bell et al. 2008:200) (Figure 128)

FUNCTION: Transportation
SITE TYPE: Trail
TOTAL FEATURES: 1
DIMENSIONS: 15.0 m (75 m2) (49.2 ft (806.8 ft2))
CONDITION: Poor
AGE: Pre-contact
ELEVATION: 120 ft. a.m.s.l.
DESCRIPTION: Site 50-10-27-20744 is a stepping stone trail located on an undulating *ʻaʻā* flow [Figure 128].The immediate trail area lacks vegetation. The trail segment crosses an *ʻaʻā* flow in a north/south direction and measures 15.0 m (49.2 ft) in length by 0.5 m (1.6 ft) wide. The trail is composed of pāhoehoe stepping stones set into *ʻaʻā* cobbles; the stepping stones are well laid in spots. All paving stones measure approximately 20 cm (0.66 ft.) in diameter or less. The stones are evenly spaced and continue for the length of the trail. Numerous attempts were made to follow the trail on both sides of the *ʻaʻā* flow without success; the north end of trail terminates on the *ʻaʻā* flow. It appears that there is some reuse of stones in the area and that this trail may have previously been part of -20722, or that a portion of trail -20744 was replaced by -20722. The site's function is interpreted as transportation. No artifacts or midden were observed. Excavation potential is considered poor.

Figure 128. Photo of SIHP # -20744; view to the northwest (Bell et al. 2008:201)

7.1.40 50-10-27-20745 (Bell et al. 2008:202) (Figure 129)

FUNCTION: Transportation
SITE TYPE: Trail
TOTAL FEATURES: 1
DIMENSIONS: 40 m northeast/southwest
CONDITION: Fair
AGE: Pre-contact
ELEVATION: 120 ft. a.m.s.l.
DESCRIPTION: Site 50-10-27-20745 is a stepping stone trail located on an *‘a‘ā* flow [Figure 129]. The trail crosses the *‘a‘ā* flow in a southwest/northeast direction and measures 28.0 m (91.8 ft) long by 0.7 - 0.8 m (2.3 ft by 2.6 ft) wide. The trail is composed of *pāhoehoe* stepping stones laid in worn *‘a‘ā* cobbles. The stones are evenly spaced and continue for the entire length of the trail. The trail is only visible on the surface of the *‘a‘ā* flow. Attempts were made to follow the trail off the *‘a‘ā* flow without success. The north end of the trail is braided and has been cut off by a bulldozer road. Discoloration of the stones from bruising is pronounced, although not as pronounced as -13493, the most distinct of the numerous trails on this particular *‘a‘ā* flow. The immediate area is vegetation free. An excavated and constructed cupboard, 50 cm (1.6 ft.) across and 70 cm (2.3 ft.) deep, is on the trail’s east side. The site’s function is interpreted as transportation. No midden or artifacts were observed. Excavation potential is considered poor.

Figure 129. Photo of SIHP #-20745; view to the north (Bell et al. 2008:203)

7.1.41 50-10-27-21588 (Gmirkin and Bond 2002:25)

A trail (SP-9) that was located and recorded during a survey by Emory and Soehren (1971) was relocated during the Temporary Sewer Line Survey. This trail was given a state site number (50-10-27-21588) during work by Durst (1999) in Honokohau I and II. The trail begins near Aimakapa Fishpond and runs mauka through Kealakehe and appears to intersect with the Mamalahoa Highway. Where this trail intersects with the a‘ā flow, just makai of Queen Ka‘ahumanu Highway, there is a built up causeway. The causeway is in excellent condition but is outside of the 157 Project Area. This immediate area has had some disturbance evident by bulldozer scarring.

7.1.42 50-10-27-23020 (Rechtman and Escott 2002:9)

Site 23020, recorded earlier by Haun and Henry (2001), is a *pāhoehoe* excavation on a low bedrock outcrop located 170 meters south of Site 23552 and 50 meters west of the proposed pipeline corridor … It consists of an excavated pit 2.7 meters N/S, 1.4 meters E/W, and 0.42 meters deep. A pile of subangular to angular fine-grained basalt cobbles and small boulders measuring 2.2 meters NW/SE by 1.6 meters NE/SW by 0.38 meters high is situated on the eastern side of the excavation pit. The site is unaltered and is interpreted as a basalt quarry.

7.1.43 50-10-27-23021 (Rechtman and Escott 2002:9) (Figure 130)

Site 23021, recorded by Haun and Henry (2001), is a small cave at the base of a large 'a'ā flow, and is located 15 meters west of the proposed pipeline corridor and 185 meters south of Site 23552 …The opening to the cave is located on the *makai* side of the lava flow and opens north into a main chamber that is oval in shape and measures 8.35 meters E/W by 2.75 meters N/S by 0.97 to 1.35 meters high … The cave is dome-shaped and has a bare lava floor, the west end of which is scattered with subangular basalt cobbles and small boulders (Haun and Henry 2001:34, [Figure 130]). Surface stones appear to have been cleared from the center of the eastern end of the main chamber.

7.1.44 50-10-27-23023 (Rechtman and Escott 2002:12)

Site 23023 was recorded by Haun and Herny (2001) as a 33 meter long *pāhoehoe* stepping stone trail segment across an *'a'ā* flow. This segment is situated roughly 10 meters *mauka* of the current survey corridor. Inspection of the site during the current study indicates that this remnant trail extends through the current study corridor in the central portion of the project area, roughly 75 meters north of Site 23553 … Roughly 40 meters of intact trail were documented during the current study where it crosses an *'a'ā* flow at an orientation of 317°/137°. The trail is defined by small *pāhoehoe* cobbles and small *pāhoehoe* slabs placed on the *'a'ā* flow at 0.5 to 2.8 meter intervals The trail segment extends *makai* from where it was previously recorded on a *pāhoehoe* flow, is approximately 190 meters long oriented at 282°/102°, and has been modified by a bulldozer road along 85 meters of its central course. The trail is defined by light tread wear that appears as a slightly darker discoloration on the ground surface … and is no longer visible in many places. The likely junction of the newly recorded segment and the previously recorded segment is situated within a grubbed area making it difficult to discern. The trail's western terminus is no longer visible where it crosses a heavily vegetated *pāhoehoe* flow. This site appears to be a portion of the trail shown on the Emerson's 1880s Map of Kailua ... The trail has been significantly altered and is interpreted as a transportation route.

7.1.45 50-10-27-23026 (Haun and Henry 2001:36, 38)

Site 23026 is a complex of five cairns located on a level pahoehoe flow near the eastern project area boundary, 292 m east of Site 23024. The features are situated in an area 9.5 m long (northwest by southeast) by 5.0 m wide. The Site 23026 features are unaltered and in good condition, and are interpreted as markers based on their formal type. No cultural remains were present at the site.

Feature A

The Feature A cairn is situated at the eastern end of the site. It consists of five flat pahoehoe slabs stacked on top of each other with a sixth slab leaning up against the western side. The cairn measures 0.68 m long (east-northeast by west southwest), 0.47 m wide, and 0.53 m in height ....

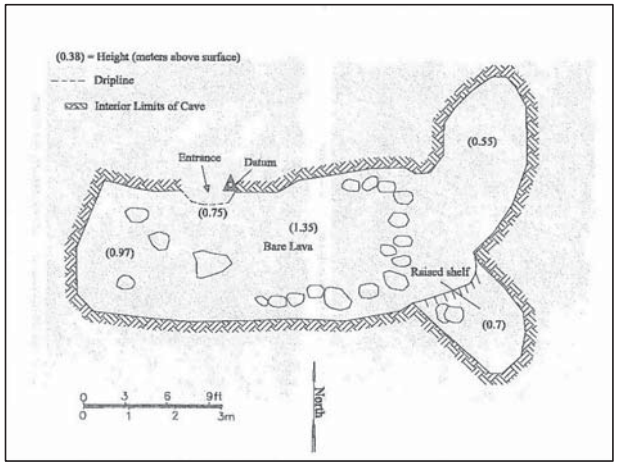


Figure 130. SIHP # -23021 plan view (Haun and Henry 2001:34)

Feature B

Feature B is located 0.35 m south of Feature A. This cairn is comprised of six flat pahoehoe slabs stacked on top of each other. Feature B measures 0.58 m long (north-south), 0.49 m wide, and 0.55 m in height (…).

Feature C

The Feature C cairn is located 3.7 m south-southwest of Feature B. It is comprised of two flat pahoehoe slabs that are leaning up against each other. The feature measures 0.51 m long (east-west) by 0.41 m wide at the base, angling up to a point at the top. Feature C is 0.44 m in height above the surrounding ground surface.

Feature D

The Feature D cairn is situated 2.1 m to the north-northwest of Feature C. It consists of three flat pahoehoe slabs piled on top of each other. It measures 0.69 m long (northeast by southwest), 0.53 m wide and 0.41 m in height.

Feature E

Feature E is located 6.3 m north-northwest of Feature D, and 6.5 m northwest of Feature A. It consists of six flat pahoehoe slabs stacked on top of each other with a seventh slab leaned up against the western side. The feature measures 0.72 m long (north-south), 0.65 m wide and 0.43 m in height.

7.1.46 50-10-27-23029 (Haun and Henry 2001:38)

Site 23029 is a pahoehoe excavation situated in the southeastern comer of the project area. The site is located on the southern side of a low pahoehoe knoll, 147 m southeast of Site 23028. A hole measuring 3.2 m long (east-west), 1.6 m wide, and 0.75 m in depth has been excavated into the base of the knoll. Stone removed from the hole have been piled to the south and southeast of the hole. This pile is 2.75 m long (northeast by southwest), 1.5 m wide, and 0.7 m in height. These stones consist of angular fine-grained basalt cobbles and small boulders. No soil or other cultural remains were present. Site 23029 is unaltered and in good condition. It is interpreted as a basalt quarry.

7.1.47 50-10-27-23033 (Haun and Henry 2006:100)

Site 23033 is small overhang located on the eastern side of a pahoehoe ridge within the corridor in the inland portion of Kealakehe seaward of the Queen Ka'ahumanu Highway at c. 81 ft elevation. This site was previously identified by Haun and Henry (2001). The entrance to the overhang faces the northeast, measuring 2.05 m long (northwest by southeast) and 1.0 m in height … The interior of the overhang is oval-shaped and is 2.7 m long (northeast by southwest) and 2.5 m wide. The overhang has a domed-shaped ceiling that is 1.3 m in height. The floor of the overhang consists of jagged lava. A series of ten flat pahoehoe slabs have been placed inside the overhang to create a relatively level surface. These slabs vary in length from 0.3 to 0.65 m, in width from 0.19 to 0.4 m, and in thickness from 0.11 to 0.2 m. No cultural remains were present at the site. Site 23033 was interpreted as a temporary habitation based on its formal type and the presence of the pahoehoe slab floor. It is unaltered and in good condition.

7.1.48 50-10-27-23047 (Haun and Henry 2001:47)

Site 23047 is a cairn situated on an uneven pahoehoe lava flow, 133 m south of Site 23046. It is comprised of stacked and piled subangular basalt cobbles, small boulders, and flat pahoehoe slabs. The cairn is 0.8 m long (northwest by southeast) and 0.7 m wide at the base. The top of the cairn is 0.65 m long by 0.55 m wide. The feature is 0.61 m in height. The cairn is built on bare lava and no cultural remains were present. The site is unaltered and in good condition. It is interpreted as a marker based on its formal type.

7.1.49 50-10-27-23048 (Haun and Henry 2001:48)

Site 23048 is a pahoehoe excavation located in the southwestern portion or the project area, 200 m southwest of Site 23047. The site is situated on a level pahoehoe flow and consists of an area 15.0 m long (east-west) by 10.5 m wide from which surface pahoehoe slabs have been broken off and scattered throughout the area … No soil is present in the area, and no other cultural remains were observed. The surface slabs may have been broken off to obtain scoriaceous lava, which is visible in the exposed areas. Site 23048 is unaltered and in good condition. The site is interpreted as an abrader quarry.

7.1.50 50-10-27-23549 (Rechtman and Escott 2002:15) (Figure 131)

Site 23549 is a C-shaped enclosure located in the southeastern comer of the project area, roughly 80 meters south of the Kealakehe Wastewater Treatment Plant access road ... The feature is constructed of loosely piled platy *pāhoehoe* cobbles, is 3.0 meters N/S, 3.2 meters F/W, and is 0.7 meters in height [Figure 131]. The interior measures 2 meters N/S and 1.75 meters F/W. The *pāhoehoe* cobbles of the enclosure range from 0.1 to 0.7 meters in width and are similar to those scattered about the immediate area. The enclosure is situated on the level and fractured surface of a linear *pāhoehoe* knoll that is higher than the surrounding ground surface [Figure 131]. There is no soil on the knoll and no other cultural remains were present within the enclosure or in the surrounding area. The site is unaltered, in good condition and is interpreted as a temporary habitation feature based on its form, size, and insubstantial construction (Cordy 1981).

7.1.51 50-10-27-23550 (Rechtman and Escott 2002:15) (Figure 132)

Site 23550 is a *pāhoehoe* excavation area located approximately 60 meters south of the Kealakehe Wastewater Treatment Plant access road ... The site contains numerous platy *pāhoehoe* cobbles (vesicular basalt) excavated from the naturally fractured bedrock ground surface. The resulting excavation pit is 1.3 meters N/S by 1.8 meters E/W and is 0.8 meters in depth [Figure 132]. A pile of excavated cobbles measuring 3.6 meters N/S by 2.1 meters E/W is located 1 meter north of the pit [Figure 132]. A fragment of cowrie shell was located approximately 1 meter west of the excavation pit, in a narrow crack in the *pāhoehoe* surface extending from the pit area. Neither soil nor any cultural remains were present in the pit. The site is unaltered, in good condition and is interpreted as a basalt quarry.

7.1.52 50-10-27-23551 (Rechtman and Escott 2002:15) (Figure 133)

Site 23551 is a partially collapsed lava blister (Feature A) and a nearby cairn (Feature B) situated on a *pāhoehoe* flow approximately 88 meters west/southwest of Site 23550 … The interior of the blister is oval, has a dome-shaped ceiling, and is 9.5 meters N/S by 6.3 meters E/W by 1.4 meters high at its maximum [Figure 133]. An opening in the blister 2.8 meters N/S by 6.0 meters E/W by 1.3-1.7 meters high allows access to the interior of the blister to the north [Figure 133]. Blister collapse and roof-fall prevent access to the low interior to the east, west and south of the opening. The accessible portion of the blister has a southward sloping *pāhoehoe* ground surface that extends north 4.5 meters from the blister opening. Two fragments of cowrie shell and a fragment of *kukui* nutshell were located in the interior of the blister. No soil was present at Feature A.

Feature A is unaltered, in good condition, and is interpreted as a temporary habitation. Feature B is a cairn located approximately 17 meters (@ 64°) from Feature A. The cairn is constructed of stacked basalt cobbles surrounding and supporting a milled and painted 2x4 post. No other cultural remains were present. The feature is interpreted as a modem survey marker.

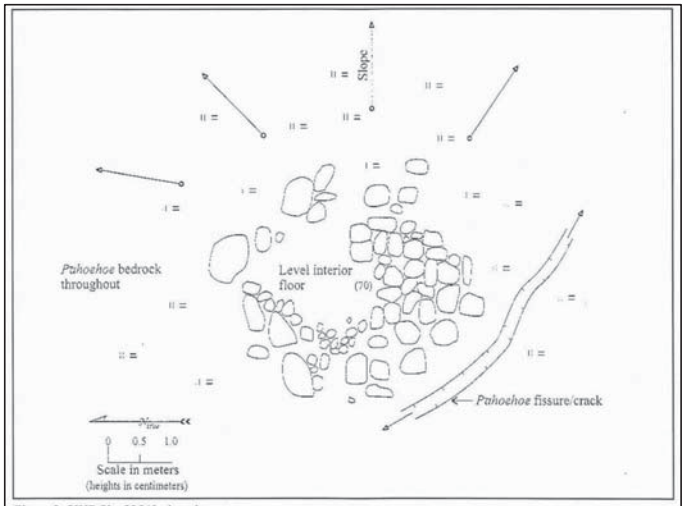


Figure 9. SIHP Site 23549 plan view.

Figure 131. SIHP # -23549 site plan and photo (view to the southwest) (Rechtman and Escott 2002:16)

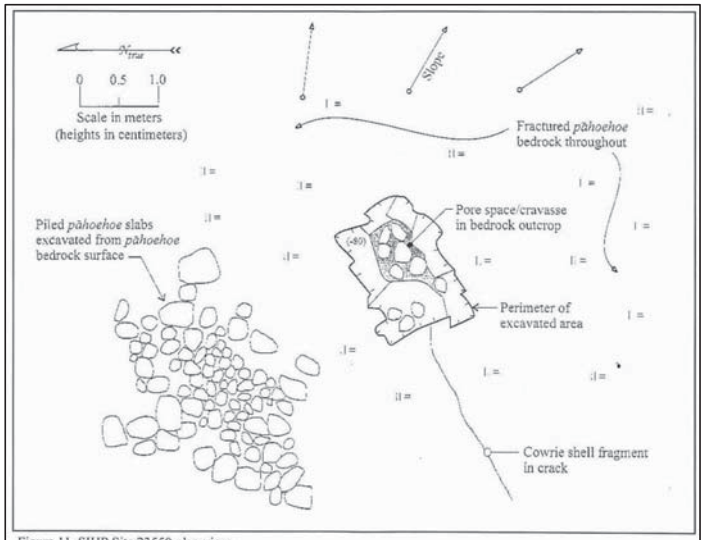


Figure 11. SIHP Site 23550 plan view.

Figure 132. SIHP # -23550 plan view and photo (view to the north) (Rechtman and Escott 2002:17)

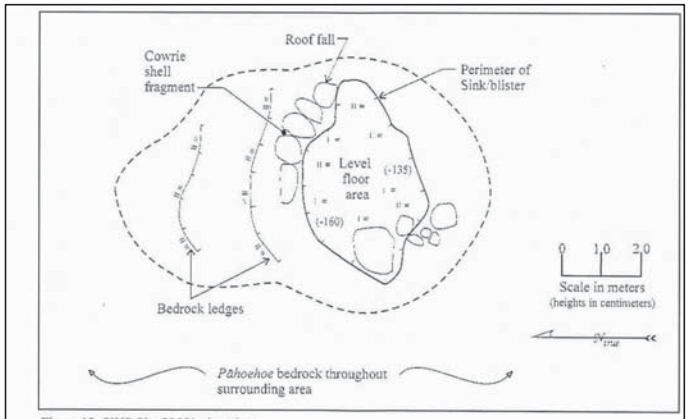


Figure 13. SIHP Site 23551 plan view.

Figure 133. SIHP # -23551 plan view and photo (view to the northeast) (Rechtman and Escott 2002:18)

7.1.53 50-10-27-23552 (Rechtman and Escott 2002:15) (Figure 134)

Site 23552 is a *pāhoehoe* excavation located in the study area utility corridor, approximately 400 meters south of Kealakehe Parkway ... The site is situated on the fractured surface of a 1evel *pāhoehoe* outcrop. Removal of the loose *pāhoehoe* surface has left a pit 4.25 meters NW/SE by 1.45 meters NE/SW by 0.8 meters deep [Figure 134]. Around the perimeter of the pit are two concentrations of vesicular basalt cobbles: one along the *mauka* edge of the pit and one along the southwestern edge [Figure 134]. There was no soil nor any cultural remains present. The site is unaltered and is interpreted as a basalt quarry.

7.1.54 50-10-27-23553 A (Rechtman and Escott 2002:15) (Figure 135)

Site 23553 is a remnant portion of *mauka*/*makai* trail (Feature A) and a cairn (Feature B) located approximately 30 meters west of the project area proposed pipeline corridor and 470 meters northeast of the Kealakehe Wastewater Treatment Plant access road… The trail is clearly visible on the surface of the friable cinder *'a'a* flow as a narrow pathway of slightly darker and slightly smaller, worn and crushed *'a'a* clinkers [Figure 135]. It is barely visible at its eastern and western termini, where it is situated on a more heavily vegetated *pāhoehoe* flow. It is likely that the trail crosses the proposed pipeline corridor and may have branched from the trail previously identified Site 23023 (85 meters west), but the connection is no longer visible.

The trail segment is 150 meters long and is orientated at 290°/110°. From the eastern terminus, it continues approximately 42 meters before splitting into two separate trails. The main trail segment continues roughly 46 meters at 290°, while the secondary segment is 55 meters long and makes an arc to the north before rejoining the main trail at a collapsed cairn. From the cairn, the trail is visible for another 20 meters where the lack of visible wear on the *pāhoehoe* makes it difficult to identify.

7.1.55 50-10-27-25549 (Haun and Henry 2006:100)

Site 25549 is an inland-seaward oriented trail located in the northeastern section of the project area in the Land of Kealakehe at elevations that range from 43 to 44 ft. The site was identified during the present project. The trail extends across an area of uneven a'a lava and is comprised of a 0.8 to 1.2 m wide cleared path through the uneven terrain with irregularly spaced flat pahoehoe slabs…. The inland end of the trail originates on the seaward side of a recently bulldozed road cut, to the west of tile Mamalahoa Highway. It extends 66.0 m in a roughly westerly direction where it terminates along the interface with an area of pahoehoe lava ... No cultural remains were found in association with the trail. Site 25549 is interpreted as a transportation route across the a'a lava based on its location and formal type. The site is altered and in fair to good condition.

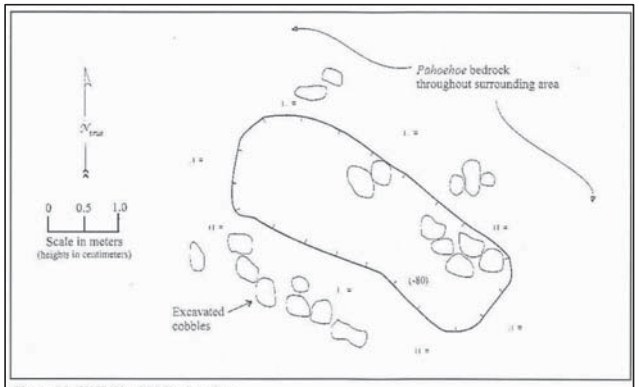


Figure 15. SIHP Site 23552 plan view.

Figure 134. SIHP # -23552 plan view and photo (view to the southeast) (Rechtman and Escott 2002:19)

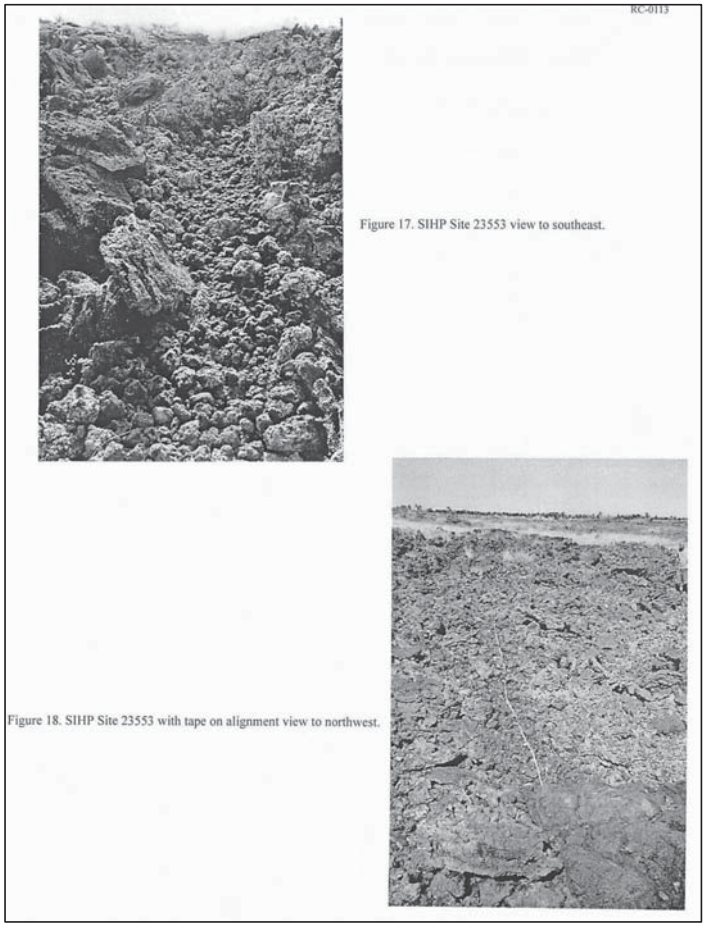


Figure 17. SIHP Site 23553 view to southeast.

Figure 18. SIHP Site 23553 with tape on alignment view to northwest.

Figure 135. Photos of SIHP # -23553 Feature A (Rechtman and Escott 2002:20)

7.1.56 50-10-27-25552 (Haun and Henry 2006:103) (Figure 136)

Site 25552 is a roughly L-shaped wall situated in an area of uneven a'a lava in the northeastern section of the project area in the Land of Kealakehe at c. 42 ft elevation. The wall is 4.35 m long (east-west) and 3.1 m long (north-north-northwest by south-southeast) and is built of stacked and piled cobbles and flat pahoehoe slabs with a large uplifted slab located at the eastern end [Figure 136]. The wall ranges in width from 0.5 to 0.68 m and in height from 0.85 to 1.2 m and the uplifted slab measures 2.35 m long, 0.4 to 1.15 m wide and from 1.2 to 1.4 m in height. The area surrounding the wall is comprised of uneven a'a lava with no soil present. A *Cypraea sp.* shell is present on top of the uplifted slab at the eastern end. Site 25552 is interpreted as a possible temporary habitation shelter based primarily on its formal type, insubstantial construction (stacked and piled stones) and area (13.4 sq m). The site is unaltered and in fair condition.

7.1.57 50-10-27-25553 (Haun and Henry 2006:103)

Site 25553 is a cairn located in the northeastern section of the project area in the Land of Kealakehe at c. 42 ft elevation. The site is located on an uneven a'a lava flow situated on the inland side of an area of level pahoehoe lava. The cairn is built of roughly stacked and piled cobbles and small boulders, measuring 0.5 m long (north-south) by 0.48 m wide at the base with sloping sides…The top of the cairn is capped with a a'a cobble that is 0.38 in height above the uneven a'a lava. No cultural remains were found in association with the cairn. Site 25553 is interpreted as a marker based on its formal type. It is unaltered and in fair condition.

7.1.58 50-10-27-25554 (Henry and Henry 2006:103, 107) (Figure 137)

Site 25554 is a low walled enclosure located in the northeastern section of the project area in the Land of Kealakehe at c. 41 ft elevation. The site is built on a level pahoehoe flow to the west of an area of uneven a'a lava. The enclosure is rectangular in shape and is 4.1 m in length (north-northwest by south-southeast) and 3.65 m wide [Figure 137]. There is a 0.5 m wide opening into the interior in the western wall. The walls of the enclosure are built of stacked and piled cobbles and small boulders with collapse present along the exterior north, west and south sides and in the interior northwest, northeast and southeast comers. The intact walls range in width from 0.55 to 0:77 m and in height from 0.2 to 0.51 m. The interior of the enclosure consists of bare pahoehoe lava with no cultural remains present.

Site 25554 is interpreted as the foundation for a permanent habitation roofed structure. Though slightly smaller in area than a typical house foundation (14.95 sq m), its formal type and substantial construction (vertical slabs) suggest it potentially functioned in this capacity. The site is unaltered and in fair condition.

7.1.59 50-10-27-25556 (Haun and Henry 2006:107) (Figure 138)

Site 25556 is an irregularly-shaped stone alignment situated in an area of level pahoehoe lava in the Land of Kealakehe, south of the spoil pile area and seaward of the sewage treatment plant at c. 39 ft elevation. The alignment is comprised of a single course of small, flat pahoehoe slabs, aligned in an irregular configuration

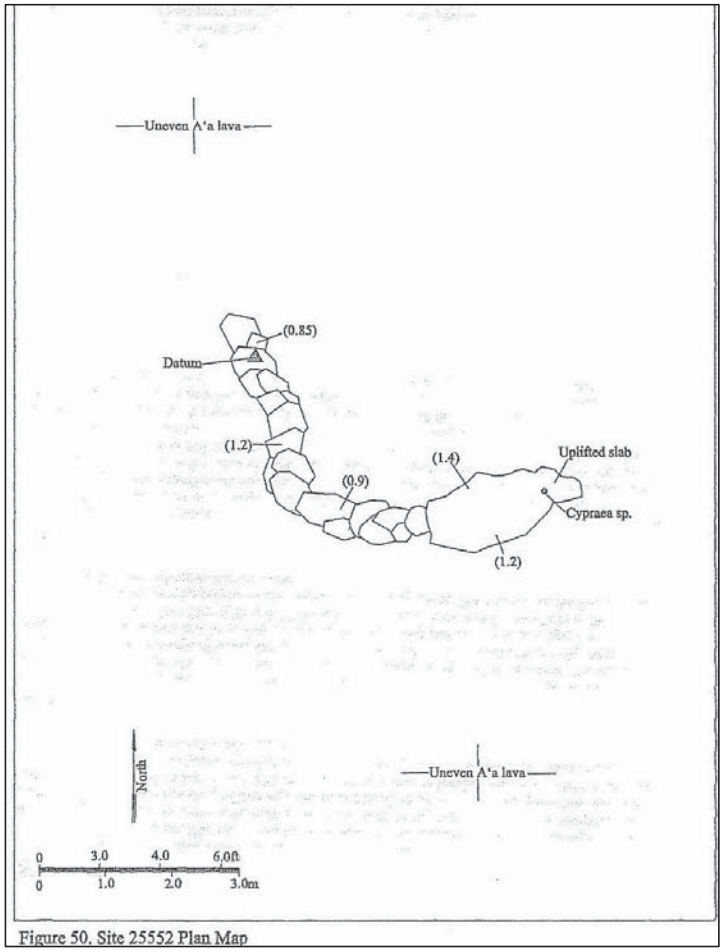


Figure 136. SIHP #-25552 plan view from Haun and Henry 2006:105

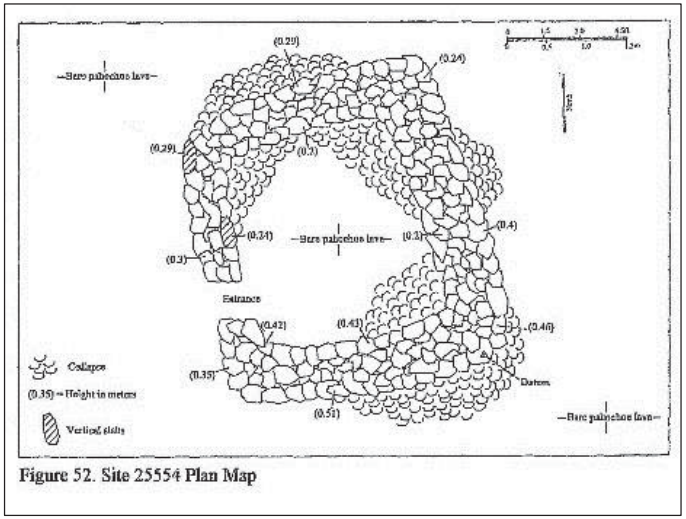


Figure 137. SIHP #-25554 plan view from Haun and Henry 2006:106

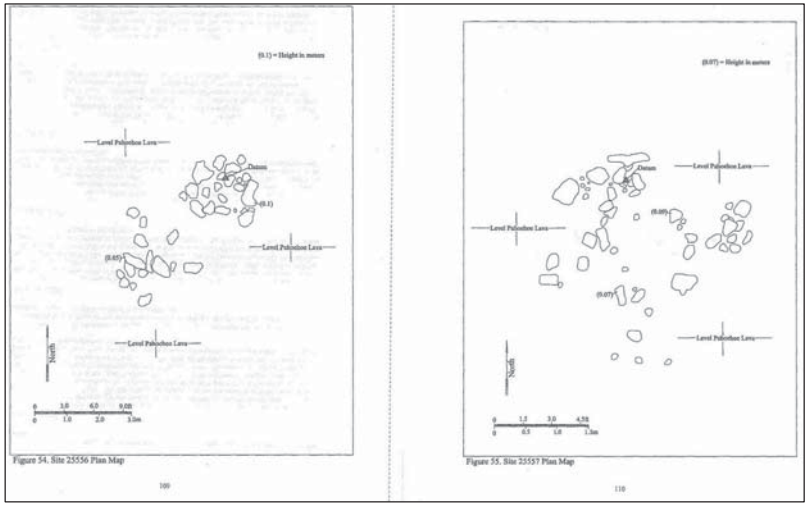


Figure 138. SIHP #-25556, -25557 plan views from Haun and Henry 2006:109-110

that is 5.55 m long (northeast by southwest) and 2.47 m wide [Figure 138]. The individual slabs range in size from 0.12 to 0.8 m long, 0.07 to 0.65 m wide and 0.05 to 0.1 m in thickness. No soil or cultural remains were present in association with the alignment. The function of the feature is undetermined. It is unaltered and in fair condition.

7.1.60 50-10-27-25557 (Haun and Henry 2006:107) (see Figure 138)

Site 25557 is a Slone alignment situated in an area of level pahoehoe lava in the Land of Kealakehe, 25.0 m south-southeast of Site 25556 at c. 38 ft elevation. The alignment is comprised of a single course of small, flat pahoehoe slabs and sub angular cobbles aligned in a roughly oval-shaped configuration that is 3.58 m long (east-northeast by west-southwest) and 2.54 m wide [see Figure 138]. The individual stones range in size from 0.07 to 0.65 m long, 0.05 to 0.35 m wide and 0.07 to 0.09 m in thickness. No soil or cultural remains were present in association with the alignment. The function of tile feature is undetermined. It is unaltered and in fair condition.

7.1.61 50-10-27-25558 (Haun and Henry 2006:107) (Figure 139)

Site 25558 is a stone alignment situated in ail area of level pahoehoe lava in the Land of Kealakehe, 45.0 m south-southwest of Site 25557 at c. 37 ft elevation. The alignment is comprised of a single course of small, pahoehoe slabs aligned in a roughly oval-shaped configuration that is 2.79 m long (east-west) and 2.19 m wide [Figure 139]. The majority of the slabs are positioned flat on the ground, ranging in length from 0.1 to 0.57 m, in width from 0.07 to 0.45 ill and in thickness from 0.06 to 0.08 m. One slab was positioned vertically measuring 0.26 ill long, 0.1 m wide and 0.32 m in height. No soil or cultural remains were present in association with the alignment. The function of the feature is undetermined. It is unaltered and in fair condition.

7.1.62 50-10-27-25643 (Haun and Henry 2006:210) (Figure 140)

Site 25643 is a stone alignment situated in the Land of Keahuolu in an area of relatively level pahoehoe lava at c. 75 ft elevation. The alignment is comprised of one to two courses of pahoehoe slabs aligned in a roughly oval-shaped configuration that is 2.56 m long (north-south) and 2.18 m wide [Figure 140]. The majority of the slabs are situated flat on the ground although three are position vertically on edge. The individual stones range in length from 0.08 to 0.79 m and in width from 0.05 to 0.44 m. The flat slabs range in thickness from 0.15 to 0.21 m and the vertical slabs are from 0.45 to 0.58m in height. No soil or cultural remains were present in association with the alignment. The function of the feature is undetermined. It is unaltered and in fair condition.

7.1.63 50-10-27-27279 (Reeve et al. 2012 Appendices:161-162)

Field Number: T-009
Site Type: Modified Overhang
Artifacts: None Observed
Midden: None Observed

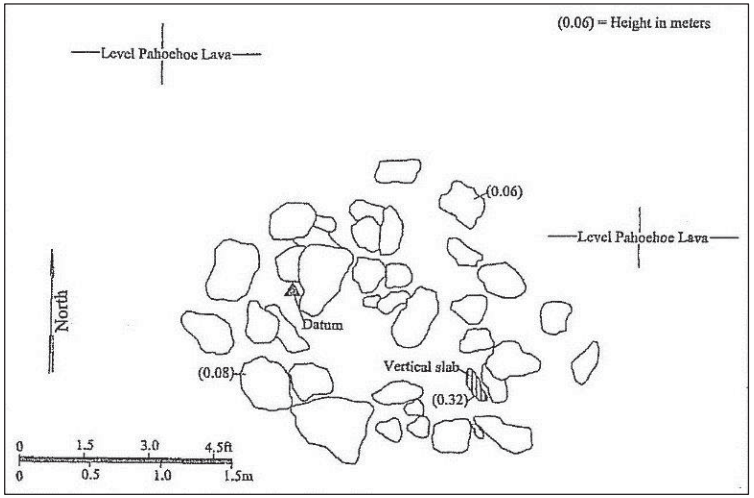


Figure 139. SIHP # -25558 plan view (Haun and Henry 2006:111)

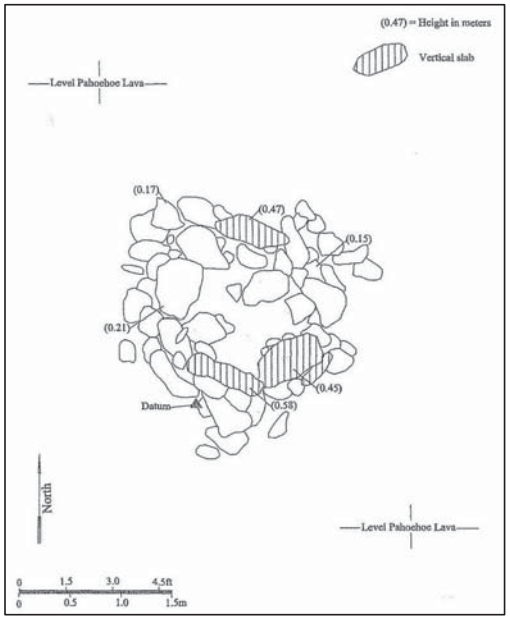


Figure 140. SIHP # -25643 plan view (Haun and Henry 2006:212)

Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Storage
Description: Site 50-10-27-27279(T-009) is a modified overhang located at the western end of the base of a sinkhole. The sinkhole measures approximately 10.0 meters in length (east to west) by c. 7.0 meters (north to south) and it measures c. 1.2 meters deep. Site 50-10-27-27279(T-009) is located approximately 50.0 meters northeast (60° az.) from the pipeline road and approximately 15.0 meters east to northeast (69° az.) from Site 50-10-27-27280 (T-010). The crevice is filled with small to large sub angular basalt cobbles and small sub angular basalt boulders. The surface of the fill is irregular and is roughly level with the surrounding bedrock. At the east end of the fill is a loose pile constructed of small to medium basalt cobbles piled 2-3 courses. The pile measures c. 0.60 meters (north to south) by c. 0.30 meters (east to west) and is c. 0.30 meters in height. The overall filled crevice

measures c. 1.7 meters (east to west) by 0.65 meters (north to south). The filled crevice is in fair condition and the integrity is good. There was no cultural material observed. It appears the fill is traditional in age and the possible function is storage.

7.1.64 50-10-27-27280 (Reeve et al. 2012 Appendices:162) (Figure 141)

Field Number: T-010
Site Type: Filled Crevice
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Good
Possible Age: Traditional
Possible Function: Uncertain
Description: Site 50-10-27-27280 (T-010) [Figure 141] consists of a single filled crevice in an area of gently undulating *pāhoehoe* lava in the northeastern quadrant of the work area. The feature is situated approximately five meters northwest from a natural overhang and c. 15 meters southwest (240° az.) from the Site 50-10-27-27279 (T-009) modified sinkhole. The surrounding vegetation consists of scattered fountain grass and Christmas berry shrubs. A relatively shallow natural crevice in the lava has been filled with small to medium cobbles to create a fairly level surface. The stones are closely piled at least two courses deep. The area of the fill is roughly oval in shape and follows the northwest to southeast axis of the crevice. It measures approximately 1.70 meters in length by c. 0.70 meters in width. The surface of the fill is c. 0.11 meters below the surrounding ground surface. The feature appears to be in good condition. No cultural material was observed in the surrounding area. It is uncertain why this natural depression in the *pāhoehoe* was intentionally filled. It appears too shallow to contain a burial. The age of this feature is also not uncertain, though given the amount of effort involved it is most likely of traditional construction.

7.1.65 50-10-27-27282 (Reeve et al. 2012 Appendices:164-165)

Field Number: T-012
Site Type: Sinkhole
Artifacts: None Observed
Midden: Present
Skeletal Remains: None Observed
Condition: Good
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27282 (T-012) consists of a unmodified sinkhole with two identified *kukui* nut shells. The sinkhole is located along a fairly level *pāhoehoe* flat surrounded by scattered fountain grass. It is 20 meters southeast (122° az.) from site T-009. The opening of the sinkhole measures approximately 4.50 meters (north to south) by 3.60 meters (east to west) and it is approximately 3.00 meters deep. The sinkhole is unmodified with roof collapse debris along the northwest rim. One

Figure 141. Photo of SIHP #-27280; view to the southeast (Reeve et al. 2012 Appendices:163)

kukui nut shell is located in the northwest overhang of the sinkhole on a fairly level surface measuring c. 2.40 meters deep with an average of c. 1.0 meter overhang ceiling space above.

The second *kukui* nut shell is a fragment with a c. 1 centimeter diameter hole (probably natural). The fragment measures approximately 3 centimeters by c. 1.5 centimeters. The outer husk and inner nut were not observed. A small chamber to the north contains a second *kukui* net shell fragment. The chamber measures roughly c. 2.9 meters (east to west) by c. 1.5 meters (north to south) and an average ceiling height of c. 0.50 meters. The floor of the overhang contains collapsed roof fall. The *kukui* nut shell is located on the west end of the chamber. The fragment is nearly complete and approximately 2.5 centimeters in diameter. The outer husk and inner nut were not observed. No artifacts, shell midden or coral were observed. Although no shell midden was found, the presence of *kukui* nut shells suggests some human use of the sinkhole. Given the surrounding environment the *kukui* nut shell fragment's presence in the cave is most likely due to human activity.

7.1.66 50-10-27-27285 (Reeve et al. 2012 Appendices:169) (Figure 142)

Field Number: T-016
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27285 (T-016) is a C-shaped wall located within a widely spaced cluster of somewhat similar sites in the inland portion of the survey area [Figure 142]. The site is situated on a level stretch of grass covered *pāhoehoe* approximately 80.0 meters west (265° az.) from the site 50-10-27-27284 (T-014) slab walled enclosure. The C-shape is open to the east and the larger *pāhoehoe* slabs are located at the western end of wall, opposite the opening, suggesting that it was built to block a westerly sea breeze. It is constructed of small to medium *pāhoehoe* boulder slabs ranging in length from 0.28 to 0.75 meters. Though the structure is now somewhat disturbed it is still possible to observe that many of its slabs were originally set on edge. The wall measures c. 2.1 meters in length across the wings (north to south) by c. 2.9 meters in depth (east to west). It ranges in height from c. 0.35 to c. 0.57 meters. The interior of the structure measures c. 0.9 meters north to south by 1.7 meters east to west. This interior consists of level *pāhoehoe* bedrock. The site is in fair condition, though somewhat collapsed. No cultural material was observed in the vicinity. The wall appears to be of traditional construction and was probably originally built as a temporary shelter.

7.1.67 50-10-27-27298 (Reeve et al. 2012 Appendices:194) (Figure 143, Figure 144)

Field Number: T-030
Site Type: Complex
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27298 (T-030) is a complex consisting of two mounds. The site is located approximately 100 meters west (226° az.) from Site 50-10-27-27297 (T-029) on a low and relatively flat east to west oriented *pāhoehoe* ridge. Although the ridge is relatively low, it provides a good view of the surrounding area, suggesting that in their original condition the mounds could have been seen from some distance. The surrounding terrain consists of undulating *pāhoehoe* lava with scattered fountain grass. Site 50-10-27-27298 appears to be traditional in age and the two mounds may have served as some form of marker. Both mounds are constructed directly atop fairly level, exposed *pāhoehoe* outcrop. The site tag is on Feature A.

Feature: A [Figure 143]
Feature Type: Stone Mound
Artifacts: None Observed

Figure 142. Photo of SIHP # -27285; view to the west (Reeve et al. 2012 Appendices:170)

Figure 143. Photo of SIHP # -27298 Feature A; view to the east (Reeve et al. 2012 Appendices:195)

Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27298 (T-030), Feature A is a relatively large, roughly rectangular mound that is badly tumbled. The mound is constructed of small to large subangular basalt cobbles and small subangular basalt boulders loosely piled 2 to 4 courses high. It is highest at the center and appears to be tumbled on all sides. Feature A measures c. 1.7 meters in length (east to west) by c. 1.2 meters in width (north to south) and has a maximum height of c. 0.52 meters. No surface cultural material was observed in vicinity of the Feature A mound.

Feature: B [Figure 144]
Feature Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27298 (T-030), Feature B is a smaller, low, roughly circular mound located approximately 5.0 meters south of Feature A. It is constructed of small subangular boulders and small pāhoehoe slab boulders loosely piled 2 courses high. This mound is in poor condition and has scattered *pāhoehoe* slabs on its north end. Feature B is 1 to 2 courses high. It measures c. 1.0 meter in length (north to south) by c. 0.80 meters in width (east to west) with a maximum height of c. 0.35 meters. No surface cultural material was observed in the vicinity of Feature B.

7.1.68 50-10-27-27299 (Reeve et al. 2012 Appendices:197) (Figure 145)

Field Number: T-031
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27299 (T-031) consists of a somewhat disturbed C-shaped wall [Figure 145]. The site is located c. 90 meters northeast (30° az.) from the intersection of the main to Campsite Road and the Pipeline Access Road. It is c. 15 meters southeast (140° az.) from Site 50-10-27-27300 (T-032). Site 50-10-27-27299 (T-031) is situated on a patch of smooth and relatively level *pāhoehoe* within undulating *pāhoehoe* terrain and is surrounded by fountain grass. The C-shape forms a very slight arc, open to the northeast. It is constructed of *pāhoehoe*

Figure 144. Photo of SIHP #-27298 Feature B; view to the north (Reeve et al. 2012 Appendices:196)

Figure 145. Photo of SIHP # -27299; view to the southwest (Reeve et al. 2012 Appendices:198)

cobbles and boulders, loosely stacked to a maximum of 2 courses high, but badly tumbled. The exterior length of the structure across the wings is approximately 1.6 meters. The exterior depth measures c. 1.1 meters. The interior length is c. 0.95 meters and the interior depth measures c. 0.50 meters. The maximum wall height is c. 0.21 meters and the average wall thickness is c. 0.30. The C-shape is badly disturbed. No surface cultural materials were found in or around the area. This site may have served as a temporary shelter built and used during the pre-Contact period.

7.1.69 50-10-27-27300 (Reeve et al. 2012 Appendices:199) (Figure 146)

Field Number: T-032
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27300 (T-032) consists of a badly disturbed C-shaped wall [Figure 146]. The site is approximately 100 meters north (15° az.) from the intersection of the main to Campsite Road and the Pipeline Access Road, and c. 15 meters northwest (320° az.) from Site 50-10-27-27299 (T-031). It is located on a level *pāhoehoe* flat within undulating *pāhoehoe* terrain and surrounded by fountain grass. The C-shape is open to the northeast. It is composed of a scattered alignment of *pāhoehoe* cobbles and small boulders that appear to have originally been loosely stacked. The structures exterior length between the wings measures c. 2 meters and the exterior depth measures c. 1.5 meters. The interior length between the wings measures c. 1.3 meters and the interior depth measures c. 0.90 meters. The maximum height of the wall is c. 0.16 meters and the average thickness of the wall is approximately 0.30 meters. The C-shape is badly disturbed. The center of the wall appears to have tumbled into the interior, leaving the C-shape 1 course high. No surface cultural material was observed. This structure may have served as a temporary habitation site, although interpretation is difficult given the disturbed nature of the site.

7.1.70 50-10-27-27301 (Reeve et al. 2012 Appendices:201)

Field Number: T-033
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation

Figure 146. Photo of SIHP #-27300; view to the southwest (Reeve et al. 2012 Appendices:200)

Description: Site 50-10-27-27301 (T-033) consists of a circular *pāhoehoe* slab enclosure. The site is approximately 90 meters north (347° az.) from Site 50-10-27-27300 (T-032) and is approximately 20 meters northwest from the Pipeline Access Road. It is located on patch of relatively smooth and level *pāhoehoe* with irregular *pāhoehoe* surfaces and fountain grass immediately outside of the enclosure. The enclosure is constructed of large *pāhoehoe* cobbles and small boulder slabs. Several of the slabs, though tumbled, may have originally been placed upright, increasing the overall height of the structure. There is a concentration of slabs along the southern wall suggesting that this may have been the direction of the prevailing wind at the time the structure was built. Three of these are still set upright. The enclosure measures approximately 2.2 meters in diameter on its exterior, and its interior measures approximately 1.3 meters in diameter. The site is in fair condition and the south side of the structure maintains greater integrity than the north. No surface cultural materials were observed. This structure may have been used as a temporary habitation site. The site tag is located along the southern wall area.

7.1.71 50-10-27-27302 (Reeve et al. 2012 Appendices:201)

Field Number: T-036
Site Type: Enclosure
Artifacts: None Observed

Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27302 (T-036) is a circular stone enclosure. It is located on a level *pāhoehoe* flat c. 15 meters west from the waste water treatment plant and c. 90 meters west (248° az.) from Site 50-10-27-27299 (T-031). The enclosure is constructed of *pāhoehoe* cobbles and small boulder slabs and small subangular boulders. The slabs and boulders are loosely stacked up to 2 courses high with some positioned upright at the southwest end. The eastern area has collapsed outward while the southwest and northeast areas appear to have partially collapsed into the interior of the enclosure. The exterior of the enclosure measures approximately 2.3 meters in diameter and the interior measures approximately 1.3 meters. The maximum wall height is c. 0.39 meters, with an average wall thickness averaging 0.40 meters. The enclosure is in poor to fair condition with many of the slabs and boulders tumbled. No cultural material was observed. The site tag is located at the east end of the enclosure.

7.1.72 50-10-27-27304 (Reeve et al. 2012 Appendices:204)

Field Number: T-039
Site Type: Battering
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Processing
Description: Site 50-10-27-27304 (T-039) is a roughly circular area of battered *pāhoehoe* bedrock located on flat *pāhoehoe* ground in a swale between two low east to west oriented *pāhoehoe* ridges. The surrounding vegetation consists of fountain grass. Bulldozing scars were observed approximately 1.0 meters to the west in same panel of pāhoehoe bedrock. The panel measures c. 5.0 meters in length (north to south) by c. 2.5 meters in width (east to west) and is approximately 3.0 meters east of pipeline access road. The site tag is on south end of battering. This battering probably represents an area where something was processed during the pre-Contact period.

7.1.73 50-10-27-27305 (Reeve et al. 2012 Appendices:204)

Field Number: T-040
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor

Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27305 (T-040) is a low, C-shaped wall constructed of small-large *pāhoehoe* slab cobbles and small *pāhoehoe* slab boulders with a few small subangular basalt boulders. It is located on a fairly level *pāhoehoe* flat, surrounded by fountain grass, and is approximately 5.0 meters west of pipeline access road. The site is constructed on a *pāhoehoe* bedrock surface and the interior consists of a natural bedrock surface. It opens to southeast, and is in very poor condition. It is 2 courses high at northwest end. The other sides are 1 course high. The interior dimensions measure c. 1.30 meters (north/south) by c. 1.10 meters (east/west). The possible function is habitation. The site tag is located at the north end.

7.1.74 50-10-27-27308 (Reeve et al. 2012 Appendices:210)

Field Number: T-045
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27308 (T-045) is a badly disturbed roughly circular mound. It is located on level north to south oriented *pāhoehoe* ridge and is constructed on ropy a *pāhoehoe* surface surrounded by undulating *pāhoehoe* and fountain grass. It is constructed of small *pāhoehoe* slab boulders and small subangular basalt boulders 1 course high. One scattering area of small-large subangular basalt cobbles is located approximately 8.0 meters southwest and a second area of scattered small *pāhoehoe* slab boulders located approximately 8.0 meters northwest. It is also 1 course high. Both may have been possibly stacked at one time but are heavily destroyed presently. The first scatter measures c. 1.20 meters in length (north/south) by c. 0.90 meters in width (east/west) with a height of c. 0.19 meters. The second scatter measures c. 1.30 meters in length (north/south) by c. 0.80 meters in width (east/west), with a height of c. 0.25. They possibly functioned as markers, as the surface of the site is too ropy for habitation. The site tag is on the center.

7.1.75 50-10-27-27378 (Reeve et al. 2012 Appendices:275–276)

Field Number: T-116
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional

Possible Function: Marker
Description: Site 50-10-27-27378 (T-116) consists of a stone mound. It is located on an east to west oriented ridge at the north boundary of the project area, directly east of the waste water treatment plant. The mound is constructed of fairly level *pāhoehoe*. Vegetation in the area consists of scattered tufts of fountain grass. The mound is constructed of subangular basalt large cobbles and small and medium boulders. The mound is badly disturbed with only nine scattered stones remaining in a roughly circular shape with no stacking or piling. The mound measures c. 1.60 meters in length by c. 1.10 meters in width with an overall height of c. 0.35 meters. There is a small scatter of cobbles and boulders down slope to the northwest. The site is in poor condition. No cultural materials were observed in or around the sites. This may have been a marker for the *ahupua‘a* boundary. Site tag is in the center of the mound.

7.1.76 50-10-27-27379 (Reeve et al. 2012 Appendices:276)

Field Number: T-117
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27379 (T-117) is located on an east to west oriented *pāhoehoe* ridge southeast of the waste water treatment plant. The mound is constructed from boulder sized *pāhoehoe* slabs and medium sized pāhoehoe cobbles. The mound is collapsed but in fair condition. It measures c. 2.5 meters in length by 2.3 meters in width with an average height of c. 0.55 meters. Given its location it is most likely traditional *ahupua‘a* marker. A modern *ahupua‘a* marker is 5 meters northwest. The site tag is located in the center of mound.

7.1.77 50-10-27-27380 (Reeve et al. 2012 Appendices:276)

Field Number: T-118
Site Type: Stone Mound
Artifacts: None Observed
Midden: Present
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27380 (T-118) consists of a stone slab mound. It is located on an east to west oriented ridge, east of the waste water treatment plant. The mound is constructed on fairly level, flat *pāhoehoe*, in an area surrounded by undulating *pāhoehoe* and scattered fountain grass. The mound is composed of *pāhoehoe* slab cobbles and small boulders roughly stacked up to 3 courses. It

measures c. 2.10 meters in lengthy by c. 1.40 meters in width with an average height of c. 0.20 meters. The mound has collapsed creating an oval shape scatter of stones. The site is in fair condition. One cowrie shell fragment is located 1.5 meters north of the mound in a small crevice. No other cultural materials were observed. The site is interpreted as traditional, and may have been used as a boundary marker for the *ahupua'a*.

7.1.78 50-10-27-27381 (Reeve et al. 2012 Appendices:277)

Field Number: T-119
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27381 (T-119) is located on a southwest - northeast running *pāhoehoe* uplift or ridge. The waste water treatment plant is 20 meters north and in plain sight. The surrounding terrain consists of undulating *pāhoehoe* lava with tufts fountain grass scattered around. The mound is constructed from *pāhoehoe* small boulders and cobble. They are loosely piled together. The mound is almost collapsed giving it a poor condition. It measures c. 2.0 meters in length by c. 1.7 meters in width and c. 0.10 meters in height. Given its location most likely a traditional *ahupua'a* boundary marker. The site tag is placed in the center.

7.1.79 50-10-27-27382 (Reeve et al. 2012 Appendices:277)

Field Number: T-123
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Historic
Possible Function: Marker
Description: Site 50-10-27-27382 (T-123) consists of a circular stone slab mound. It is located on an east to west oriented ridge at the northern boundary of the project area, and west of the unpaved road leading to the waste water treatment plant. The terrain surrounding the site consists of undulating *pāhoehoe* lava and scattered fountain grass. The mound is constructed on fairly level, flat *pāhoehoe* with a large area of broken *pāhoehoe* immediately to the north. The mound is composed of subangular basalt cobbles and boulders and slab cobbles and boulders. The perimeter is loosely stacked with both small boulders and small boulder slabs up to 3 courses high. The interior is filled with cobbles. The mound measures c. 0.90 meters in length by c. 0.80 meters in width and is c. 0.45 meters in height. A wooden survey stake with wire attached to one end leans on the mound and most likely

stuck out from the mound at one time. Two survey nails are located directly to the west and a modern mound is directly to the east. The site is in fair condition. No cultural materials were observed. This may have been a marker for the *ahupua'a* boundary.

7.1.80 50-10-27-27398 (Reeve et al. 2012 Appendices:287)

Field Number: T-154
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Good
Possible Age: Modern
Possible Function: Marker
Description: Site 50-10-27-27398 (T-154) consists of a stone mound located atop a *pāhoehoe* ridge toward the northeastern corner of the project area. It is situated c. 5 meters southeast of Site 50-10-27-27379 (T-117). The mound is relatively intact and is constructed of loosely stacked *pāhoehoe* slabs. It is in good condition. The site is located on the northern boundary line of the *ahupua'a* and probably served as a modern survey marker.

7.1.81 50-10-27-27400 (Reeve et al. 2012 Appendices:287-288)

Field Number: T-156
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27400 (T-156) consists of a roughly rectangular stone walled enclosure situated within the floor of a sinkhole. The site is located in the *mauka* portion of the survey area, east of the pipeline access road and north of the main access road. Three walls of loosely stacked stones have been constructed with the edge of the sinkhole forming the back wall of the enclosure. The mound is presently in fair condition. No cultural material was noted at the site, but a waterworn cobble was observed on the ridge to the south. The site appears to have served as a temporary habitation shelter constructed during the pre-Contact period.

7.1.82 50-10-27-27401 (Reeve et al. 2012 Appendices:288)

Field Number: T-157
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed

Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27401 (T-157) is a *pāhoehoe* slab enclosure. The site is located near the southern boundary of the survey area, south of the main access road and east of the pipeline access road. It is situated on a slightly raised area of relatively smooth *pāhoehoe* lava. The roughly oval enclosure is constructed of *pāhoehoe* slabs, which appear to have originally been set on edge. The enclosure is badly collapsed and in poor condition. No cultural material was noted at the site. It seems likely that Site 50-10-27-27401 (T-157) was constructed during the pre-Contact period to serve as a temporary occupation shelter.

7.1.83 50-10-27-27402 (Reeve et al. 2012 Appendices:288)

Field Number: T-158
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27402 (T-158) is a badly disturbed stone mound. The site is located near the southern boundary of the survey area, south of the main access road and east of the pipeline access road. It consists of collapsed mound of *pāhoehoe* slabs situated atop a *pāhoehoe* knoll. The mound is in poor condition. No cultural material was found at the site. It is possible that the mound was built during the pre-Contact period to serve as a marker.

7.1.84 50-10-27-27403 (Reeve et al. 2012 Appendices:289)

Field Number: T-159
Site Type: Complex
Possible Age:
Possible Function:
Description: Site 50-10-27-27403 (T-159) consists of a pair of *pāhoehoe* slab mounds located near the southern boundary of the survey area, south of the main access road and east of the pipeline access road. The two stone mounds rest on a low rise in the *pāhoehoe*. They appear to have been constructed during the pre-Contact period to serve as markers.

Feature: A
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional

Possible Function: Marker
Description: Site 50-10-27-27403 (T-159), Feature A is one of a pair of *pāhoehoe* slab mounds situated on a rise in the *pāhoehoe* lava. The mound is in fair condition. No cultural material was noted at this feature, which may have served as a Traditional era marker.

Feature: B
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27403 (T-159), Feature A is the second of a pair of *pāhoehoe* slab mounds situated on a rise in the pāhoehoe lava. The mound is in fair condition. No cultural material was noted at this feature, which may have served as a Traditional era marker.

7.1.85 50-10-27-27404 (Reeve et al. 2012 Appendices:289–290)

Field Number: T-160
Site Type: Stone Mound
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Marker
Description: Site 50-10-27-27404 (T-160) consists of a rough stone mound. The site is located near the southern boundary of the survey area, south of the main access road and east of the pipeline access road. The mound itself is roughly built of *pāhoehoe* slabs and is in fair condition. No cultural material was found at the site. The mound is likely to have been erected during the pre-Contact period to serve as some form of marker.

7.1.86 50-10-27-27405 (Reeve et al. 2012 Appendices:290)

Field Number: T-161
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27405 (T-161) consists of a C-shaped wall located in the southern portion of the survey area, south of the main access road and just west

of the pipeline access road. The C-shape rests on relatively smooth *pāhoehoe* and is constructed of *pāhoehoe* slabs that appear to have originally been set on edge. The C-shape is in fair condition. No cultural material was noted at the site. It seems probable that the Site 50-10-27-27405 (T-161) C-shape was built during the pre-Contact period to serve as a temporary shelter. An area of possible battering was noted on the *pāhoehoe* bedrock near the structure.

7.1.87 50-10-27-27406 (Reeve et al. 2012 Appendices:290)

Field Number: T-162
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27406 (T-162) consists of the remnants of a *pāhoehoe* slab enclosure. The site is located toward the southern portion of the survey area, almost immediately adjacent to the pipeline access road. The site is located on relatively smooth lava and appears to be a partially collapsed oval *pāhoehoe* slab enclosure, though it may originally have been more of a C-shaped wall. The disturbed nature of the stones makes identification difficult. The structure is in fair condition. No cultural material was noted at the site. Site 50-10-27-27406 (T-162) probably served as a temporary windbreak shelter constructed during the pre-Contact period.

7.1.88 50-10-27-27407 (Reeve et al. 2012 Appendices:290-291)

Field Number: T-163
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27407 (T-163) is a roughly oval enclosure. It is located just north of the southern boundary of the project area, slightly west of the pipeline access road. The enclosure is constructed of *pāhoehoe* slabs that are now somewhat disturbed, but may originally have been roughly set on edge. It is in poor condition. No cultural material was observed at the site. It is likely that this enclosure was constructed as a temporary windbreak shelter, possibly during the pre-Contact period. Approximately 5 meters west of the structure is a waterworn stone and what may be a filled crevice.

7.1.89 50-10-27-27408 (Reeve et al. 2012 Appendices:291)

Field Number: T-164
Site Type: U-shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27408 (T-164) is a U-shaped wall. It is located near the southern boundary of the survey area, just west of the pipeline access road. The U-shape is constructed of *pāhoehoe* slabs that may originally have been set on edge. It is in fair condition. No marine shell midden or other surface cultural material was noted at the site. Site 50-10-27-27408 (T-164) may have served as a Traditional windbreak shelter.

7.1.90 50-10-27-27409 (Reeve et al. 2012 Appendices:291)

Field Number: T-165
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27409 (T-165) consists of a badly disturbed C-shaped shelter. The site is located near the southern boundary of the survey area, west of the pipeline access road. It is built of *pāhoehoe* slabs and is in poor condition. No surface cultural material was observed at the site, which may originally have served as a windbreak shelter constructed during the pre-Contact period.

7.1.91 50-10-27-27410 (Reeve et al. 2012 Appendices:292)

Field Number: T-166
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Uncertain
Description: Site 50-10-27-27410 (T-166) consists of a small, oval stone walled enclosure. The site is located within the southern portion of the survey area, just west of the pipeline access road, adjacent to sites 50-10-27-27411 and 50-10-27-27412. This enclosure is primarily constructed of *pāhoehoe* slabs, many of which may originally have been set on edge. It is in fair condition. No marine shell midden

or other surface cultural material was noted at the site. Though of traditional construction, the site looks too small to have served as a habitation feature. Its original purpose is uncertain.

7.1.92 50-10-27-27411 (Reeve et al. 2012 Appendices:292)

Field Number: T-167
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Uncertain
Description: Site 50-10-27-27411 (T-167) consists of a small *pāhoehoe* slab enclosure similar to Site 50-10-27-27410 (T-166). It is located within the southern portion of the survey area, just west of the pipeline access road, and adjacent to sites 50-10-27-27410 and 50-10-27-27412. Constructed of *pāhoehoe* slabs, the enclosure is in fair condition. No surface cultural material was observed at the site. Though of traditional construction, the site looks too small to have served as a habitation feature. Like Site 50-10-27-27410 (T-166), its original purpose is uncertain.

7.1.93 50-10-27-27412 (Reeve et al. 2012 Appendices:292–293)

Field Number: T-168
Site Type: Modified Overhang
Artifacts: Traditional
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27412 (T-168) is a modified overhang located in the southern portion of the survey area, just west of the pipeline access road. It is adjacent to sites 50-10-27-27410 and 50-10-27-27411. Stacked stone walls within the overhang form a rough enclosure. Though it is possible that this enclosure may be simple a lava excavation, it seems more likely that it represents some form of small shelter. What appears to be a broken anchor stone (a small waterworn boulder with a pecked and abraded groove around its center) was found in the wall fill of the enclosure. The enclosure itself is in fair condition. No surface cultural material was observed at the site. It is possible that the modified overhang was utilized as a traditional shelter for temporary habitation.

7.1.94 50-10-27-27413 (Reeve et al. 2012 Appendices:293)

Field Number: T-169
Site Type: C-Shaped Wall

Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27413 (T-169) consists of the badly disturbed remnants of a C-shaped wall. The site is located in the southern portion of the survey area, west of the pipeline access road. It is constructed of *pāhoehoe* slabs, at least some of which appear to have originally been set on edge. The structure is badly disturbed and in poor condition. No surface cultural material was observed at the site, which may originally have served as a windbreak shelter constructed during the pre-Contact period.

7.1.95 50-10-27-27414 (Reeve et al. 2012 Appendices:293)

Field Number: T-170
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27414 (T-170) consists of a C-shaped wall. The site is located in the southern portion of the survey area, just west of the pipeline access road and northeast of Site 50-10-27-27413 (T-169). The C-shape is constructed of *pāhoehoe* slabs, at least some of which appear to have originally been set on edge. It is in fair condition. No surface cultural material was noted at the site. This C-shape was probably built during the pre-Contact period to serve as a temporary windbreak shelter.

7.1.96 50-10-27-27415 (Reeve et al. 2012 Appendices:294)

Field Number: T-171
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27414 (T-170) consists of a C-shaped wall constructed of *pāhoehoe* slabs. The site is located in the southern portion of the survey area, just west of the pipeline access road and north of Site 50-10-27-27414 (T-170). It is constructed atop a relatively level *pāhoehoe* flow. A number of the *pāhoehoe* slabs that make up the C-shape appear to have originally been set on edge. The

structure is in fair condition. No surface cultural material was noted at the site. Like Site 50-10-27-27414 (T-170), this C-shape was probably built during the pre-Contact period to serve as a temporary windbreak shelter.

7.1.97 50-10-27-27416 (Reeve et al. 2012 Appendices:294–295)

Field Number: T-172
Site Type: Complex
Possible Age:
Possible Function:
Description: Site 50-10-27-27416 (T-172) is a complex of two features, both of them C-shaped walls. The site is located toward the center of the project area, south of the main access road into the campgrounds and west of the pipeline access road. The two adjacent *pāhoehoe* slab C-shapes were probably constructed during the pre-Contact period to serve as temporarily occupied windbreak shelters.

Feature: A
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27416 (T-172), Feature A consists of a C-shaped wall constructed of *pāhoehoe* slabs, many of which appear to have originally been set on edge. The feature is in fair condition. No surface cultural material was observed within or around Feature A. The feature was probably built during the pre-Contact period as a windbreak shelter.

Feature: B
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27416 (T-172), Feature B consists of the badly damaged remnants of a C-shaped wall. The structure is built of *pāhoehoe* slabs, and is in poor condition. No surface cultural material was observed within or around the structure. Like Feature A, Feature B was probably built during the pre-Contact period as a windbreak shelter.

7.1.98 50-10-27-27417 (Reeve et al. 2012 Appendices:295)

Field Number: T-173
Site Type: C-Shaped Wall

Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27417 (T-173) consists of a rough C-shaped wall. It is located toward the center of the survey area, immediately south of the main access road and just west of the pipeline access road. The C-shape is very roughly constructed of *pāhoehoe* slabs, at least some of which appear to have originally been set on edge. The structure is somewhat disturbed and in poor condition. No surface cultural material was noted at the site. This C-shape was probably built during the pre-Contact period to serve as a temporary windbreak shelter.

7.1.99 50-10-27-27421 (Reeve et al. 2012 Appendices:296)

Field Number: T-177
Site Type: Modified Crevice
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Uncertain
Description: Site 50-10-27-27421 (T-177) is a modified crevice. It is located on a *pāhoehoe* flat north of Site 50-10-27-6530 (T-121) toward the northern boundary of the project area. No cultural material was observed in the vicinity. The modifications to the crevice appear to be traditional in age, but the original purpose is uncertain.

7.1.100 50-10-27-27422 (Reeve et al. 2012 Appendices:296)

Field Number: T-178
Site Type: C-Shaped Wall
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Poor
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27422 (T-178) consists of the badly disturbed remnants of a C-shaped wall. The site is located near the northern boundary of the survey area. The C-shape is constructed of *pāhoehoe* slabs, several of which may originally have been set on edge. It is in poor condition. No surface cultural material was noted at the site. This C-shape was probably built during the pre-Contact period to serve as a temporary windbreak shelter.

7.1.101 50-10-27-27439 (Reeve et al. 2012 Appendices:303)

Field Number: T-198
Site Type: Wall Segment
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Uncertain
Description: Site 50-10-27-27439 (T-198) consists of a rough wall segment. It is located toward the northern boundary of the survey area at the northern base of a lava ridge and just north of a natural overhang. The wall is constructed of loosely piled rubble and is very rough in its construction. No surface cultural material was noted at the site. Though the site appears to be in fair condition, the relative location and rough construction of the wall does not immediately suggest it was utilized as a windbreak shelter. Although it probably dates to the pre-Contact period, its original function is uncertain.

7.1.102 50-10-27-27440 (Reeve et al. 2012 Appendices:304)

SIHP Number: 50-10-27-27440
Field Number: T-199
Site Type: Complex
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27440 (T-199) is a complex consisting of two wall segments (Features A and B) and an enclosure (Feature C). The site is located very close to the northern boundary of the survey area. No surface cultural material was noted at any of the three features. All three features appear to represent temporary habitation structures probably constructed during the pre-Contact period.

Feature: A
Site Type: Wall Segment
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27440 (T-199), Feature A is one of a pair of adjacent *pāhoehoe* slab wall segments. Both wall segments are located on a relatively level stretch of *pāhoehoe* lava. The wall segment is constructed of loosely stacked and piled pāhoehoe slabs, some of which may originally have been positioned on edge. It is in fair condition.

Feature: B
Site Type: Wall Segment

Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27440 (T-199), Feature B is similar in its size, construction and condition to the nearby Feature A *pāhoehoe* slab wall segment.

Feature: C
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27440 (T-199), Feature C is an enclosure located c. 10 meters north of the Feature A and B wall segments. The enclosure is also constructed of *pāhoehoe* slabs and is in fair condition.

7.1.103 50-10-27-27441 (Reeve et al. 2012 Appendices:305)

Field Number: T-200
Site Type: Enclosure
Artifacts: None Observed
Midden: Present
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27441 (T-200) consists of a stone walled enclosure. It is located along the northern boundary of the project area. The enclosure is constructed of *pāhoehoe* slabs and is somewhat disturbed. No surface cultural material was observed in the immediate area of the enclosure. It is likely that this structure served as a temporary shelter during the pre- Contact period. Just east of the enclosure is one of a series of cairns that appear to be of modern construction. They seem to mark the course of a modern trail across the lava. The occasional fragment of waterworn coral or cowrie shell was noted along the course of the possible trail, and these may also have served to mark its route.

7.1.104 50-10-27-27442 (Reeve et al. 2012 Appendices:305)

Field Number: T-201
Site Type: Scatter
Artifacts: Traditional
Midden: Present
Skeletal Remains: None Observed

Condition: Good
Possible Age: Traditional
Possible Function: Activity Area
Description: Site 50-10-27-27442 (T-201) consists of a very light scatter of cultural material. It is located inland of the coast, just south of the northern boundary of the survey area. The scatter consists of two waterworn pebbles, a cowrie shell, and fragments of waterworn coral. Though the scatter is relatively small, it does indicate human presence and activity in this part of the project area. The two waterworn pebbles may have been used in the pre-Contact period as slingstones. A cache of similar waterworn pebbles was found nearby. These may also have been intended for use as slingstones.

7.1.105 50-10-27-27447 (Reeve et al. 2012 Appendices:307)

Field Number: T-208
Site Type: Enclosure
Artifacts: None Observed
Midden: None Observed
Skeletal Remains: None Observed
Condition: Fair
Possible Age: Traditional
Possible Function: Habitation
Description: Site 50-10-27-27447 (T-208) consists of a very rough stone walled enclosure. The site is located toward the southern boundary of the survey area, west of the main access road and east of the pipeline access road. The enclosure is constructed of *pāhoehoe* slabs, some of which may originally have been set on edge, but are now collapsed. The structure is in fair condition. No surface cultural material was observed in the immediate vicinity of the enclosure. It is likely that this structure served as a temporary shelter during the pre-Contact period.

7.1.106 50-10-27-27559 (Reeve et al. 2012 Appendices)

No site description given.

7.1.107 50-10-27-28794 (Monahan et al. 2012:261) (Figure 147, Figure 148)

Temp. Site No.: T-091010-7 (Monahan et al. 2011)
Site Type: Filled Crevice
No. of Features: 1
Functional Interpretation: Indeterminate-Possible Agricultural Clearing Feature
Probable Age: Indeterminate
Overall Dimensions: 0.9 m N/S by 3.8 m E/W
Topography: Level *pāhoehoe* flow
Elevation: 94 ft (29 m) AMSL
Description: SIHP # 50-10-27-28794 is a filled crevice… adjacent to the Kaloko-Honokōhau National Historical Park [Figure 147]. SIHP # 28794 consists of several *pāhoehoe* cobbles and small boulders that have been placed within a natural crevice

. SIHP # -28794, view to east

Figure 147. Photos of SIHP # -28794; view to the east (top) and west (bottom) (Monahan et al. 2012:262)

in the *pāhoehoe* surface. The filled crevice measures 0.9 m N/S by 3.8 m E/W. No artifacts or midden were observed in the area.

From an archaeological perspective, this feature retains little evidence of formal construction, and, therefore, both its age and function are indeterminate. Based on oral-historical information cited by NPS staff, and confirmed as accurate by Analu Josephides of the SHPD, in the context of discussing other features in the project area, it was believed to be possible that this site represented a burial. Subsurface testing of this feature was conducted to determine if human skeletal remains were present. CSH obtained concurrence from the SHPD before testing this site.

Test Excavation Findings

Excavation of SIHP # -28794 was halted at the exposure of solid bedrock, which was encountered between 70 and 90 cmbs. A small, unmodified coral cobble, a portion of a *kukui* nut shell, and sparse amounts of charcoal were identified during the excavation of SIHP # -28794 at 70 to 75 cmbs [see Figure 147, Figure 148]. SIHP # -28794 may represent an agricultural clearing feature. Subsurface testing did not reveal any human skeletal remains. The age of this feature is indeterminate.

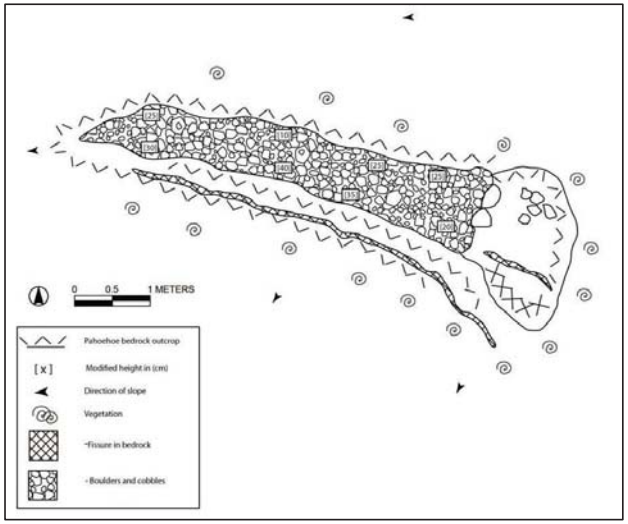


Figure 148. SIHP #-28794 plan view from Monahan et al 2012:263

7.1.108 50-10-27-29344 (Monahan et al. 2012:255) (Figure 149, Figure 150)

Temp. Site No.: Excavation 0 (Monahan and Yucha 2012)
Site Type: Excavated Pit
No. of Features: 1
Functional Interpretation: Indet.-Possible Quarry or Sweet Potato Planter or Bird Pit
Probable Age: Indeterminate-Probably Prehistoric (Pre-Contact)
Overall Dimensions: 1.0 m N/S by 1.0 m E/W
Topography: *'A'ā* flow
Elevation: 75 ft (23 m) AMSL
Description: SIHP # 50-10-27-29344 is an excavated pit in a *pāhoehoe* lava blister. The site location is depicted in …. The excavated pit was created by bashing and removal of sections of *pāhoehoe* creating an opening in the flow [Figure 149, Figure 150]. Two small boulder-sized *pāhoehoe* blocks have been left in the pit floor. Larger sections of fractured *pāhoehoe* are located along the east side of the pit. Low overhangs are present along the west side of the pit. This site was pointed out to CSH by NPS archaeologists during the supplemental survey of the south segment (Monahan and Yucha 2012).
The excavated pit measures approximately 1.0 m N/S by 1.0 m E/W by 0.30 m deep. There is relatively little vegetation or soil-sedimentary matrix in or immediately adjacent to the pit. No portable cultural materials, other than the removed rocks, were observed by CSH archaeologists.
It is difficult to unequivocally date this site, although it seems likely to be of prehistoric (pre-Contact) age. Its function is currently indeterminate. A wide variety of excavated pits in *pāhoehoe* have been documented in similar physiographic settings in the Kona region. The pit may have functioned as a quarry (e.g., a source of rock material) or as a sweet potato planter or as a bird pit. It is possible that further work (excavation) at the site may contribute additional information to further clarify its age or function.

7.1.109 50-Ha-D13-81 (Renger 1971:28)

A major *mauka-makai* trail, well worn, runs mostly across smooth pahoehoe.

7.1.110 SP-1 through SP-8, SP-10 (Gmirkin and Bond 2002:22, 25) (Figure 151, Figure 152)

A total of ten features were identified during the survey. Features were marked with yellow flagging and assigned temporary ID numbers (NPS SP-1 through 10).

Of these features six appear to be excavated pits or quarried areas which have been partially or totally refilled (SP-1, 3, 4, 5, 6, and 8), one pecked or battered area (SP-2), a natural depression that has been partially enclosed with a one-stone high wall (SP-7); a foot worn trail (SP-9 [SIHP # -21588]); and a possible mound or ahu (SP-10).

The excavated pits (SP-3, 4, 5, and 6) appear to correspond with those identified in Barr et al.'s survey in 1993. These features appear on a map of the Queen

Figure 149. Photo of SIHP # -29344; view to the northwest (Monahan et al. 2012:256)

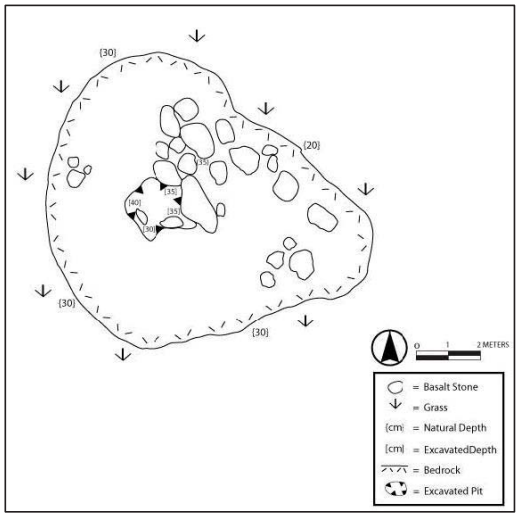


Figure 150. SIHP # -29344 plan view (Monahan et al. 2012:257)

Ka‘ahumanu Interchange Project Area… as “Pahoehoe Excavations”. These features were not further described or given any site numbers. Site SP-8, another pahoehoe excavation, is located along a crack on a pahoehoe rise. This site is most likely associated with other nearby features (SP-7 and 9).

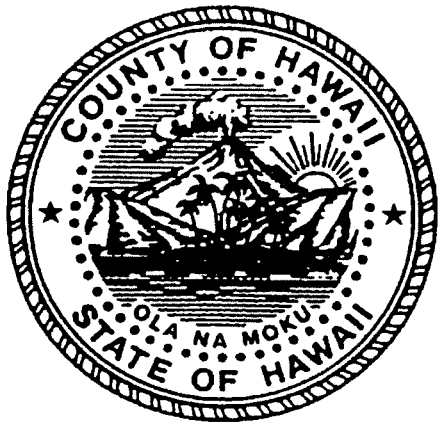
An area of battering (SP-2) [Figure 151] was located near an isolated pahoehoe excavation (SP-1) [Figure 151]. …

… A possible ahu (SP-10) is located just south of the trail within the Temporary Sewer Line. This feature is in very poor condition and may have been a result of the bulldozer activity.

Figure 151. Photos of SP-1 and SP-2 (Gmirkin and Bond 2002:23)

Figure 14. Pāhoehoe Excavation, SP-3.

Figure 152. Photos of SP-3, SP-7, and SP-8 (Gmirkin and Bond 2002:24)



APPENDIX E

FINAL

Cultural Impact Assessment for the Kealakehe Wastewater Treatment Plant Master Plan, Kaloko, Kealakehe, Keahuolū Ahupua‘a, North Kona District, Hawai‘i Island

TMKs: [3] 7-3-009:027; 7-4-008:002, 058, 073; 7-4-020:007, 019, 021, 022; and 7-5-005:007

Prepared for

Wilson Okamoto Corporation

Prepared by

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April 2018

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Management Summary

Reference	Cultural Impact Assessment for the Kealakehe Wastewater Treatment Plant Master Plan, Kaloko, Kealakehe, Keahuolū Ahupua‘a, North Kona District, Hawai‘i Island, TMKs: [3] 7-3-009:027; 7-4-008:002, 058, 073; 7-4-020:007, 019, 021, 022; 7-5-005:007 (Spencer et al. 2018)
Date	April 2018
Project Number(s)	Cultural Surveys Hawai‘i, Inc. (CSH) Job Code: KEALAKEHE 5
Agencies	Department of Health – Office of Environmental Quality Control (DOH-OEQC)
Land Jurisdiction	County/State/Private
Project Location	The project area is located on the leeward side of Hawai‘i Island north of Kailua-Kona. The project area straddles Queen Ka‘ahumanu Highway (Route 19) within Kaloko, Kealakehe, and Keahuolū Ahupua‘a. The northern portion of the project area is located at Hina Lani Street and Route 19. The southern portion of the project area extends slightly north of Kealakehe Parkway and spans south on Route 19. The southern portion of the project area spans *mauka* (towards the mountain) and *makai* (towards the ocean) of Route 19. The *makai* (seaward) southern portion of the project area includes Kealakehe Waste Water Treatment Plant (WWTP) and a portion of the Queen Lili‘uokalani Trust (QLT) Children’s Center.
Project Description	The current project will upgrade the Kealakehe WWTP to provide effluent treatment to produce R-1 recycled water. This project may be funded by federal funds through the State of Hawai‘i DOH Clean Water State Revolving Fund (CWSRF) Program, which would constitute a federal action and will require the project to meet all National Environmental Policy Act (NEPA) and Hawai‘i SRF program requirements. Facilities to be constructed as part of this project include water reuse, wastewater collection and treatment enhancements, and effluents disposal elements. R-1 water produced at the Kealakehe WWTP will be initially stored on site in a 500,000-gallon above grade tank. The storage tank will also serve as a clearwell for the buffer parcel irrigation pumps, provide pressure head for transmission of R-1 water to the Old Kona Airport Park and QLT lands, and feed the R-1 distribution system to the north. The extent of the site infrastructure for the initial and future R-1 storage and distribution system to the north will consist of new, repurposed, and recently installed components. Recycled water infrastructure (including the “purple pipe” required to differentiate recycled water lines from other pipelines) was installed in 2016 in

	conjunction with the Queen Ka‘ahumanu Highway Widening Project from Kealakehe Parkway to the entrance of the Kohanaiki Golf and Ocean Club. A new pipeline will be constructed from Kealakehe WWTP to connect with the Queen Ka‘ahumanu purple pipe at Kealakehe Parkway. R-1 water will be pumped from WWTP to an existing, unused potable water storage tank on Hina Lani Street that will be permanently isolated from the potable water distribution system and recommissioned for R-1 service. To the south, a new pipeline will be constructed to convey R-1 water to the Old Kona Airport Park, whose irrigation infrastructure will be modified to facilitate the use of R-1 water. A high-head R-1 pump station will be constructed in the future to deliver water to a planned elevated tank located *mauka* (inland; east) of the WWTP, expanding the system to provide storage and adequate pressure for additional uses. Potential future users include the proposed Kealakehe Regional Park, Honokohau Harbor, industrial and commercial operations within the service area, QLT land development and other projects.
Project Acreage	The overall project area is approximately 199 acres.
Document Purpose	This cultural impact assessment (CIA) provides information pertinent to the proposed project’s potential impacts to cultural beliefs, practices, and resources pursuant to the State of Hawai‘i environmental review process under Hawai‘i Revised Statutes (HRS) §343. The CIA follows the Office of Environmental Quality Control’s *Guidelines for Assessing Cultural Impacts*. The document will likely also support the project’s historic preservation review under HRS §6E and HAR §13-275 and §13-284. This CIA investigation may also be used to support the National Historic Preservation Act, Section 106 consultation/review as set forth in 54 U.S.C. §306108 and 36 CFR 800.2(C)4 and the NEPA consultation. A future letter will be sent out either by the State or County of Hawai‘i to accomplish the Section 106 consultation.

Results of Background Research	Background research for this project yielded the following results (presented in approximately chronological order): 1. *Mo‘olelo* (stories) suggest the remains of Kamehameha I maybe have been buried in Kaloko Ahupua‘a. Kamakau states that the *iwi* (bones) of Kamehameha were taken to Kekaha in Kaloko at a secret cave (Kamakau 1961:215). 2. Pukui shares a *mo‘olelo* of ‘Ōhiki, a legendary hero, who prayed to Pele to save the priest, Ka-lua-lapa-uila. As a result, a storm arose. The priest turned into a *manō* (shark) as it tried to enter a *heiau* (pre-Christian place of worship) to save the priest’s human form. One of Pele’s sisters, Hi‘iaka-noho-lae (“Hi‘iaka living at [the] point”) came to live in this sacred area that was forbidden from Pele (Pukui et al. 1974:70). 3. A distinguishing feature of the Kona landscape are the many trails that cross and zig-zag through each *ahupua‘a* (land section spanning from the mountain to the sea). The *alaloa* (belt road around an island, a long road) is a trail that crossed the *makai* lands that linked royal centers, coastal communities, and resources (Maly and Maly 1993:73). A *mauka* trail called Kealaehu (“The Path of Ehu”) passed the area a little *mauka* of the old Māmalahoa Highway. Kealaehu spanned from Ka‘ū to Kawaihae. 4. Another distinct feature of the Kona landscape are the *hōlua* (sled) slides. *Hōlua* is an ancient sport that can be traced back to the time of Pele and was pursued by those of *ali‘i* (chief) ranking. The sleds were narrow but long (approximately 12 to 18 feet [ft]) and used to race downhill. The track itself ran *mauka* to *makai* and covered with *pili* grass. The track was slicked with *kukui* (candlenut; *Aleurites moluccana*) oil (Mitchell 1975:38). 5. In the early nineteenth century, the residents of Kaloko Ahupua‘a were feeling the pressures and consequences of Western Contact. Native Hawaiians were enlisting as seamen on foreign ships while harbor facilities were being constructed in Kailua and Kealakekua. 6. The *ahupua‘a* of Kaloko was awarded and kept by Lot Kamehameha (Kamehameha V) during the Māhele. A total of 21 additional land claims were made in Kaloko of which 12 were awarded in the uplands. Kealakehe Ahupua‘a was awarded to Kekuapanio, a young noble who was a favorite amongst *ali‘i* such as Kauikeaouli (Kamehameha III), who later returned the land to the government. The entire *ahupua‘a* of Keahuolū was awarded to Ane Keohokālole who held two walled house lots “from very ancient times” along the shoreline.

	7. Oral histories indicate that during the mid-1800s, private residences were scattered along the coastline, *mauka* regions (specifically above 900 ft), and in the vicinity of Māmalahoa Highway. *Mauka* and *makai* trails were utilized by upland families who traveled to access coastal resources and gather water during upland droughts. Goats and cattle contributed to droughts by stripping the vegetation of the area. In 1870, a resident known as J. Kihe stated that the families who resided in the Kekaha region moved with the exception of one family who remained. 8. Previous archaeology yielded habitation sites, temporary habitiaton sites, lava tubes, lava shelters, trails (pre-Contact and historic), historic campsites, and recreational activities (such as *papamū* [checkerlike game], *kōnane* [ancient game resembling checkers], petroglyphs, *hōlua* [slide]).
Results of Community Consultation	CSH contacted a total of 37 parties including the Office of Hawaiian Affairs (OHA), the State Historic Preservation Division (SHPD), the County of Hawai‘i, other agencies, Native Hawaiian Organizations (NHOs) and knowledgeable community members. Of the 37 parties consulted, a total of eight people/agencies responded to the consultation letter. Five people participated in formal interviews, however, only four were authorized to be used in this study. CSH initiated its outreach effort in June 2017 through March 2018 through letters and emails. Below is a preliminary list of individuals who shared their *mana‘o* (thoughts, opinions) and *‘ike* (knowledge) about the project areas and their corresponding *ahupua‘a*: 1. Nicole Keaka Lui, descendant of Keahuolū and Kekaha* 2. Rick Gmirkin, archaeologist, Ala Kahakai National Historic Trail* 3. Cynthia Nazara, cultural consultant and descendant of Kekaha* 4. George Van Gieson, retired fire captain and *kama‘āina* (native born) 5. Māhealani Pai, descendant of Honokōhau-Kaloko-Kohanaiki* 6. County of Hawai‘i – Planning Department, Cultural Resources Commission 7. Ikaika Nakahashi, Cultural Historian (Maui County and Hawai‘i County) – State of Hawai‘i, State Historic Preservation Division (SHPD) 8. Kaleo Kuali‘i, cultural consultant and descendant of Kohanaiki *Authorized use of interviews.
Cultural Community Concerns and Recommendations	The following four participants, who authorized use of the interviews, voice and framed their concerns in a cultural context.

	1. Ms. Nicole Lui is concerned about the possible destruction of the Māmalahoa Trail. She is also concerned about future development and how it impacts significant and cultural sites. She focused on sites found in the vicinity of the QLT lands to Department of Transportation lands near the Māmalahoa Trail. She supports ongoing preservation and protection of these areas and strongly suggests the project be rerouted to cause no further damage and continuous archaeological and cultural monitoring. 2. Mr. Rick Gmirkin expressed deep concern with preserving the Kohanaiki Trail (also called Road to the Sea), Māmalahoa Trail and other *mauka* and *makai* trails within the expanse of the project area. As the Māmalahoa Trail is threatened by possible ground disturbance associated with the Kealakehe WWTP project, he further urges the preservation and protection of this trail. 3. Cynthia Nazara expressed strong concerns about preserving the remaining portions of the Māmalahoa Trail. Although portions of the trail have been disturbed by previous construction, she fears further development will cause greater harm to the trail. Ms. Nazara strongly advised that the water lines be moved to protect existing historic sites. 4. Mr. Māhealani Pai is concerned the project may unearth burials and possibly disturb burials situated within the crevices of lava. Mr. Pai knows of several caves *makai* of Queen Ka‘ahumanu Highway that may also be a location for burials. He pointed out that when Queen Ka‘ahumanu Highway was first widened, *iwi* were found south of Kaloko National Park. It is of utmost importance for Mr. Pai that if workers come into contact with *iwi*, they be handled with great respect and reverence in seeking the continuation of their *moe loa* (eternal rest). He requested appropriate parties be contacted efficiently so the correct procedures may take place to ensure proper handling and treatment.
Impacts and Recommendations	Based on information gathered from the cultural and historical background, and the community consultation, CSH identified potential impacts and makes the following recommendations based on approved community consultations. 1. Community participants voiced concerns regarding the Māmalahoa Trail and suggest the project be rerouted to avoid further disturbance and destruction. One of the community participants suggested archaeological and cultural monitoring for the Māmalahoa Trail. One participant strongly urged that CSH review a previously published monitoring report to gain further insight of the Māmalahoa Trail and known *mauka-makai* trails.

	2. Previous archaeological studies have yielded a number of burials (Carpenter 1995; Ching and Rosendahl 1968; Emory and Soehren 1971; Estioko-Griffin and Lovelace 1980; Ladd 1968; Monahan et al. 2012; Neighbor Island Consultants 1973; Renger 1971; Rosendahl 1993; Soehren 1980b; Soehren 1981). In addition to previous archaeological studies, a community participant has shared their knowledge of burials found north and *makai* of the project area. 3. In the event that any potential historic properties are identified during construction activities, all activities will cease and the SHPD will be notified pursuant to HAR §13-280-3. In the event that *iwi kūpuna* (ancestral bones) are identified, all earth moving activities in the area will stop, the area will be cordoned off, and the SHPD and Police Department will be notified pursuant to HAR §13-300-40. In addition, in the event of an inadvertent discovery of human remains, the completion of a burial treatment plan, in compliance with HAR §13-300 and HRS §6E-43, is recommended. 4. In the event that *iwi kūpuna* and/or cultural finds are encountered during construction, project proponents should consult with cultural and lineal descendants of the area to develop a reinterment plan and cultural preservation plan for proper cultural protocol, curation, and long-term maintenance.

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Section 1 Introduction

1.1 Project Background

At the request of Wilson Okomoto Corporation, Cultural Surveys Hawai‘i, Inc. (CSH) has prepared this cultural impact assessment (CIA) report for the Kealakehe Wastewater Treatment Plant Master Plan, Kaloko, Kealakehe, and Keahuolū Ahupua‘a, North Kona District, Hawai‘i Island, TMKs: [3] 7-3-009:027; 7-4-008:002, 058, 073; 7-4-020:007, 019, 021, 022; and 7-5-005:007. The project areas are depicted on a portion of the 1996 U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle (Figure 1), tax map plats (Figure 2, Figure 3, and Figure 4), and a 2013 aerial photograph (Figure 5).

The Hawai‘i State Department of Health (DOH) advocates for the use of recycled water provided that public health and water resources are not compromised. Use of recycled water has become more significant due to the state’s growing population, limited potable water resources, and waste water disposal issues. The County of Hawai‘i, Department of Environmental Management (County) intends to upgrade the Kealakehe Waste Water Plant (WWTP) to provide effluent treatment to produce R-1 recycled water.

Facilities to be constructed as part of this project include water reuse, wastewater collection and treatment enhancements, and effluents disposal elements. R-1 water produced at the Kealakehe WWTP will be initially stored on site in a 50,000-gallon above grade tank. The storage tank will also serve as a clearwell for the buffer parcel irrigation pumps, provide pressure head for transmission of R-1 water to the Old Kona Airport Park and Queen Lili‘uokalani Trust (QLT) lands, and feed the R-1 distribution system to the north. The extent of the site infrastructure for the initial and future R-1 storage and distribution system to the north will consist of new, repurposed, and recently installed components. Recycled water infrastructure (including the “purple pipe” required to differentiate recycled water lines from other pipelines) was installed in 2016 in conjunction with the Queen Ka‘ahumanu Highway Widening -roject from Kealakehe Parkway to the entrance of the Kohanaiki Golf and Ocean Club. A new pipeline will be constructed from Kealakehe WWTP to connect with the Queen Ka‘ahumanu purple pipe at Kealakehe Parkway. R-1 water will be pumped from WWTP to an existing, unused potable water storage tank on Hina Lani Street which will be permanently isolated from the potable water distribution system and recommissioned for R-1 service.

To the south, a new pipeline will be constructed to convey R-1 water to the Old Kona Airport Park, whose irrigation infrastructure will be modified to facilitate the use of R-1 water. A high-head R-1 pump station will be constructed in the future to deliver water to a planned elevated tank located *mauka* (inland; east) of the WWTP, expanding the system to provide storage and adequate pressure for additional uses. Potential future users include the proposed Kealakehe Regional Park, Honokohau Harbor, industrial and commercial operations within the service area, QLT land development, and other projects.

This project may be funded by federal funds through the State of Hawai‘i DOH Clean Water State Revolving Fund (CWSRF) Program, which would constitute a federal action and will require the project to meet all National Environmental Policy Act (NEPA) and Hawai‘i SRF program requirements.

1.2 Document Purpose

This cultural impact assessment (CIA) provides information pertinent to the proposed project's potential impacts to cultural beliefs, practices, and resources pursuant to the State of Hawai‘i environmental review process under Hawai‘i Revised Statutes (HRS) §343. The CIA follows the Office of Environmental Quality Control's *Guidelines for Assessing Cultural Impacts.* The document will likely also support the project's historic preservation review under HRS §6E and HAR §13-275 and §13-284.

This CIA investigation may also be used to support the National Historic Preservation Act, Section 106 consultation/review as set forth in 54 U.S.C. §306108 and 36 CFR 800.2(C)4 and the NEPA consultation. A future letter will be sent out either by the State or County of Hawai‘i to accomplish the Section 106 consultation.

1.3 Scope of Work

The scope of work for this CIA includes the following:

1. Examination of cultural and historical resources, including Land Commission documents, historic maps, and previous research reports with the specific purpose of identifying traditional Hawaiian activities including gathering of plant, animal, and other resources or agricultural pursuits as may be indicated in the historic record.
2. Review of previous archaeological work at and near the subject parcel that may be relevant to reconstructions of traditional land use activities; and to the identification and description of cultural resources, practices, and beliefs associated with the parcel.
3. Consultation and interviews with knowledgeable parties regarding cultural and natural resources and practices at or near the parcel; present and past uses of the parcel; and/or other practices, uses, or traditions associated with the parcel and environs.
4. Preparation of a report that summarizes the results of these research activities and provides recommendations based on findings.

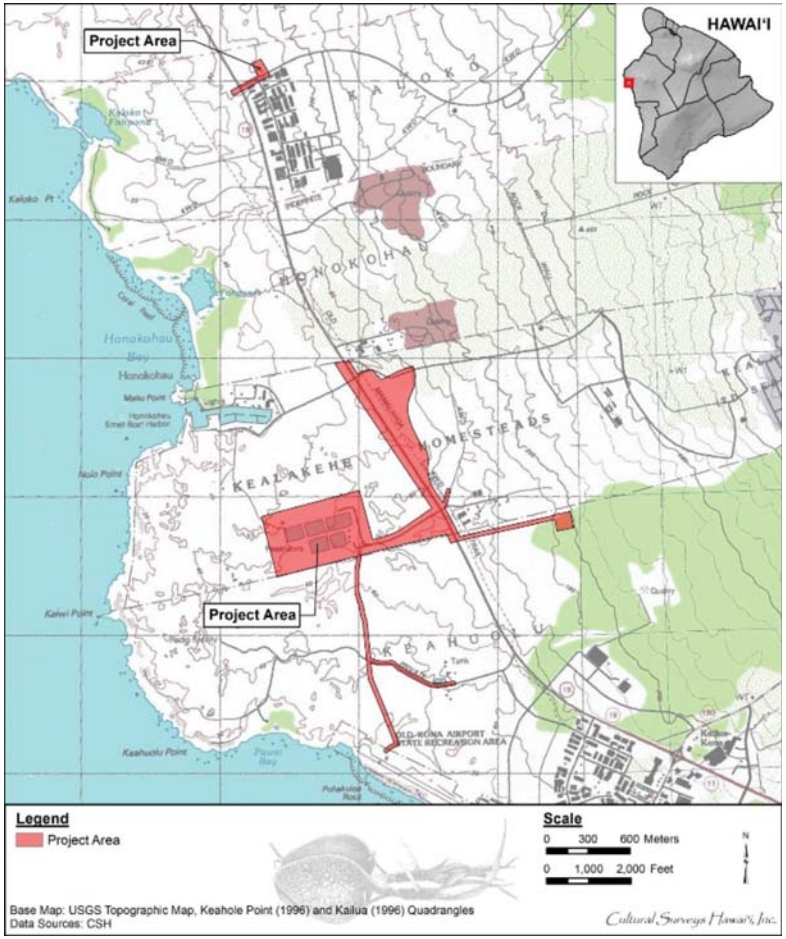

Figure 1. Portion of the 1996 USGS 7.5-minute topographic quadrangle showing the location of the project areas

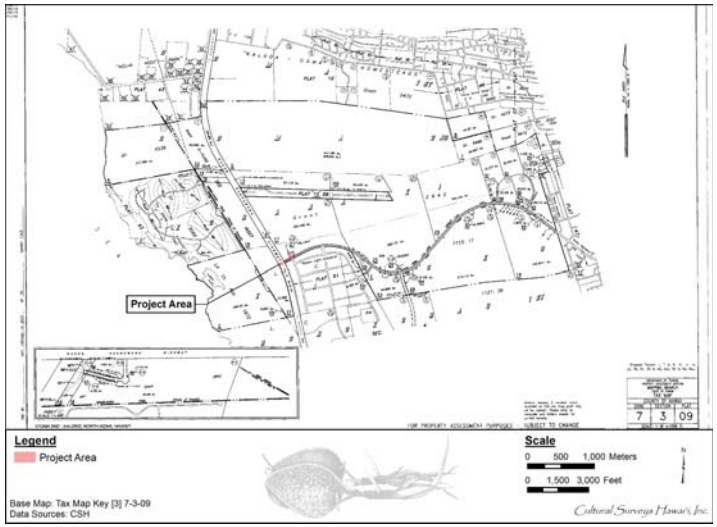

Figure 2. Tax Map Key (TMK) [3] 7-3-09 showing the project area (Hawai‘i TMK Service 2014)

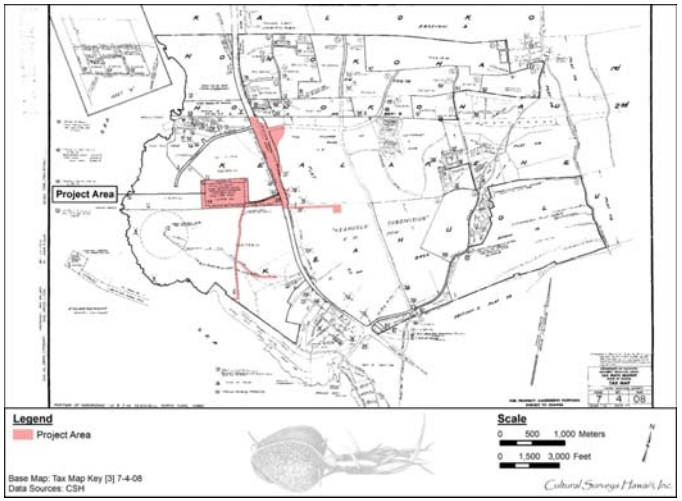

Figure 3. TMK: [3] 7-4-08 showing the project area (Hawai‘i TMK Service 2014)

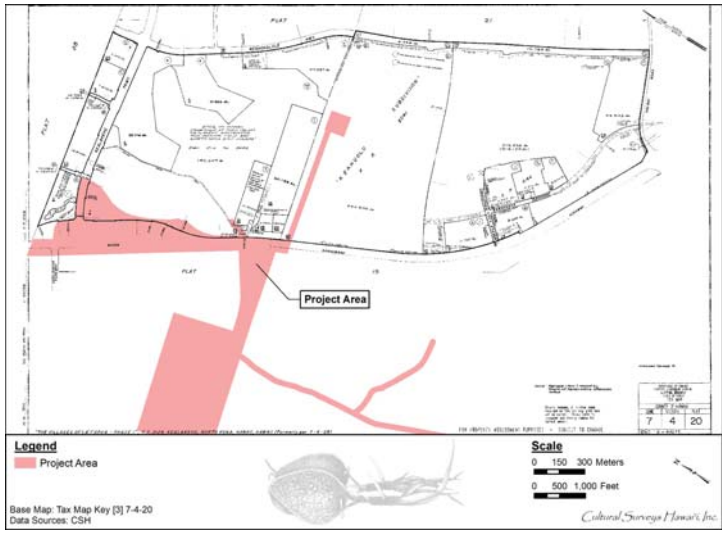

Figure 4. TMK: [3] 7-4-20 showing the project area (Hawai'i TMK Service 2014)

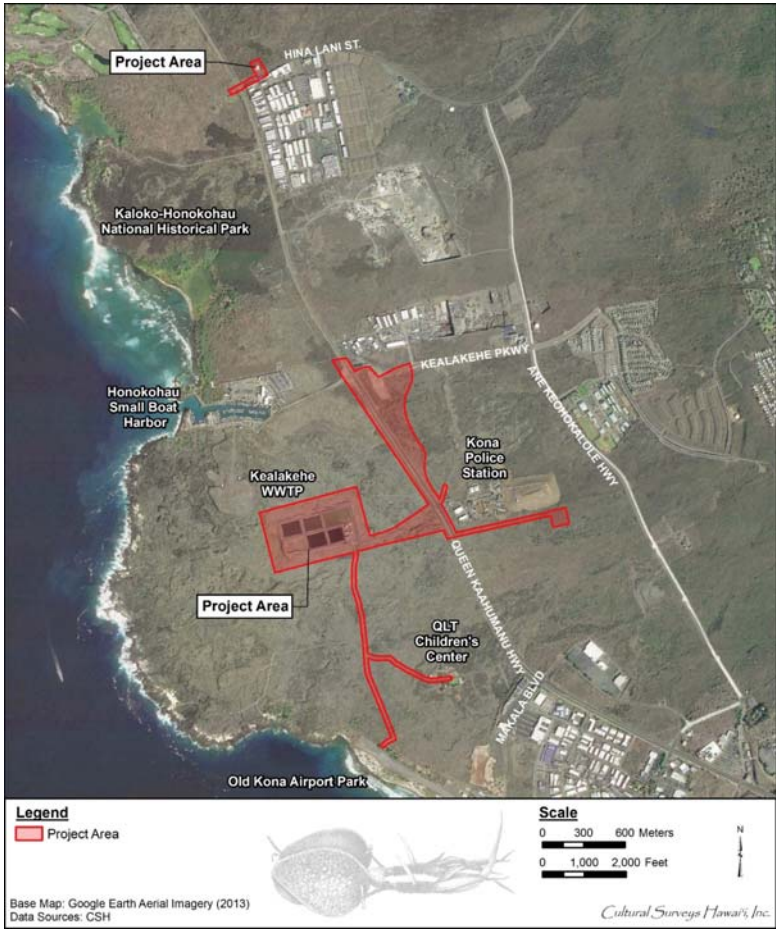

Figure 5. Aerial photograph of the project area (Google Earth 2013)

1.4 Environmental Setting

1.4.1 Natural Environment

The current project spans the Kohanaiki, Kaloko, Honokōhau, Kealakehe, and Keahuolū Ahupua‘a though the exact project areas are in a remote section in Kaloko and will stretch across Kealakehe and Keahuolū. The land surface within these *ahupua‘a* (land division spanning from the mountain to the sea) are comprised predominately of exposed *‘a‘ā* (rough lava) and *pāhoehoe* (smooth, unbroken lava). The surface characteristics of these land types are described below.

According to the U.S. Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) database (2001) and soil survey data gathered by Sato et al. (1973), the project area's soils consist primarily of Lava Flows, Pahoehoe (rLW) and in some areas, Lava Flows, Aa (rLV) (Figure 6). Lava Flows, Pahoehoe is described as below:

> Lava flows, pahoehoe (rLW), has been mapped as a miscellaneous land type. This lava has a billowy, glassy surface that is relative smooth . . . In some areas, however, the surface is rough, and broken, and there area hummocks and pressure domes. [Sato et al. 1973:34]

Pahoehoe lava has little to no soil covering resulting in limited vegetation. Moss and lichen can be found on Pahoehoe. In areas of heavier rainfall *‘ōhi‘a* (*Metrosideros polymorpha*), *‘ōhelo ‘ai* (*Vaccinium reticulatum),* and *‘a‘ali‘i (Dodonaea viscosa)* thrive by rooting in the cracks and crevices of pahoehoe.

Aa is described as below:

> Lava flows, Aa (rLV), has been mapped as a miscellaneous land type. This lava has practically no soil covering and is bare of vegetation, except for mosses, lichens, ferns, and a few small ohia trees. [Sato et al. 1973:34]

The physical characteristics of *‘a‘ā* differentiates from *pāhoehoe* in that it is very jagged and broken. It can be described as piles of glassy, sharp pieces. In areas of heavier rainfall, *‘a‘ā* assists in directing water to the underground water supply and helps with watershed.

1.4.2 *Makani* (Wind)

Makani is the Hawaiian word for wind. The ‘Eka and Kēhau *The Wind Gourd of La‘amaomao* tells the story of how Pāka‘a and his son Kuāpāka‘a, descendants of the wind goddess La‘amaomao, control the winds of Hawai‘i. These winds, which were contained in a gourd, could be called forth by chanting their names. Pāka‘a's chant traces the winds of Hawai‘i in the *moku* (district) of Kona. The winds of the Kona region are poetically recalled as follows:

Hau is of Kapalilua,

‘Eka is of Kona,

Kīpu is of Kahuā,

‘E‘elekoa is of Uli,

Kīpu‘upu‘u is of Waimea,

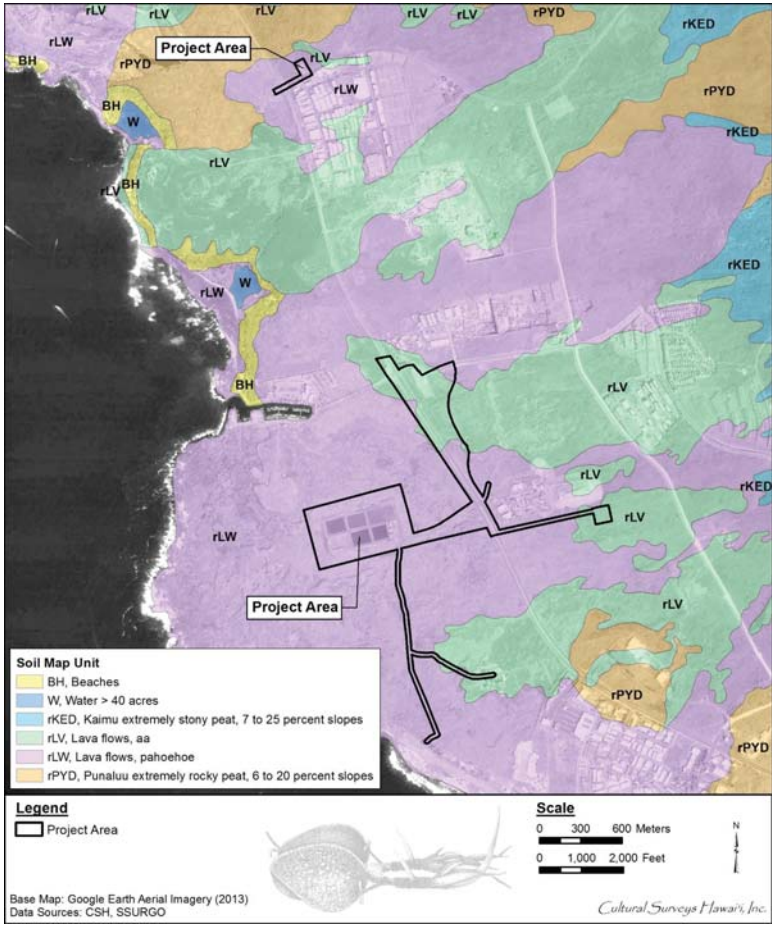

Figure 6. Overlay of *Soil Survey of the State of Hawaii* (Foote et al. 1972), indicating soil types within and surrounding the project area (USDA SSURGO 2001)

‘Ōlauniu is of Kekaha,

Pa‘ala‘a is in the ocean,

Nāulu is of Kawaihae,

A wind that comes

And dashes the milo leave of Makaopau,

[Nakuina 1990:47]

John Papa ‘Ī‘ī’s account of Kamehameha’s return to Hawai‘i also mentions the ‘Eka wind of this region:

> The gentle Eka sea breeze of the land was blowing when the ship sailed past the lands of the Mahaiulas, Awalua, Haleohiu, Kalaoas, Hoona, on to Oomas, Kohanaiki, Kaloko, Honokohaus, and Kealakehe, then around the cape of Hiiakanoholae, which was two long points of land. At first it seemed that these two were the only jutting points of land, but then more were seen, extending as far as Kapalilua. After Hiiakanoholae Point, Kaliliki Point was passed, and then the many houses that covered the land from Honuaula to Auhaukeae were visible. Anchor was dropped outside the reef at Honuaula, and the eyes of those aboard ship traveled over the land from Kaliliki to Honuaula, a land of rough aa and smooth pahoehoe, adorned with growth. [‘Ī‘ī 1959:110]

Another passage describes two separate winds, one that passes through Kamakahonu and another in Kekaha. Kamakahonu, the coastal area where Kamehameha set up residence, is now the site of King Kamehameha Hotel.

> Furthermore, there was no gale such as blew in Lahaina and some other places to push houses over. The only strong wind that blew along these beaches was the one that came from the upland occacionally, called the Kuhonua. Although coconut leaves were bend over sometimes and *‘i‘iwi* and *‘apapane* birds blown by the wind were seen perching on coconut or *noni* trees and on stone walls, no house was ever damaged. The Kuhonua winds blew for only a few hours at a time, after which was customary calm of the land returned. A little more frequent was a cold wind from Kekaha, the Hoolua. Because of the calm of that land, people often slept outside of the tapa drying sites at night. It is said to be a land that grows cold with a dew-laden breeze, but perhaps not so cold as in Hilo when the Aalahonua blows. [‘Ī‘ī 1959:122]

1.4.3 *Ua* (Rain)

Kona weather is typified by afternoon showers brought on by warm air which has been moved inland by light sea breezes. The humid air gradually condenses over higher altitudes throughout the day. At night the land cools resulting in breezes which send warm air back out to sea. Rainfall in this general area averages 30 inches per year (Giambelluca et al. 1986).

1.4.3.1 Ka Ua Nāulu

A certain rain known in the Kona area is the Nāulu rain. Though it is not location specific to any *ahupua‘a* associated with the project areas, it is generalized as a Kona wind. The following

oli (chant) is taken from “*A Kona Hema ‘o Kalani,*” glorifying the different characteristics of Kona.

Ahuwale nā kualono	The ridges are in plain view
‘Ike ‘ia ka pae ‘ōpua	The cloud bankds are seen
E kukū ana i ke kai	Rising over the sea
I ke kai hāwanawana	Over the whispering sea
‘Ōlelo ‘o Kawaihae	Kawaihae calls out
Hae ana e ka Nāulu	Pour down, O Nāulu

[Akana and Gonzalez 2015:188]

The following *mele kanikau* (lamentation song) was written by Queen ‘Emalani Kaleoonālani after the death of her husband, King Alexander Liholiho. A *mele kanikau* makes references to places significant to the deceased and at times poetically suggests a journey of departing with the expectation of no return. This is so the spirit of the deceased can reach its final resting place. The following *mele kanikau* makes references to Kona and the Nāulu rain.

‘O Kona ia o ke kai malino a ‘Ehu ē!	Oh, Kona it is, of the tranquil sea of ‘Ehu, oh!
Ke ala a ‘Ehu, ke ala a kāua i hele ai	The pathway of ‘Ehu, the path we two traversed
I ke ao, i ka pō, pōwehiwehi i ka ua Nāulu a weli	By day, by night, made dim and threatening by the stormy Nāulu rains
He weliweli, he maluhia i ke aloha iā ‘oe	Frightful, but peaceful because of love for you
Iā ‘oe, iā ‘oe, e Kalopelekei i ka lā ē!	For you, for you, O Kalopelekei of the day, oh!

[Akana and Gonzalez 2015:188-189]

1.4.4 Built Environment

Much of the land surrounding the project area remains undeveloped. The most significant development is the Queen Ka‘ahumanu Highway, which runs through a large portion of the project area (PA).

In the northern portion of the PA, a large, white water tank stands on the north side of Hina Lani Street within the project area. It is a distinct landmark very near the intersection of Hina Lani Street and the Queen Ka‘ahumanu Highway. To the south of the northern project area across Hina Lani Street is an industrial area often referred to as “Kaloko Industrial” or “New Industrial” (in reference to an older industrial area near the old Kona airport). This area features numerous large warehouses, light industrial and commercial businesses occupying industrial style buildings (Home Depot and Costco, among others).

Near the northern part of the *mauka* portion of the PA at the intersection of Kealakehe Parkway and Queen Ka‘ahumanu Highway is the Honokōhau Industrial Park that houses the Goodfellow Brothers Base yard, Queen K Chevron, L&L Drive Inn, and numerous warehouses.

During the construction of Phase 1 of the Queen Ka‘ahumanu widening project, the area near the intersection of Kealakehe Parkway and Queen Ka‘ahumau Highway was used for stockpiling material and as a staging area. This area has been completely bulldozed and is clear of all former construction activity.

In the central portion of the *mauka* project area are numerous jeep roads crisscrossing the landscape. During the survey, archaeologists observed abandoned cores and bore holes. It is likely that the majority of these jeep trails are a direct result of Geotechnical coring activity. There is also a County of Hawai‘i Wastewater Division pond that is completely fenced off with water running into it from a large-diameter PVC pipe.

The former Kona landfill and an unnamed industrial center that features the Kona Police Station, the Humane Society, a heavy machinery yard, and a waste transfer station is located directly north of a portion of the *mauka* project area. Also, within the project area is the existing Kealakehe WWTF and the Queen Lili‘uokalani Children’s Center. Within and surrounding the project area are numerous bulldozed jeep roads crisscrossing the lands.

Overall, the majority of both portions of the project area appear not to have been dramatically impacted by modern activity, with the exception of a swath of bulldozing along both sides of Queen Ka‘ahumanu Highway and the area in the *mauka* portion between Kealakehe Parkway and Hale Makai Place. Similarly, there is a swath of bulldozing around the water tank located on Hina Lani in the northern portion of the project area.

Section 2 Methods

2.1 Archival Research

Research centers on Hawaiian activities including *ka‘ao* (legends), *wahi pana* (storied places), *‘ōlelo no‘eau* (proverbs), *oli, mele* (songs), traditional *mo‘olelo* (stories), traditional subsistence and gathering methods, ritual and ceremonial practices, and more. Background research focuses on land transformation, development, and population changes beginning with the early post-Contact era to the present day.

Cultural documents, primary and secondary cultural and historical sources, historic maps, and photographs were reviewed for information pertaining to the study area. Research was primarily conducted at the CSH library. CSH cultural researchers also gather information at other archives and libraries including the Hawai‘i State Archives, the Bishop Museum Archives, the University of Hawai‘i at Mānoa’s Hamilton Library, Ulukau, The Hawaiian Electronic Library (Ulukau.org 2014), the State Historic Preservation Division (SHPD) Library, the State of Hawai‘i Land Survey Division, the Hawaiian Historical Society, and the Hawaiian Mission Houses Historic Site and Archives. Information on Land Commission Awards (LCAs) were accessed via Waihona ‘Aina Corporation’s Māhele database (Waihona ‘Aina 2000), the Office of Hawaiian Affairs (OHA) Papakilo Database (Office of Hawaiian Affairs 2015), and the Ava Konohiki Ancestral Visions of ‘Āina website (Ava Konohiki 2015).

2.2 Community Consultation

2.2.1 Scoping for Participants

The cultural department commences our consultation efforts by utilizing our previous community contact list to facilitate the interview process. We then review an in-house database of *kūpuna* (elders), *kama‘āina* (native born), cultural practitioners, lineal and cultural descendants, Native Hawaiian Organizations (NHOs; includes Hawaiian Civic Clubs and those listed on the Department of Interior’s NHO list), and community groups. CSH also contacts agencies such as the SHPD, OHA, and the appropriate Island Burial Council where the proposed project is located for their response on the project and to identify lineal and cultural descendants, individuals and/or NHO with cultural expertise and/or knowledge of the study area. CSH is also open to referrals and new contacts.

2.2.2 “Talk Story” Sessions

Prior to the interview, CSH cultural researchers explain the role of a CIA, how the consent process works, the project purpose, the intent of the study, and how their *‘ike* (knowledge) and *mana‘o* (thought, opinion) will be used in the report. The interviewee is given an Authorization and Release Form to read and sign.

“Talk Story” sessions range from the formal (e.g., sit down and *kūkā* [consultation, discussion] in the participant’s place of choice over set interview questions) to the informal (e.g., hiking to cultural sites near the study area and asking questions based on findings during the field outing). In some cases, interviews are recorded and transcribed later.

CSH also conducts group interviews, which range in size. Group interviews usually begin with set, formal questions. As the group interview progresses, questions are based on interviewees' answers. Group interviews are always transcribed and notes are taken. Recorded interviews assist the cultural researcher in 1) conveying accurate information for interview summaries, 2) reducing misinterpretation, and 3) adding missing details to *mo‘olelo*.

CSH seeks *kōkua* (assistance) and guidance in identifying past and current traditional cultural practices of the study area. Those aspects include general history of the *ahupua‘a*; past and present land use of the study area; knowledge of cultural sites (for example, *wahi pana*, archaeological sites, and burials); knowledge of traditional gathering practices (past and present) within the study area; cultural associations (*ka‘ao* and *mo‘olelo*); referrals; and any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the study area.

2.2.3 Interview Completion

After an interview, CSH cultural researchers transcribe and create an interview summary based on information provided by the interviewee. Cultural researchers give a copy of the transcription and interview summary to the interviewee for review and ask that they make any necessary edits. Once the interviewee has made those edits, CSH incorporates their *‘ike* and *mana‘o* into the report. When the draft report is submitted to the client, cultural researchers then prepare a finalized packet of the participant's transcription, interview summary, and any photos taken during the interview. We also include a thank you card and honoraria.

It is important that CSH cultural researchers cultivate and maintain community relationships. The CIA report may be completed, but CSH researchers continuously keep in touch with the community and interviewees throughout the year—such as checking in to say hello via email or by phone, volunteering with past interviewees on community service projects, and sending holiday cards to them and their *‘ohana* (family). CSH researchers feel this is an important component to building relationships and being part of an *‘ohana* and community.

"*I ulu no ka lālā i ke kumu*—the branches grow because of the trunk," is an *‘ōlelo no‘eau* (#1261) shared by Mary Kawena Pukui with the simple explanation: "Without our ancestors we would not be here" (Pukui 1983:137). As cultural researchers, we often lose our *kūpuna* but we do not lose their wisdom and words. We routinely check obituaries and gather information from other community contacts if we have lost our *kūpuna*. CSH makes it a point to reach out to the *‘ohana* of our *kūpuna* who have passed on and pay our respects including sending all past transcriptions, interview summaries, and photos for families to have on file for genealogical and historical reference.

Section 3 *Ka‘ao* and *Mo‘olelo*

Hawaiian storytellers of old were greatly honored; they were a major source of entertainment and their stories contained teachings while interweaving elements of Hawaiian lifestyles, genealogy, history, relationships, arts, and the natural environment (Pukui and Green 1995:IX). According to Pukui and Green (1995), storytelling is better heard rather than read for much becomes lost in the transfer from the spoken to the written word and *ka‘ao* are often full of *kaona* or double meanings.

Ka‘ao are defined by Pukui and Elbert (1986:108) as a "legend, tale […], romance, [and/or], fiction." *Ka‘ao* may be thought of as oral literature or legends, often fictional or mythic in origin, and have been "consciously composed to tickle the fancy rather than to inform the mind as to supposed events" (Beckwith 1970:1). Conversely, Pukui and Elbert (1986:254) define *mo‘olelo* as a "story, tale, myth, history, [and/or] tradition." The *mo‘olelo* are generally traditional stories about the gods, historic figures or stories which cover historic events and locate the events with known places. *Mo‘olelo* are often intimately connected to a tangible place or space.

In differentiating *ka‘ao* and *mo‘olelo* it may be useful to think of *ka‘ao* as expressly delving into the *wao akua* (realm of the gods), discussing the exploits of *akua* (gods) in a primordial time. *Mo‘olelo* on the otherhand, reference a host of characters from *ali‘i* (royalty), to *akua* and *kupua* (supernatural beings), to finally *maka‘āinana* (commoners), and discuss their varied and complex interactions within the *wao kānaka* (realm of man). Beckwith elaborates, "In reality, the distinction between *ka‘ao* as fiction and *mo‘olelo* as fact cannot be pressed too closely. It is rather in the intention than in the fact" (Beckwith 1970:1). Thus a so-called *mo‘olelo*, which may be enlivened by fantastic adventures of *kupua*, "nevertheless corresponds with the Hawaiian view of the relation between nature and man" (Beckwith 1970:1).

Both *ka‘ao* and *mo‘olelo* provide important insight into a specific geographical area, adding to a rich fabric of traditional knowledge. The preservation and passing on of these stories through oration remains a highly valued tradition. Additionally, oral traditions associated with the study area communicate the intrinsic value and meaning of a place, specifically its meaning to both *kama‘āina* as well as others who also value that place.

The following section presents traditional accounts of ancient Hawaiians living in the vicinity of the project area. Many relate an age of mythical characters whose epic adventures inadvertently lead to the Hawaiian race of *ali‘i* and *maka‘āinana*. The *ka‘ao* in and around the project area shared below are some of the oldest Hawaiian stories that have survived; they still speak to the characteristics and environment of the area and its people.

3.1 *Ka‘ao* and *Mo‘olelo* of Kaloko

3.1.1 *Iwi* (Bone) of Kamehameha

There are numerous versions of *mo‘olelo* about the famous fishpond along the seashore at Kaloko Ahupua‘a, including some versions suggesting the remains of Kamehameha I may have been buried nearby. In his chapter recounting the death of Hawai‘i's greatest leader, Kamakau states,

> After the kahuna had performed his office [ritual duties], Ulu-maheihei prepared to carry out the command of Kamehameha given before his death . . . to secrete his bones in a place where they could not be found . . . to put them in a place which could never be pointed out to anyone. At midnight, therefore, when black darkness had fallen and no one was likely to be on the road and the rough lava plains of Pu‘uokaloa lay hushed, Hoa-pili sent his man, Ho‘olulu, to bring the container of wicker work in which the bones of Kamehameha were kept to Kaloko in Kekaha [the coast of North Kona] . . . The next morning Hoa-pili and Ke-opu-o-lani took care to Kaloko where Hoa-pili met the man who had charge of the secret cave and together they placed the bones there. ‘The morning star alone knows where Kamehameha’s bones are guarded.’ [Kamakau 1961:215]

Another passage describing the care of Kamehameha’s bones is mentioned below:

> The children and grandchildren of Keaweaheulu had the natural right to care for the body of Kamehameha beucase they controlled the burial places of Kiolakaa and Waiohinu at Kau. But Kamehameha distrusted them, because when his own father, Keoua, died, they took the bones to hide in the pali [cliff] of Kaawaloa, and furthermore pointed out that place to other people. He thought they would not be true to his bones, there he gave them to Hoapili to hide and not reveal.
>
> About midnight, when people were sleeping and no one passing along the paths, and the lava field of Puuokaloa lay sacred in silence, Hoapili sent his man Hoolulu to get the tiedup bundle of the body of Kamehameha and take it to Kaloko, Kekaha. He got is, laid it on his back, carried a gun in his hand and went out on the a-a along the path of Puuokaloa. He saw a stone which he thought was a man and fired his gun at it. The sound was heard at Kailua and Honokohau, and the chiefs thought that the body of Kamehameha had been taken by some man.
>
> Early in the morning, Hoapili and Keopuolani went in a boat to Kaloko and met the trusted servant who was watching the pit where the body was concealed.
>
> ‘Only the stars of the heavens known Kamehameha.’ [Westervelt in Thrum and Bordner 2006:144]

3.1.2 ‘Ōhiki and Kaiwi

Pukui et al.’s entry for Ka-iwi, described as “land points near Kai-lua, Kona, Hawai‘i, and farther north in the same district,” summarizes *mo‘olelo* originally documented by Fornander about the sandy beach area between Kaloko and Honokōhau known as ‘Ōhiki:

> At one of the points [along this coast] is a rock believed to be a petrified shark, the shark form of a priest (Ka-lua-lapa-uila). When the priest was about to be burned at ‘Ōhiki, a legendary hero, Ka-miki, prayed to Pele and a terrible storm arose. The priest’s shark form was turned to stone as it tried to enter the *heiau* to save the human form of the priest. One of Pele’s sisters, Hi‘iaka-noho-lae (Hi‘iaka living [at the] point), came to live here, making the place sacred and forbidden to Pele. In the story of Punia, the shark Kai‘ale‘ale, who had swallowed Punia, came here and was cut open by the people; Punia came out alive but was bald. [Pukui et al. 1974:70]

3.1.3 Lonoikamakahiki

The coastal sections of Kaloko and Honokōhau Ahupua‘a are named in the *mo‘olelo* about the famous sixteenth or seventeenth century ruler of Hawai‘i Island named Lonoikamakahiki (Lono-i-ka-makahiki), who was involved in several famous battles with the chiefs of Maui and other parts of Hawai‘i. Kamakau describes the invasion of Kama, chief of Maui, who sent his spies along the Kona coast:

> The spies sent by Kama-lala-walu went to Hawaii and landed at Kawaihae in the evening. Ka-uhi-o-ka-lani ran about that same evening and returned before the canoes were dismantled and placed in the house. The keepers of the gods at Mailekini were servants of Kama, and so they concealed the canoes of the spies. When Ka-uhi-o-ka-lani returned his fellow spies and hosts asked, ‘Where did you go?’ ‘I went visiting from here to the lava bed and the pond that lies along the length of the land.’ ‘Kaniku is the lava bed and Kiholo, the pond. Then did you turn back?’ ‘No, I went on to the long stretch of sand, to the small bay with a point on that side and one of this side. There are large inland ponds.’ ‘The sand stretch is ‘Ohiki, and the walled-in ponds are Kaloko and Honokohau. Then you came back?’ ‘No, I went on to the large rocky cape below, where there was a small bay with big groves of coconut trees. The land from there on is good and a small village is located there.’ [Kamakau 1992:56]

3.1.4 The Story of Kamiki

Kepā Maly (in Henry et al. 1993) translated the “Kaao Hooniua Puuwai no Ka-Miki” (The Heart stirring Story of Ka-Miki) that appeared in the newspaper *Ka Hoku o Hawai‘i* between 1914 and 1917. The legend provides details about life and the environment of the entire island of Hawai‘i. Ka-Miki, the quick or adept one, and his brother Maka‘iole (“rat or squinting eyes”), traveled around the island to participate in competitions ca. the thirteenth century when Pili-a-Ka‘aiea was the chief of Kona. The boys’ parents were Pōhaku-o-Kāne (male) and Kapa‘ihilani (female), the *ali‘i* (chiefs) of Kaloko and Kohanaiki. The legend relates that the supernatural brothers “were empowered by their ancestress Ka-uluhe-nui-hihi-kolo-i-uka (the great entangled growth of uluhe fern which spreads across the uplands), a reincarnate form of the earth-mother goddess, creative force of nature Haumea (also called Papa) who dwelt at Kalama‘ula on Hualālai, in the uplands of Kohana-iki, Kona” (Maly in Henry et al. 1993:21–22). The twins were raised by Ka-uluhe, who taught them how to use their supernatural powers. Portions of the legend that are relevant to the current study follow.

In ‘O‘oma and Kalaoa, the priests of the different *ahupua‘a* are named:

> Puhili was the high priest of ‘O‘oma and Kohanaiki, the place where he lived is on the plain of Kohanaiki, at the shore, and bears his name to this day. It is on the boundary between Kohanaiki and ‘O‘oma.
>
> Kalua‘ōlapa was the priest of the lands between Haleohiu, [Hāmanamana], and Kamāhoe, which is also referred to as Nā-Kalaoa-wai‘ole (The waterless Kalaoa [lands]). Kalua‘ōlapa lived on the *‘ilima*-covered plain of Māulukua [Maly in Henry et al. 1993:22].

> . . . While at Kalāhiki (Kona-hema), with Kūalaka‘i and his fishermen in the hālau wa‘a (canoe sheds) of Kuaokalā, Ka-Miki described the fishing grounds of [Kekaha] his home region. The narratives include the following site descriptions:
>
> Ka‘ele-huluhulu (Splintered outer hull) This place name described the splintered or rough nature of canoes from the area of Hale‘ōhi‘u. At low tide canoes had to be dragged over an outcropping of rock in the waters of the canoe landing at Hale‘ōhi‘u [Maly in Henry et al. 1993:22] . . .
>
> . . . Ho‘onā is a point near the tip of Keāhole, and it is the source of the famous supernatural currents Ke-au-kā (The current that strikes), Ke-au-kāna‘i (The current of smooth waters), and Ke-au-miki (The current that pulls out to the deep sea). [These currents are identified as brothers of Pele *mā* in the lore of Pele’s migration to Hawai‘i.]
>
> Ka-Miki was fishing off of the deep sea ko‘a of Pāo‘o (between Ho‘onā and Hale‘ōhi‘u), when the aku began to strike at the canoe. Ka-Miki told his companion Uhalalēma to take the first caught and place it in a gourd container. After this the aku rose like biting dogs, tearing at the water, and Ka-Miki moved like a swift wind. In no time the canoe was filled with more than 400 aku.
>
> An amazing thing is that although Pili’s fishermen, and all the fishermen of the region, were fishing at Kāka‘i, Kanāhāhā (Hale‘ōhi‘u), and all the way from the fort [at Ahu‘ena] to Kahawai (Ka‘ūpūlehu), none of them caught any fish at all . . .
>
> After catching more than 400 aku, Ka-Miki landed the canoe at Nā-Hono-‘elua, now called Honokohau. Ka-Miki divided the fish among the family of the sacred chiefess Paehala and people of those lands . . . [Maly in Henry et al. 1993:24]

Maly (in Henry et. al 1993:28) notes that Hale-o-Lono, Ki‘ikahala, and ‘Ohiki are associated with sites and/or place names that are shared by Kaloko and Kohanaiki.

Ka-Miki completed his journey around the Big Island and

> . . . became the foremost champion of Pili (7/26/1917). It was at this time that Ka-Miki learned about the sacred palama chiefess Paehala of Honokohau; lands also called Na-Hono-i-na-Hau-‘Elua (the bays of the two dews). Pili gave Ka-Miki permission to wed Paehala if she and her family agreed, and Paehala was the foremost beauty of Kona.
>
> When the chiefess agreed to marry Ka-Miki, Pili told Ka-Miki, that he would also, ‘oversee the chiefs’ sacred fishponds [at Kaloko and Pa‘aiea]; the schools of kala, uhu, and palani; and all the lands of Kekaha from Hikuhia which is above Napu‘u (also called Napu‘upo‘alu); and lands between Keahualono at Kaniku to the plain of Kanoenoe, marked by the hill of Pu‘uokaloa at Keahuolu’ (10/18/1917). [Maly in Henry et al. 1993:18]

3.2 *Ka‘ao* and *Mo‘olelo* of Kealakehe and Keahuolū

The following stories take place in either Kealakehe and Keahuolū Ahupua‘a, as these are neighboring land sections.

3.2.1 Pu‘u-o-Kaloa

There is a mound-hill at Keahuolū and Kealakehe, the *ahupua‘a* to the north, that is also associated with mists. According to the “Legend of Ka-Miki,” a series of stories about a supernatural hero who traveled around the Hawaiian Islands in the thirteenth century:

> The mound-hill called Pu‘u-o-Kaloa sits upon the plain of Kanoenoe which is associated with both Keahuolu and Kealakehe. The settling of mists upon Pu‘u-o-Kaloa was a sign of pending rains; thus the traditional farmers of this area would prepare their fields. This plain was referenced by Pili when he described to Ka-Miki the extent of the lands which Ka-Miki would over see upon marrying the scared chiefess Paehala of Honokōhau. The inheritance lands included everything from the uplands of Hikuhia above Nāpu‘u and the lands of the waterless Kekaha, which spanned from the rocky plain of Kanikū (Keahualono) to the plain of Kanoenoe at Pu‘ukaloa. [*Ka Hoku o Hawai‘i* 25 October 1917, as translated by Maly 1994:A-4]

For an expanded version related to farming, see Section 3.3.1.

3.2.2 Punia: A Tale of Sharks and Ghosts of Kekaha

The story of Punia and the shark, Kai‘ale‘ale, is told by Fornander in his “Hawaiian Antiquities and Folklore” (Fornander 1959:9–17). In his account, the story begins in the district of Kohala and ends at ‘Alula in Kealakehe. Punia was the son of Hina from Kohala who wanted to catch lobsters for his mother, but the caves where the lobsters were found were guarded by Kai‘ale‘ale and his sharks. The sharks were feared by fisher folk of the area but Punia devised a plan and succeeded in killing all the sharks except for Kai‘ale‘ale. Like the biblical story of Jonah and the whale, Punia tricked Kai‘ale‘ale into swallowing him whole. Punia started a fire inside of the shark and scraped his insides. Weakened, the shark breached at ‘Alula, near the point of Maliu, in the *ahupua‘a* of Kealakehe. The people of ‘Alula cut open the shark and saved Punia.

Punia headed back to Kohala on the trail and saw several ghosts along the way tying stones for sinkers to the bottom of their fishing nets. In an attempt to save himself, Punia chanted the following:

Auwe no hoi kuu makuakane o keia kaha e!	Alas, O my father of these coasts!
Elua wale no maua lawaia o keia wahi	We were the only two fishermen of this place (kaha).
Owau no o ko‘u makuakane,	Myself and my father,
E hoowili aku ai maua i ka ia o ianei,	Where we used to twist the fish up in the nets,
O kala, o ka uhu, o ka palani,	The kala, the uhu, and the palani,
O ka ia ku o ua wahi nei la,	The transient fish of this place.
Ua hele wale ia no e maua keia kai la!	We have traveled over all these seas,
Pau na kuuna, na lua, na puka ia.	All the different place, the holes, the runs.
Make ko‘u makuakane, koe au.	Since you are dead, father, I am the only one left.

[Fornander 1919:298–299]

Thinking that Punia was an experienced fisherman from whom they could learn where the fish were, the ghosts asked Punia if they could work under him. As they jumped in the ocean with him to go fishing, Punia strangled all of the ghosts except one with a net. The ghost fled and Kekaha became safe for human habitation.

3.3 Wahi Pana (Legendary Places)

Wahi pana are legendary or storied places of an area. These legendary or storied places may include a variety of natural or human-made structures. Oftentimes dating to the pre-Contact period, most *wahi pana* are in some way connected to a particular *mo‘olelo*, however, a *wahi pana* may exist without a connection to any particular story. Davianna McGregor outlines the types of natural and human-made structures that may constitute *wahi pana*:

> Natural places have mana, and are sacred because of the presence of the gods, the akua, and the ancestral guardian spirits, the ‘aumakua. Human-made structures for the Hawaiian religion and family religious practices are also sacred. These structures and places include temples, and shrines, or heiau, for war, peace, agriculture, fishing, healing, and the like; pu‘uhonua, places of refuge and sanctuaries for healing and rebirth; agricultural sites and sites of food production such as the lo‘i pond fields and terraces slopes, ‘auwai irrigation ditches, and the fishponds; and special function sites such as trails, salt pans, holua slides, quarries, petroglyphs, gaming sites, and canoe landings. [McGregor 1996:22]

As McGregor makes clear, *wahi pana* can refer to natural geographic locations such as streams, peaks, rock formations, ridges, offshore islands and reefs, or they can refer to Hawaiian land divisions such as *ahupua‘a* or *‘ili*, and man-made structures such as fishponds. It is common for places and lanscape features to have multiple names, some of which may only be known to certain *‘ohana* or even certain individuals within an *‘ohana*, and many have been lost, forgotten, or kept secret through time. Place names also convey *kaona* and *huna* (secret) information that may even have political or subversive undertones. Before the introduction of writing to the Hawaiian Islands, cultural information was exclusively preserved and perpetuated orally. Hawaiians gave names to literally everything in their environment, including points of interest that may have gone unnoticed by persons of other cultural backgrounds. Hawaiians have named taro patches, rocks and trees that represented deities and ancestors, sites of houses and *heiau* (pre-Christian place of worship), canoe landings, fishing stations in the sea, resting places in the forests, and the tiniest spots where miraculous or interesting events are believed to have taken place (Pukui et al. 1974:x).

3.3.1 Pu‘u-o-Kaloa

As discussed in the previous section and mentioned in the story of Ka-Miki, here is another legendary account that discusses the importance Pu‘u-o-kaloa:

> Pu‘u-o-kaloa is a mound-hill site in the lands of Keahuolu-Kealakehe, not far from the shore of Kaiwi and Hi-iakanoholae. During periods of dry weather (*Ka lā malo‘o*) when planted crops, from the grassy plains to the *‘ama‘uma‘u* (fern forest zone), and even the ponds (*ki‘o wai*) were dry, people would watch this hill for signs of coming rains. When the *līhau* (light dew mists) sat atop the hill of Pu‘u-o-kaloa, rains were on the way. Planters of the districts agricultural fields watched for omens at Pu‘uokaloa, and it was from keen observation and diligent work that people prospered on the land. If a native of the land was hungry and came asking for food, the person would be asked:
>
> Ua ka ua i Pu‘ukaloa, ihea ‘oe?
>
> When rains fell at Pu‘ukaloa, where were you? (If the answer was…)
>
> *I Kona nei no*!
>
> In Kona (there would be no sweet potatoes for this person)
>
> But if the answer was:
>
> *I Kohala nei no!*
>
> In Kohala! (The person would be given food to eat for they had been away, thus unable to accomplish the planting.) [*Ka Hōkū o Hawai‘i* 19 March 1914, as translated by Maly 1994:A-5]

These legendary accounts emphasize the importance of rainfall in this relatively dry region for farmers, who were cultivating sweet potatoes and other crops on the plains of Kealakehe and Keahuolū. In pre-Contact times, Hawaiians in these *ahupua‘a* would have lived primarily along the coast and in a habitation belt about two miles inland (Kelly 1983:14).

3.3.2 Kahinihini‘ula

According to the Malys (Maly 2000; Maly and Maly 2002), extensive research translating Hawaiian language documents and interviewing *kūpuna*, this bathing pool is associated with *mo‘o* (supernatural water spirits), who ensured the water stayed clean and free from pollutants. Kama‘āina Kihe, born in the area in the middle nineteenth century, had this to say about Kahinihini‘ula:

> He wai auau keia no na alii i ka wa kahiko. He u‘i keia wai, he hu‘i iniki i ka ili o ka ipo ke auau.
>
> Eia keia wai i kahakai, aia iwaena o ke-a pele, ua hoopuniia e ka pohaku a puni. Aia ma ka palena o ke Ahupuaa o Kaloko a me Konokohau-Nui, aia malaila keia wai auau kaulana o Nalii e auau ai o ua au i hala
>
> O ka moolelo o keia wai;
>
> O ka wa kahiko, he mea maa mau i Nalii ka noho ana ma na kahakai, oia hoi ko Kaloko mau alii, a pela no hoi ko Honokohau, Ma kahi i kapaia o Ahauhale, malaila e noho ai nalii o Kaloko, a ma kahi hoi i kapaia o Waihalulu, malaila e noho ai ko na Honokohau poe alii.
>
> I ka wa la‘ila‘i a hulili wela o ka La iluna o ke aa ame ke one, oia ka wa e hele ai e auau iloko ona kiowai hu‘ihu‘i iniki nei o Kahinihiniula. Aia a pau ka auau ana a hoi ae a ma ka pa ona kiowai nei, alila, olelo ae la ka mea auau. ‘Heaha no la hoi ia i kahi wai o Kahinihiniula? Hu‘i konikoni i ka ili, iniki me he ipo ala i ka poli.’

Ke waiiho nei no ua kiowai nei a hiki i keia la ma kela wahi o Nalii ua pau kahiko i ka lilo i lepo, a o kela wai, aia no ke waiho nei a hiki i keia la. Ua waiho ia keia kiowai i kia hoomanao poina ole noia poe i hala kahiko loa mao, a ka hanau, na hou e maka‘ika‘i aku ai i ka lakou mau mea i hana ai.

Translation:

This is a bathing pool of the chiefs of days gone by. It is a beautiful pond, with cool water that causes the skin of the sweetheart that bathes there to tingle. The pool is on the shore in the middle of a lava flow, entirely surround by stone. It is there on the boundary of the ahupua‘a of Kaloko and Honokōhau-Nui. It is there that one will find this famous swimming pond of the chiefs of days gone by. Here is the tradition of this pond—

In ancient times, the chiefs would regularly live along the shore, that is, the chiefs of Kaloko and Honokohau. At the place called Ahauhale, is where the chiefs of Kaloko lived. The place called Waihalulu, is where the chiefs of Honokohau lived.

In the times when all was still and the sun glistened above the ‘ā‘ā and the sands, that is when they would go swim in this cool pond (kiowai), Kahinihiniula, which caused the skin to tingle. When they were finished bathing, they would go to the enclosure (pā) that was near the pond. Then the one who had been bathing would say, ‘What is it about the pond of Kahinihiniula? It is cold and pinches the skin, like a sweetheart one holds close to the breast.’

The pond is still there to this day, at the place of the chiefs of past time. They have returned to the earth, but the pond is still there today. This pond is an unforgettable monument for those ancient people who have gone. Those works of old and the pond may be seen by travelers of this generation. [J.W.H.I. Kihe in “Na Hoonanea o ka Manawa.” *Ka Hoku o Hawai‘i*, 13 September 1923; translated by Maly 2000]

3.3.3 Place Names of Kaloko, Kealakehe, and Keahuolū

The primary source for place names in this section is Lloyd Soehren’s (2010) online database, *Hawaiian Place Names*. Soehren has compiled all names from mid-nineteenth century land documents such as Land Commission Awards (LCA) and Boundary Commission Testimony (BCT) reports. The Boundary Commission testimony lists boundary points for many (but not all) of the *ahupua‘a*. The names of *‘ili ‘āina* (land units within an *ahupua‘a*) and *‘ili kū* (land units rewarded separately from a specific *ahupua‘a*) are compiled from the testimony in Māhele Land Commission Awards, from both awards successfully claimed and from those rejected.

The Soehren database includes place name meanings from the definitive book on Hawaiian place names, *Place Names of Hawaii* (Pukui et al. 1974). In cases where Pukui et al. (1974) do not provide a translation, Soehren often suggests a meaning for simple names from the *Hawaiian Dictionary* (Pukui and Elbert 1986). Thomas Thrum (1922) also compiled a list of place names in the 1922 edition of Lorrin Andrews’ *A Dictionary of the Hawaiian Language*, although these meanings are considered less reliable than those in *Place Names of Hawaii*. Oftentimes these place names can be found on historic maps.

3.3.3.1 Place Names of Kaloko Ahupua‘a

Situated between Kohanaiki and Honokōhau Ahupua‘a is Kaloko Ahupua‘a (also in Kekaha lands). This dry and barren landscape is home to the famous Kaloko fishpond. Pukui et al. state that it is a land section and fishpond near Kai-lua, North Kona, Hawai‘i. Kamehameha’s bones may have been hidden near here (RC215); the Kamehameha family reserved the pond for themselves in 1848 (Pukui et al. 1976:77–78).

Table 1. Kaloko Ahupua‘a Place Names

***‘Ili* Name**	**Type**	**Meaning of Name**	**Description**
Haleape	*‘Ili ‘āina*	House of *‘ape* (a taro like plant; Alocasia macrorrhiza)	Claim no. 10327 by Nahuina for his “apana ili o Halaape [sic] Kaloko ahupuaa.” Claim no. 7909 by Kamaole is for his “apana ili o Makaawe & Haleape, Kaloko ahupuaa.”
Haleolono	*‘Ili ‘āina*	House of Lono	Claim no. 9243 by Kalaikoa is for “kona apana 1 kihapai kalo ili o Kealaehu & Luahineeku & Haleolono ma Kaloko ahupuaa.”
Kaewewai	Awaawa, boundary point	Not available	“. . . an awaawa with water near the shore road . . .” Between Okuhi and Kaohe on the Kaloko/Honokohau boundary
Kaloko	*Ahupua‘a*	The pond	Retained by Lot Kamehameha, LCAw 7715:11; ancient fishing rights extend out to sea; Kamehameha’s bones may have been hidden in Kaloko.
Kanaio	*‘Ili ‘āina*	The false sandalwood tree	Claim no. 9160 by Kanu is for “kona apana ili o Kanaio ma Kaloko.”
Kaohe	Boundary point, grove	Not available	“. . . a grove of trees . . .” above the aa; between Kaewewai & Kiikii [Kīkī] on Kaloko/Honokohau boundary
Kapokalani	Boundary point, place	Not available	“. . . along an iwi aina to Kapokalani at the Govt. road [Old Upper Road on TM 7301] . . . ” on Kaloko/Honokohau boundary; SE corner TMK 7308:67, SW corner TMK 7324:15; Cf. Pukalani, Pukaalani
Kaukahoku	Place, triangulation station	The star appears	A survey station located near Kohanaiki/Kaloko boundary, TMK 7324:16; elev. about 1900 ft; coordinates estimated

***‘Ili* Name**	**Type**	**Meaning of Name**	**Description**
Kealaehu	*‘Ili ‘āina*	The dusty road	Claim no. 10951:1 by Wahahee is in the “ili o Kealaehu Kaloko ahupuaa”; also claim no. 10346:2 by Nahueholua, no. 10693:2 by Paele; Claim no. 9243 by Kalaikoa is for “kona apana 1 kihapai kalo ili o Kealaehu & Luahineeku & Haleolono ma Kaloko ahupuaa.”
Kiikii	Boundary point	To fetch, summon, procure	Unclear whether in Kaloko or Honokohau; between Kaohe and Kapokalani on Kaloko/Honokohau boundary; Cf. Kiki 373.20.005 which may be the same place
Kikahala	*‘Ili ‘āina*	Not available	Claim no. 7797:1 by Kamohoalii is for “kona apana 1, 12 kihapai kalo ili o Kikahala Kaloko ahupuaa”; Claim no. 10951: by Wahahee is for a “pahale ili o Kikahala Kaloko ahupuaa”; Claim no. 10346 (not awarded) by Nahueholua is for “apana 1, 8 kihapai kalo & uala ili o Kiikahala [*sic*] ma Kaloko ahupuaa”; also claim no. 9242 by Keaweahookino in “ili o Kiikahala ma Kaloko ahupuaa”
Kiki	Kū‘ula (*heiau* near sea for worship of fish gods)	Not available	Claim no. 10694 by Puhi is for “kona apana ili o Kiki ma Kaloko ahup”; Cf. Kiikii 373.20.021 which may be the same place
Kukuiha‘a	*‘Ili ‘āina*	Not available	Claim no. 9238:1 by Kahoohanohano is for “kona apana 1 ili o Kukuihaa Kaloko ahupuaa”; Claim no. 9241:2 by Kaiama is for his “apana 2, kihapai kalo ili o Kukuihaa.”
Lueahineeku	*‘Ili ‘āina*	Not available	Claim no. 9241 by Kaiama is for “kona apana 1 ili o Luahineeku Kaloko ahupuaa”; Claim no. 9243 by Kalaikoa is for “kona apana 1 kihapai kalo ili o Kealaehu & Luahineeku & Haleolono ma Kaloko ahupuaa.”
Makaawe	*‘Ili ‘āina*	Not available	Claim no. 7909 by Kamaole is for his “apana ili o Makaawe & Haleape Kaloko ahupuaa.”

***‘Ili* Name**	**Type**	**Meaning of Name**	**Description**
Okuhi	Awaawa, boundary point	Not available	“. . . an awaawa in the sea with a point on each side of it”; boundary at shore between Kaloko and Honokohau; probably ‘ōkuhe, a variety of ‘ō‘opu fish (PE)
Oloupe	*‘Ili ‘āina*	Not available	Claim no. 9237 by Kahiona for “kona apana ili Oloupe Kaloko ahupuaa”; TMK 7308:36
Papuaa	*‘Ili ‘āina*	Not available	Claim no. 9238 by Kahoohanohano is for his “apana 2, kihapai ili o Papuaa Kaloko ahupuaa.”
Puu Iki	Boundary point, hill	Not available	Course 1, 6864 ft from shore along Kaloko/Honokohau boundary; elev. about 260 ft
Ulawini	*‘Ili ‘āina*	Not available	Claim no. 7797 by Kamohoalii is for his “apana 2. Kihapai uala ili o Ulawini Kaloko ahupuaa.”
Ulukukahi	*‘Ili ‘āina*	Not available	Claim no. 9060 by Kioku is for “kona apana ili o Ulukukahi Kaloko ahupuaa.”
Waimea	*‘Ili ‘āina*	Not available	Claim no. 10693 by Paele is for “kona apana 1, ili o Waimea Kaloko ahupuaa.”

3.3.3.2 Place Names of Kealakehe

Between the *ahupua‘a* of Honokōhau and Keahuolū is Kealakehe. The *ahupua‘a* is also in the Kekaha region. Pukui et al. (1974) provide no literal translation for this *ahupua‘a*.

Table 2. Kealakehe Ahupua‘a place names

***‘Ili* Name**	**Type**	**Description**
Kaenaena	Boundary point, hill	A hill between Puu Nahaha and Kaeeku, on Kealakehe/Keahuolu boundary; quad uncertain; “I do not know places called Kaenaena . . .”
Kahihiie	Boundary point	“. . . the corner of the lands Kealakehe, Keahuolu & Lanihauiki . . . ” (BC 45); also spelled Kahiihiie (BCT 1:364), Kahihiia (BCT 1:358)
Kahuaakaulei	Boundary point, place	Above the Government road “in the woods (I have not been there . . .”; on Kealakehe/Keahuolu boundary between Keahuuaa and Ohiawela

***‘Ili* Name**	**Type**	**Description**
Kaiwi Point	Boundary point	Boundary between Kealakehe and Keahuolu
Kalokoloa	Inlet	A narrow inlet in *pāhoehoe*, probably a collapsed lava tube; between Kaluakauaka and Noio Point on Kealakehe shore
Kaluakauaka	Inlet	Between Kaiwi Point and Kalokoloa on Kealakehe shore
Kalualapauila	Boundary point, *heiau*	The Kealakehe/Keahuolu boundary passes “a few fathoms on the north side of a heiau called Kalualapauila”; also known as Luapauwila
Kaniohale	*‘Ili ‘āina*	Claim no. 10306 by Nuole is “i ka ili aina o Kaniohale ahupuaa Kealakehe”; also claim no. 9252 by Kauhai, 10070:3 by Mioi, 10671 by Pepe
Kaohia	*‘Ili ‘āina*	Claim no. 8608:1 by Kaahui is “i ka ili aina i Kaohia ahupuaa Kealakehe, 4 kihapi kalo . . .”; also claim no. 7483 by Kalua, claim no. 10950 by Waiwaiole
Kealakehe	*Ahupua‘a*	Retained by Keohokalole, LCAw 8452:12; ancient fishing rights to *‘opelu* extend out to sea
Lae Niau	Boundary point, hill	“. . . an ahu pohaku at the Government road” (1:355); “. . . a puu makai of said road” [Old Upper Govt. road on TM] (1:356); a triangulation station on USGS, elev. 1487; between Kalualapauila and Keahupuaa on Kealakehe/Keahuolu boundary; also written Kalaeoniau; coordinates estimated
Ohiawela	Boundary point, spring	“I have not been there, but have heard that there is a spring there”; between Kahuaakaulei and Kahihiia, on Kealakehe/Keahuolu boundary
Opilopilo	*Kahawai* (stream, creek)	“turn north to kahawai Opilopilo, the mauka corner of Kealakehe”
Puu Nahaha	*Pu‘u* (hill, peak)	“. . . a hill of aa called Puu Nahaha . . .” on Kealakehe/Keahuolu boundary between Puu Ulaula and Puu o Hulihuli; elev. 150 ft
Puu o Hulihuli	Boundary point, place	Between Puu Nahaha and Kalualapauwila, about 220 ft elev. on Kealakehe/Keahuolu boundary; also spelled “Puuouliuli” (BCT 1:356), Puohulihuli on USGS
Puu o Kaloa	Boundary point, knoll	Kamakau: “The spot where [Ke-alii-o-kaloa] was killed was called Puu-o-Kaloa, situated between Kailua and Honokohau”; ‘Ī‘ī places it along the trail from Kamakahonu to Kiholo; an *oioina* [resting place], on Kealakehe/Keahuolu boundary (BCT); coordinates estimated

***‘Ili* Name**	**Type**	**Description**
Puu Ulaula	Boundary point, *pu‘u*	On boundary Kealakehe/Keahuolu; between Puu o Kaloa and Puu Nahaha

3.3.3.3 Place Names of Keahuolū

Keahuolū Ahupua‘a is located within a transitional area between two distinct ecological zones. Lands to the south of Keahuolū, known as Kona Kai ‘Opua (“Kona of the distant horizon clouds above the ocean”), between Kailua Bay and Keauhou Bay, are generally recognized as the fertile agricultural district and population center of North Kona (Kelly 1983; Kirch 1985:166). The relatively dry Kekaha-wai-‘ole (“the waterless place”) area of North Kona to the northeast is characterized by coastal fishponds and relatively barren lava inlands.

The name of the *ahupua‘a,* Ke-ahu-o-lū, has been translated in two ways. The first is as “the ahu [cairn or altar] of Lū” (Pukui et al 1974:101). There are no legendary accounts of a Hawaiian named Lū, but an *ahu* is a mound, often used as an altar, so the name could refer to “the altar of Lū.” The name of the land has also been written as Ke‘ohu‘olu (Maly 1994:A-3), which means “the refreshing mists.”

Table 3. Keahuolū Ahupua‘a place names

***‘Ili* Name**	**Type**	**Description**
Halepau	*Ko‘a* (fishing shrine), *‘ili ‘āina*	“Ko‘a of Halepa‘u, Halepa‘u section, land of Keahuolu . . . A small fishing heiau situated on the pahoehoe 100 feet from the sea . . .”
Hiiakanoholae	Point	Now called Keahuolu Point on USGS; the traditional name is Hiiakanoholae
Hoenui	Boundary point, place	“a pile of stones makai of the wall of Governor Adams”; “a good ways makai of Governor Adams’ wall”; also called Puu Hoe; between Pohakuloa and Puu o Kaliu on Keahuolu/Lanihau boundary; about 200 ft elev.
Honu	*‘Ili ‘āina*	Claim no. 10303:1 by Maa for his taro land “i ka ili aina i Maili, ahupuaa o Keahuolu” is bounded “Mauka o Honu ili aina.”
Kaaialii	Boundary point	“on the south side of ulu hala” on Keahuolu/Lanihaunui between Kekaulele and Keahupuaa
Kahoi	Boundary point, place	A point on the Keahuolu/Lanihaunui boundary, about 600 ft elev.; not named in testimony
Kahuoli	Boundary point, *kīhāpai kō‘ele* (small land unit	“an old kihapai koele, there are 2 kuleanas there, on Lanihau, adjoining Keahuolu”

***‘Ili* Name**	**Type**	**Description**
	farmed by a tenant for the chief)	[LCAw 5317 to Kaaawa and 10007 to Luhai, on either side of Mamalahoa Hwy]
Kaohiahoomoekanaka	Boundary point, place	“The mauka corner is on a pali . . . The koa is on Lanihau and Kaloko”; “a place called Kauwau or Kaohiahomoekanaka” (BC 45); “Ohiakaukanaka, a pali in the woods [is] the mauka end of Keahuolu”; “an ahua called Kaohiamoekanaka”; same as Ohiakaukanaka, Kaohiamoekanaka; see Kauwau for story
Kaopapa	Boundary point, *pūnāwai* (water spring)	“a place in the woods in Akolea fern a pūnāwai”; between Puu Koae and Puu Lepo on the Keahuolu/Lanihau boundary; near the *mauka* corner of Lanihaunui, about 2500 ft elev.; coordinates estimated
Kapulehu	Boundary point, *‘oi‘oina* (peak, cape)	Between Nohoanaomaa and Waiakamalama on the Keahuolu/Lanihau boundary
Keahupuaa	*Ahu*, boundary point	At Government road (Mamalahoa Hwy), between Lanihaunui and Keahuolu; probably a Makahiki altar at the land boundary (Malo 1951:146)
Kealakehe	*Ahupua‘a*	Returned by Kekuapanio, retained by *aupuni* at the Māhele
Keanawai	Water hole	“a water hole, where there used to be a great many houses”; “on Keahuolu”; between Keahupuaa and Paeheo on the Keahuolu/Lanihau boundary
Kekaulele	Boundary point	A point on the Keahuolu/Lanihaunui boundary, between Paaaina and Kaaialii
Kohiamoekanaka	Boundary point, place	“The mauka corner of Keahuolu is an Ahua called Kaohiamoekanaka”; also called Kaohiahoomoekanaka, Ohiakaukanaka, perhaps Ohiapiipa
Maili	Village, *‘ili ‘āina*	“Maili is an ili aina on Keahuolu near the boundary at Puu Hoe [Hoenui] . . .”; “Maili is an old village at Puu o Kaliu a palipali ahua, where houses used to stand . . .”; Claim no. 10303 by Maa is “i ka ili aina i Maili, ahupuaa o Keahuolu”
Nohoanaomaa	Boundary point, place	“an oioina at the mauka corner of Lanihaunui”; at its junction with Keahuolu; also spelled Nohoanaa (BC 25 and 45),

***‘Ili* Name**	**Type**	**Description**
		Nohonoa, Nohonakeaa, Nohoanaoa; about 2580 ft elev.
Ohiakaukanaka	Boundary point	“a place called Kauwau or Kaohiahomoekanaka [*sic*]” (BC 45) at southeast corner Keahuolu; also called Kaohiahoomoekanaka, Kaohiamoekanaka, Kauwauhoomoekupapau
Ohiapiipa	Boundary point, place	Between Kauwau and Waiakamalama on Keahuolu/Lanihauiki boundary; perhaps same as place called Ohiakaukanaka (1:357), Kaohiamoekanaka (1:356) or Kaohiahoomoekanaka (BC 45; 1:357)
Paaaina	Boundary point, place	A point on the Keahuolu/Lanihaunui boundary, between Hoenui and Kekaulele
Paeheo	Boundary point, place	A point on the Keahuolu/Lanihaunui boundary, between Keanawai and Puekaiki
Papuaa	*‘Ili ‘āina*	Claim no. 11071 by Aki is “i ka ili aina i Papuaaiki ahupuaa Keahuolu”; Claim no. 10303:2 by Maa in Maili is bounded “Mauka o Papuaanui ili aina . . .Ma Kohala o Papuaaiki.”
Pohakuloa	Boundary point, rock	“a prominent point of rocks at the sea shore called Pohakuloa” marks the boundary between Keahuolu and Lanihaunui
Puekaiki	Boundary point, place	Between Paeheo and Puu Koae, above Government road (Mamamalahoa Hwy) on Keahuolu/Lanihau boundary
Puu Koae	Boundary point, place	“a very small ahua, of dirt and stones” spelled Puukoai’ “a puu lepo” spelled Puu Koae; Between Keanawai and Kaopapa on the Keahuolu/Lanihaunui boundary
Puu Lepo	Boundary point, *kualapa* (ridge)	“a kualapa . . .above the young koa trees in the ohia”; on Keahuolu/Lanihauiki boundary, between Nohoanaomaa and Waiakamalama
Puu o Kaliu	*‘Ili ‘āina*	“Maili [q.v.] is an old village at Puuokaliu, a palipali ahua . . .” Claim no. 10345 by Nahaalualu is “i ka ili aina o Puuokaliu ahupuaa Keahuolu, Hawaii.”
Ululele	*‘Ili ‘āina*	Claim no. 10198 by Hailewalewa is “i ka ili aina i Ululele, ahupuaa Keahuolu.”

***‘Ili* Name**	**Type**	**Description**
Waiakamalama	Boundary point, water hole	“where the natives get water when it fails below the woods. You have to dig to get it”; between Kapulehu and Ohiapiipa on Keahuolu/Lanihauiki boundary
Waianuia	Boundary point, place	A point on the Keahuolu/Lanihaunui boundary, not named in testimony; about 500 ft elev.

3.3.4 Heiau (Place of Worship)

Thomas Thrum first recorded archaeological features for the Island of Hawai‘i in 1908, based on literature reviews and field visits he had conducted over the course of several decades. At roughly the same time—around 1906-1907—J.F.G. Stokes of the Bernice Pauahi Bishop Museum also conducted a suvery of *heiau* on the Island of Hawai‘i. The few *heiau* mentioned within this section are those identified by Stokes (Stokes and Dye 1991).

3.3.4.1 Luapauwila Heiau

The *heiau* of Luapauwila was recorded by Stokes as a walled structure on the ‘Elemakule homestead, Grant Number 3765 in Kealakehe. The *heiau* was said to be 3.5 miles from the ocean (Stokes and Dye 1991:40).

3.3.4.2 Makaopi‘o Heiau

Makaopi‘o Heiau is located at Noio Point in ‘Alula Bay within the Kealakehe Ahupua‘a. The *heiau* was not identified by Stokes’ survey of the Island of Hawai‘i but is among the most prominent *heiau* within this district today. The structure is a fisherman’s *heiau* of the Hale-o-Lono class. It is a low rectangular platform built out into a shallow, pond area. According to the National Park Service (NPS):

> Its outstanding features are two great upright stone slabs, measuring over six feet five inches in height, that rise above the pavement perpendicular to the seaward face. The stones, one of which bears a petroglyph of a man about twenty-four inches high, may have represented fishermen’s gods. Also present is a small *ko‘a* (fishing shrine) comprising a large, smooth stone standing on a platform (U.S. Department of Interior 1975). Nearby are ancient house sites, petroglyphs, and bathing pools. [Greene 1993:Chap. VIII, Sect. 6.29]

3.3.4.3 Halepa‘u Ko‘a

Halepa‘u Ko‘a is described as a fishing *heiau* built on the *pāhoehoe* 100 ft from the sea. It is sheltered by a coconut grove in the area. The walls of this *heiau* are in great condition and stand 4 ft high (Stokes and Dye 1991:40).

3.3.4.4 Kawaluna Heiau

Kawaluna is listed as a *heiau* located in the *‘ili* of Pawai in the *ahupua‘a* of Keahuolū and is further described below:

> The *heiau* is an enclosure without an opening, the walls of which have been carefully rebuilt. The interior was filled with loose stones piled up without arrangement. A local informant stated that an old fisherman was in the habit of offering fish in this *heiau*. Asked as to the resulting luck, he answered that it was not as much as that of other fishermen, perhaps becuase the offering was made at a *heiau* instead of Halepa‘u Ko‘a nearby. [Stokes and Dye 1991:40–41]

3.3.4.5 Palihiolo Heiau

Palihiolo Heiau is a *luakini heiau* said to have been rebuilt by Kalākaua. This *heiau* was surrounded by a coconut grove which is where Kalākaua‘s grandfather was hanged for murder.

> This is an insignificant pen, 25 by 29 feet in size with small, thin walls, built on the upper slopes of the beach. Coral has been spread over the floor as paving. The only interest attaching to the place is the account given by a very old native living in the coconut palm grove. He said that Palihiolo was formerly a *heiau* for human sacrifice and that it was rebuilt on Kalākaua‘s orders before the latter left for the United States (about 1890). The old native also said that Kalākaua promised to have a sacrifice at Palihiolo on his return from America but that he died in that country. The old native was very insistent on the truth of his statements. It might be mentioned that the surrounding grove of palms is where Kalākaua‘s grandfather was hanged for murder. Other information from the old native, given here for convenience, is that this king ordred of the four *heiau* in this area—the two *heiau* of Kawaluna and Palihiolo, where human sacrifices were formerly offered, and the *ko‘a* of Halepa‘u and Mākā‘eo. It might be remarked that these four structures have the appearance of having been built in recent times. [Stokes and Dye 1991:42]

3.3.5 *Ala Hele* (Trails)

A distinguishing feature of this landscape are the many trails that cross and zig-zag through each *ahupua‘a*. Different terms describe each type of trail but most importantly, these trails were utilized as a highway of sorts for the *kūpuna* of this area. Not only can these trails be seen as a common highway for travel but also as an avenue for linking families, traditions, stories, and the history of these lands. As a whole, the trails described below create a map showing the paths most commonly used to obtain resources from the *kama‘āina* of this area.

As described by Kepā Maly:

> One trail is the *alaloa* (State Site No. 21664) that crossed the *makai* (near shore) lands, linking royal centers, coastal communities, and resources together. The other major thoroughfare of this region is ‘*Kealaehu*’ (The path of Ehu), which passes through the uplands (once passing Kuapehu, generally a little above the old Māmalahoa Highway). Kealaehu passes from Ka‘ū into South and North Kona, and continues on to Ka‘ūpūlehu, where it then cuts *makai* to Kīholo (meeting with the *makai* alignment of the *alaloa*). The trails then continue into Kohala, passing through Kawaihae and beyond. [Maly and Maly 1993:73]

David Malo also recalls the different features of the landscape and includes some terminology for the different types of trails:

> A place where runs a long and narrow stretch of beaten earth, a road namely, is termed *ala-nui*; another is *kua-moo* (lizard back). When a road passed around the circumference of the island, it was called the *ala-loa*. A place where the road climbed an ascent was termed *piina*; another name was *hoopiina*; another name still was *koo-ku*; and still another name was *auku*.
>
> Where a road passed down a descent, it was termed *ihona,* or *alu,* or *ka-olo* (*olo-kaa,* to roll down hill), or *ka-lua,* or *hooi-hona*. The terraces or stopping places on a (steep) road where people are wont to halt and rest are called *oi-o-ina*. [Malo 1951:17]

In addition to these terminologies, Kepā Maly also notes the following:

> *Ala hula‘ana* (trails or routes which ended at points on the ocean or at streams that travelers swam to cross to the other side);
>
> *Ala ‘ūlili* (marked trails on the steep cliffs);
>
> *Ala hakalewa* or *ala kaula* (trails along sheer cliffs from which one would at times dangle from rope ladders);
>
> *Ala pi‘i uka* or *ala pi‘i mauna* (trails which ascend to the uplands or mountain; now generally called *mauka-makai* trails);
>
> *Ala kai* (ocean trails on which canoes were used to travel form place to place on one island or between the various Hawaiian Islands.

3.3.6 Hōlua (Slide)

Another prominant feature seen across the landscape are *hōlua* slides. *Hōlua,* an ancient sport that can be traced back in *mo‘olelo* to the time of Pele, was mostly pursued by those of chiefly ranking. The sport itself consisted of a narrow *papa hōlua* (sled) about 12 to 18 ft long that was used to race downhill (Mitchell 1975:38). The *hōlua* track often ran from *mauka* to *makai* and was covered with *pili* grass (*Heteropogon contortus*) and slicked with *kukui* oil (candlenut; *Aleurites moluccana*) (Mitchell 1975:38). It was said the best time of day to ride was when the sun was directly overhead as it would heat the oil and create great speed for the person riding the *hōlua.*

> Pela no i ka heeholua, he hana hooikaika no ia no ke kino, a ke waiho nei no na holua o ka poe kahiko mai Hawaii a Kauai. He holua pali kekahi, a he puuhonua kekahi, a he mau wahi no hoi i hana maoli ia a kiekie e like we ka holua o Kaneaka, e waiho la ma Keauhou, Kona Akau, Hawaii. He hana hooikaika kino no ia, a ua pilikia pinepine ka poe hawawa. O ka poe maa nae ma ia hana, ua lele ka ulu o na wawae a me na lima, a ua lele aku na puanaana o na lima me na oloolo wawae; a o ka hanu o ke kanaka, ua hoomaha oia iloko o ke ea mama loa. Ua oi kona mama mamua o ka lio kukini a me ke kaa ahi holo mama. O ka papa heeholua, he koaie, he uhiuhi, he mamane, he oa, he mau wahi papa lahilahi, ua like me elua anana a me ka hapa ka loa, a he hapa iniha paha ka manoanoa; ua kunihia ma ka lahilahi, he eha paha iniha ma ke kiekie a oi ae a emi iho. Ua hana kaulua ia na papa, he hapa kapuai paha ke akea, a ua hana ululiia a paa loa me ke ie a me ka aha. Ua imua mikioi ia me ka paa loa. A o na niao malalo, ua hanaia me ka mikioi loa, a ma ka ihu o na papa, ua hana winiwini ia a like me ka nuku o ka manu koloa, a kaua ia

> iluna, e iho pono aku ana imua: a ua uhiia o luna o kahi e moe iho ai ke kino o ke kanaka i ka ahu moena makalii, a koe aku o mua a hiki i ka nuku o na papa. Ua hana pahee loa ia o lalo o na niaao e pili ana i ka lepo, ua lohi ia a pahee loa me ka hinu kukui a me kekahi mau mea hoopahee e ae. Ua haliia ka holua me ka iwi pili i kaka ia ka lau a koe iho o ka iwi wale no. O ka wa awakea, oia ka wa kupono no ko heeholua ana, oia no hoi ka wa pahee o ka mauu, a ua pakika loa ka holo ana, aohe no hoi he lua e like me ia ka mama loa. [Samuel Kamakau, *Ka Nupepa Kuokoa*, 28 Kekemapa 1867]

Translation:

> Sledding (*he‘e holua)* was another favorite sport, carried on sometimes over a cliffside, sometimes on the slope of a hill over a course either laid out on the ground or artifically built up, like that at Kaneaka at Keauhou in North Kona, Hawaii. This was a vigorous sport in which beginners suffered, but those who were accustomed to it guided the board with legs and arms and could keep their balance and breathe lightly as they sped faster than a racehorse or a railroad train. The runners were made of hard wood like the *koai‘e, uhiuhi,* or *mamane,* about two and a half fathoms long and a half inch thick, tapering upward, and some four inches high. They were set in paris six inches apart and fastened together neatly and firmly with cord of coconut fiber. In front they turned straight up and then pointed outward like the beak of a duck. The top where the person lay was woven over with fine matwork leaving a space between it and the runners. The runners were made slippery with *kukui*-nut oil or some other vegetable oil. The course was covered with stalks of *pili* grass stripped of the blade and laid evenly. Midday was the favorite time for the sport when the heat of the sun made the grass slippery and the sled could then attain terrific speed. [Kamakau 1992:242–243]

3.4 ‘Ōlelo No‘eau (Proverbs)

Hawaiian knowledge was shared by way of oral histories. Indeed, one’s *leo* (voice) is oftentimes presented as *ho‘okupu* (“to cause growth,” a gift given to convey appreciation, to strengthen bonds); the high valuation of the spoken word underscores the importance of the oral tradition (in this case, Hawaiian sayings or expressions), and its ability to impart traditional Hawaiian “aesthetic, historic, and educational values” (Pukui 1983:vii). Thus, in many ways these expressions may be understood as inspiring growth within the reader or between speaker and listener:

> They reveal with each new reading ever deeper layers of meaning, giving understanding not only of Hawai‘i and its people but of all humanity. Since the sayings carry the immediacy of the spoken word, considered to be the highest form of cultural expression in old Hawai‘i, they bring us closer to the everyday thoughts and lives of the Hawaiians who created them. Taken together, the sayings offer a basis for an understanding of the essence and origins of traditional Hawaiian values. The sayings may be categorized, in Western terms, as proverbs, aphorisms, didactic adages, jokes, riddles, epithets, lines from chants, etc., and they present a variety of literary techniques such as metaphor, analogy, allegory, personification, irony, pun, and repetition. It is worth noting, however, that the sayings were spoken, and that

their meanings and purposes should not be assessed by the Western concepts of literary types and techniques. [Pukui 1983:vii]

Simply, *‘ōlelo no‘eau* may be understood as proverbs. The Webster dictionary notes it as “a phrase which is often repeated; especially, a sentence which briefly and forcibly expresses some practical truth, or the result of experience and observation.” It is a pithy or short form of folk wisdom. Pukui equates proverbs to a treasury of Hawaiian expressions (Pukui 1995:xii). Oftentimes within these Hawaiian expressions or proverbs are references to places. This section draws from the collection of author and historian Mary Kawena Pukui and her knowledge of Hawaiian proverbs describing *‘āina* (land), chiefs, plants, and places. The following proverbs concerning Waikīkī come from Mary Kawena Pukui’s *‘Ōlelo No‘eau* (Pukui 1983).

There are no *‘ōlelo no‘eau* by Mary Kawena Pukui that speak directly of Kaloko, Kealakehe, or Keahuolū. The proverbs listed below describe the ‘Eka wind and also paint a picture of one method of subsistence in this region.

3.4.1 *‘Ōlelo No‘eau* # 1690

The following *‘ōlelo no‘eau* speaks of the ‘Eka wind, a characteristic of the Kona area.

Ke ‘Eka, makani ho‘olale wa‘a o na Kona.

The ‘Eka breeze of Kona that calls to the canoemen to sally forth to fish.

Refers to Kona. [Pukui 1983:182]

3.4.2 *‘Ōlelo No‘eau* # 1690

The following *‘ōlelo no‘eau* also mentions the ‘Eka wind that would fill the sails and aid fisherman in getting to their fishing grounds with ease.

Ka makani kūkulu pe‘a nui, he ‘Eka.

The ‘Eka , the wind that sets up the big sails.

When the ‘Eka wind blew in Kona, Hawai‘i, the fishermen sailed out to the fishing grounds. [Pukui 1983:159]

3.4.3 ‘Ōlelo No‘eau #2023

The following *‘ōlelo no‘eau*, in short, makes a reference to

Luahine, ke kā‘awe o Ka‘ahumanu.

Luahine, shoulder covering of Ka‘ahumanu.

Ka‘ahumanu was hurt when Kamehameha took her sister Kaheiheimalie as one of his wives. She swam out to sea with the intention of going until her strength gave out. While in the water she saw a boy following her. She cried out to him to go back, but he kept following. Noticing that he was getting tired, she allowed him to lean on her shoulder to rest. Pity for the boy, Luahine, made her swim back to shore. So it was said that the boy was Ka‘ahumanu‘s shoulder cover. [Pukui 1983:218]

Samuel Kamakau also makes a reference to this incident in *The Ruling Chiefs of Hawai‘i* but also includes the location*:*

At one time after the period called the Kaipalaoa, about 1789, Kamehameha deserted Ka-‘ahu-manu and lived entirely with Ka-heihei-malie, whome he treated as his wife. Ka-‘ahu-manu suffered so much from this separation that one dark night she swam from Ke‘ei in Kekaha to Honaunau, a distance of five or seix miles, expecting every moment to be devoured by sharks, but rendered reckless by love and grief and not caring what became of her. From this feat her law called the ‘Ocean swimming law.’ [Kamakau 1992:315]

3.5 *Oli* (Chants)

3.5.1 Surfing Chant

A surfing chant honors the old surf spots of Kona and makes a passing reference to a few places of Kealakehe:

He’e mai Hi‘iakanoholae	Hi‘iakanoholae surfs
He’e nā ‘Alula i Kealakehe	‘Alula surfs at Kealakehe
He‘e i nā nalu o Kaiwi . . .	Surfing the waves of Kaiwi

3.5.2 Lele Kowali Chant

An ancient game called Lele Kowali is described below:

A rope eight fathoms long, sometimes ten fathoms and over, is fastened to a coconut tree. It makes a long high swing. At the time of swinging, the person swinging, either man or woman is decently appareled. Two persons pull the swing. When the swing has oscillated high the rider chants to make the swinging more enjoyable.

The chant that accompanies this game mentions sea cliffs and splashing waves and briefly mentions Kealakehe:

A Kaula i ka palena o ke Koolau,	At Kaula, the border of Koolau,
Pale ke Koolau, pale ka Hilo paliku,	Separated is the Koolau, separated is precipitous Hilo,
Ku mai ka Hoolua me ka Moae,	The Hoolua and the Moae arise,
Moae awaa i ke kai e palipali,	The Moae which plows the sea and makes it billowy,
Palipali ke kai holeoleo i ka makani,	The sea is billowy and boisterous by the wind,
Ahu ke kupikipikio hana ka ale,	The billows are tempestuous, the waves being active,
Ku kila ka la lea molale i ka ehukai,	Majestically stands the sun reflected through the sea-spray,
Ehukai pii i ka pali o Okalakala,	The sea-spray which mounts the cliffs of Okalakala,

Na mahamaha a ka ino,	The ends of the tempest,
Ola na hulu ai a ka makani,	The food of life is saved by the wind,
Kaka ka Uhu o Hanalailai i ka malie,	The *uhu* of Hanalailai is caught in the calm,
Ka pali kui laau o Kealakehe kowea	The tree-belted cliffs of Kealakehe kowea
Keehi ia e ka makani	Are frowned upon by the breeze,
Hai welau ka pali i manawa.	In time breaking the crest thereof.

[Fornander 1919:201]

3.6 *Mele* (Song)

3.6.1 Kohanaiki Chant

E noho ana no,	Dwelling there,
E walea ana I ka hī aku,	Enjoying the *aku* lure fishing,
I ka pua a ka lehua i ke kai.	The *lehua* flower of the sea.
Kai kōpīpī i ka welelau lima,	In the ocean which salts the finger tips,
Ke hi‘i ala i ke Aku-mua-kau.	Holding the first caught *aku.*
Kaukāhi ka lima o Hale‘ohi‘u ke ko‘a.	Fish set in the hand at the fishing station of *Hale‘ohi‘u.*
I ka lāā puka mauka a napo‘o makai,	Where the sun is seen to rise from the uplands, and set in the sea,
I ka nalu wili mai o Apo‘ula.	In the twisting waves of *Apo‘ula.*
‘Ale mai mauka a ho‘I hou no i kai.	Waves which crest on the shore and return to sea.

[*Ka Hana Lawai‘a* 22 January 1914]

3.6.2 A Song for Lili‘uokalani

In 1962, Pukui interviewed *kama‘āina* Lowell Keli‘iahonui “Kanaka” Punihaole (who was born at Makalawena ca. 1899). The Hawaiian language tape was translated and transcribed by Maly. Lowell Punihaole talked about how Queen Lili‘uōkalani liked to stay at the shores of Honokōhau. Ha‘aheo, *kama‘āina* and wife of the local doctor, composed this song for her Lili‘uōkalani (Maly and Maly 2002:333):

Lei ho‘i a o Kānekina,	Kānekina wears a lei,
E popohe mai nei i ke ala nui.	The trail brings him around.
Ahiahi kāua e nauē,	In the evening we two shall go,
E ‘ike nā ‘ōpu‘u rose.	to see the rose buds.
Ho‘okomo i ke awa o Honokōhau,	Enter into the landing of Honokōhau,

E ‘ike nā manu i ka loko wai.	and see the birds at the pond.
Hā‘ina ‘ia mai ana kapūana,	So spoken is the refrain,
Ō‘ū ‘oe a o ka nahele.	You are perched there in the forest.

Section 4 Historical Background

4.1 Early Historic Period in Kaloko

By the first decades of the nineteenth century, the inhabitants of Kaloko would have long experienced the social pressures and consequences of Western Contact. “As early as 1788, Hawaiians began enlisting as seamen on the foreign ships that stopped at Island ports, and their number increased rapidly with the growth of whaling in the Pacific” (Schmitt 1973:16). As harbor facilities were developed at Kailua and Kealakekua during the early 1800s, these burgeoning ports became centers of a population drawn from increasingly isolated (economically and socially) areas like Kalok. Newly introduced diseases cut the population severely.

The movement of people from Hawai‘i Island to O‘ahu and Kaua‘i, in particular, was also related to economic opportunities to own land in the so-called “leeward islands.”

Early missionary residents made the first estimates of the population of the North Kona District. Asa Thurston estimated a population of not less than 20,000 people along a 30-mile stretch of the Kona coast. These residents were clustered on the coast, but some families also lived in a habitation belt about 2 miles inland (Kelly 1983:14). A formal census was conducted in 1832, and 12,432 people were recorded for the district of Kona. By 1835, this number had declined to 5,957. By 1853, the number had dropped to 2,210 (Schmitt 1973:21, 29, 31). The missionary William Ellis (Ellis 1979:32) visited the Kona area in 1822 and noted deserted villages and abandoned fields “everywhere to be met with.”

4.2 Early Historic Period in Kealakehe and Keahuolū

Few written records relate the early history of Kealakehe and Keahuolū. However, in 1869, the land was described thus by David Kalākaua:

> This land is situated in the District of North Kona, bounded by the ahupua‘a of Lanihau (in Kailua) belonging to Prince Lunalilo on the Ka‘u side, and on the Kohala side, by Kealakehe, a government land and Honokohaniki belonging to Keelikolani. Keahuolu runs clear up to the mountains and includes a portion of nearly one half of Hualalai mountains. On the mountains the koa [*Acacia koa*], kukui and ohia abounds in vast quantities. The upper land or inland is arable, and suitable for growing coffee, oranges, taro, potatoes bananas &c. Breadfruit trees grow wild as well as the Koli [*kolī*; castor-oil plant] oil seed. The lower land is adopted for grazing cattle, sheep, goats, &c. The fishery is very extensive and a fine grove of cocoanut trees of about 200 to 300 grows on the beach. The flat land near the sea beach is composed chiefly of lava, but herbs and shrubbery grows on it and [it is] suitable for feed of sheep and goats. It is estimated at 15,000 to 20,000 acres or more. [Donham 1990:B-7, B-8]

In 1792, Archibald Menzies, the first foreigner to record his visit to Kekaha described the land of Kekaha as “barren and rugged with volcanic dregs and fragments of black lava . . . in consequence of which the inhabitants were obliged to have recourse to fishing for their sustenance” (Menzies 1920:99). However, he observed that the land was more fertile further up Hualālai Mountain where plantations of roots and vegetables were cultivated and where breadfruit

plantations thrived. He observed from higher elevations that the Kekaha region was surrounded by luxuriant plantations with scattered villages (Figure 7).

Menzies made the following observations on a hike to the top of Hualālai on 17 and 18 January 1792:

> [January 17] We commenced our march with a slow pace, exposed to the scorching heat of the meridian sun, over a dreary barren track of a gradual ascent, consisting of little else than rugged porous lava and volcanic dregs, for about three miles, when we entered the bread fruit plantations whose spreading trees with beautiful foliage were scattered about that distance from the shore along the side of the mountain as far as we could see on both sides. Here the country began to assume a pleasant and fertile appearance through which we continued our ascent for about two miles further, surrounded by plantations of the esculent roots and vegetables of the country, industriously cultivated . . . From this place we had a delightful view of the scattered villages and shore underneath us, and of the luxuriant plantations around us . . .
>
> January 18 . . . We observed here and there on the path little maraes [shrines] pointed out by taboo sticks in the ground round a bush or under a tree. In passing these places the natives always muttered a prayer or hymn, and made some offering as they said, to their akua, by leaving them a little piece of fruit, vegetable or something or other at these consecrated spots. Even in this distant solitary hut, we found a corner of it consecrated by one of these taboo sticks which the natives earnestly requested us not to remove when we took possession of it, and we very strictly obeyed their injunction, conceiving that religious forms whatever they are, ought to be equally inviolable everywhere. [Menzies 1920:151–160]

4.3 The Māhele and the Kuleana Act

Prior to 1848, all land belonged to the *akua*, held in trust for them by the paramount chief and managed by subordinate chiefs. In the mid-1800s, Kamehameha III decreed a division of lands called the Māhele, which divided land for private land ownership in Hawaiian society (Chinen 1958). In 1848, lands were divided into three portions: crown lands, government lands, and lands set aside for the chiefs. Individual plots, called *kuleana* (Native Hawaiian land rights) awards, were granted within these divided lands to native inhabitants who lived on and farmed these plots and came forward to claim them. The chiefs and *konohiki* (headman of an *ahupua‘a* land division under the chief) were required to pay a commutation fee for their lands, usually about one-third the value of any unimproved lands. Awardees usually “returned” a portion of the lands awarded to pay the commutation fee for the lands they “retained.” The returned lands usually became government lands (Chinen 1958:13).

The Kuleana Act was legislated in 1850, allowing *maka‘āinana* (commoners) to own land parcels which they were currently and actively cultivating and/or residing. In theory, this “set aside” hundreds of thousands of acres as potential *kuleana* parcels which led to about 10,000 claimants obtaining approximately 30,000 acres. The *konohiki*, 252 chiefs, divided up about a million acres. Many Hawaiians were disenfranchised by these acts (Cordy et al. 1991).

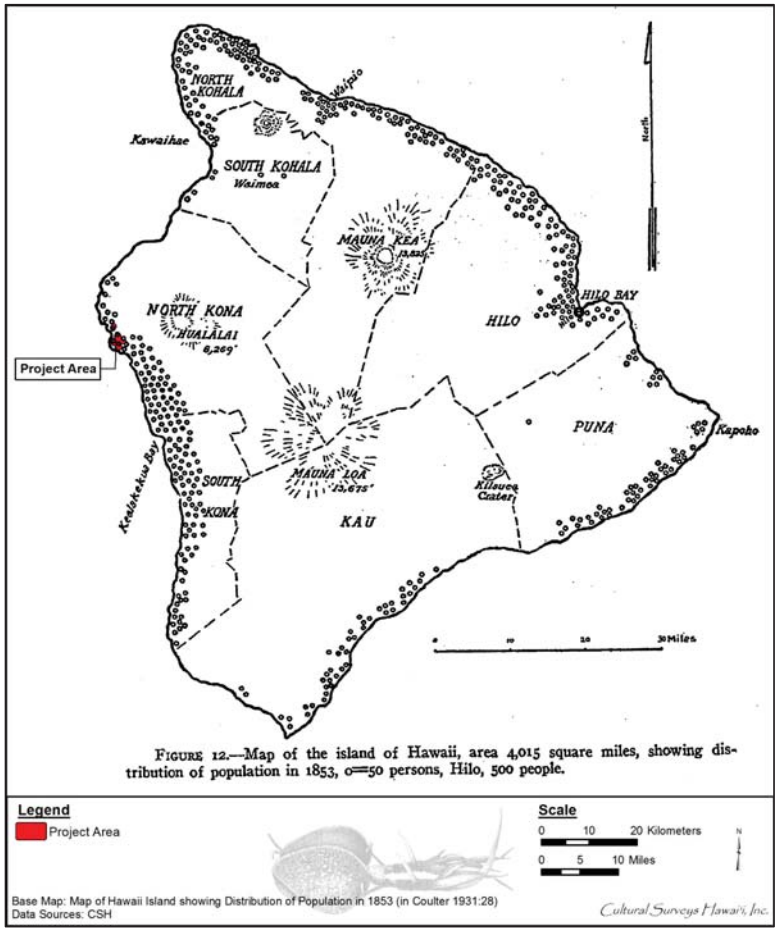

Figure 7. 1853 map of Hawai'i (Coulter 1931:28) depicting the population and project area in red

4.3.1 Kaloko: Konohiki Land

Kaloko was awarded and kept by Lot Kamehameha (LCA 7715) who later ruled Hawai'i as Kamehameha V. A total of 21 additional claims of land were made in Kaloko of which 12 were awarded (Table 4). Lands were claimed in 15 *'ili* but awarded in only 12. Kelly (1971) noted that all 12 commoner or *kuleana* awards were located within the Upland Zone between elevations of 1,200 to 1,700 ft, which are outside the current project area. Only six claims mention crops grown on claimed land and taro was the predominant crop. House lots were claimed in only two of the 18 cases but Cordy notes that housing data is poor for this period (Cordy et al. 1991:411, 415).

Kaloko is documented during the 1870s in testimonies by Hawaiians before the government's Boundary Commission. Testifying on 12 August 1873, Nahuina (who had earlier received LCA 10327 in Kaloko) describes himself as "born at Kaloko, North Kona, Hawaii at the time of Keikepuipui, the building of the *heiau* at Kailua, and have always lived there" and states that the boundaries of Kaloko were shown to him by his father, the former *konohiki* of the *ahupua'a*. Identifying the *mauka* portions of the boundary, Nahuina notes boundaries defined by vegetation and a wall ("*iwi aina*"), and recalls a former habitation site:

> From the makai side of Kaupulehu the boundary runs along said land, the koa being on Kaloko and the mamani and pukeawe [*sic*] on Kaupulehu to the corner of Lanihau 2nd Keahuolu and Honokohaunui . . . Ohiawela, a *pali*, on the road through the woods is a point on the boundary. This place is above Honokohaunui, thence turn makai to Kahua, a place in the fern where houses used to stand, from thence the boundary runs makai along an *iwi aina* to Kapokalani, at the Government road. Thence makai still following the *iwi aina* to Kiikii an ili aina, thence to Kaohe, a grove of trees thence to *aa* . . .

Nahuina adds that Kaloko has "ancient fishing rights extending out to sea." Testifying on the same date, Hoohia, who "moved to Honokohauiki when quite small and reside[s] there now," adds details that suggest the *mauka* Kaloko-Honokōhau boundary was defined by different vegetation that also reflected former traditional gathering rights: "Honokohaunui ends at Ohiawela, a *pali*. Kaloko takes the *koa*, and Honokohaunui, the *ohia* . . . The *olona* [*olonā*; *Touchardia latifolia*] grows on Honokohaunui and Kealakehe and the *koa* on Kaloko."

Table 4. Land Commission Awards in Kaloko

LCA	Awardee	*'Ili*	R.P.	Acreage
7797	Kamohoalii	Kikahala, Ulauiui	3972	5.3
7909	Kamaole	Makaawe, Hale'ape	5377	7.0
9060	Kioku	Ulukukahi	4012	4.0
9160	Kanu	Kanaio	6938	2.5
9237	Kahiona	Oloupe	–	2.8

LCA	Awardee	*‘Ili*	R.P.	Acreage
9238	Kahoohanohano	Pāpua‘a	3316	1.8
9241	Kaiama	Kealaehu, Luahine‘eku, Haleolono	3772	4.3
9242	Keawehokina	Kikahala, Kealaehu	3744	2.8
9243	Kaleiko	Kealaehu, Luahine‘eku, Haleolono	3786	1.8
10327	Nahuina	Hale‘ape	3891	3.5
10694	Puhi	Kiki	3763	3.5
10951	Wahahee	Kealaehu, Kikahala	5095	2.0
7715	Kapuaiwa, Lota	Ahupua‘a Award	8214	4,320.0

4.3.2 Kealakehe: Government Land

Kealakehe was awarded to Kekuapanio who returned the land to the government. Kekuapanio was one of a group of young nobles that were the favorites of Kauikeaouli (Kamehameha III). Within Kealakehe, 23 *kuleana* claims were made of which 11 were awarded. The claims are presented in Table 5. According to Donham 1990, all claims were made in six *‘ili* (Donham 1990b:B-4). Testimonies showed claimants listed numerous cultivated parcels planted in taro and sweet potatoes and at least ten houses and a fair-sized banana patch was situated in the uplands. No LCAs were found within or in the vicinity of the project area.

Table 5. Land Commission Awards in Kealakehe

	Awardee	*‘Ili*	R.P.	Acreage
7483	Kulua	Ka‘ōhia, Makakiloi‘a	4040	2.6
7897	Kahuenui 2	Kukui‘ōmino	4002	4.9
8608	Kaahui	Ka‘ōhia, Kalihi, Pū‘ohe, Kukui‘ōmino, ‘Ililoa	5228	3.9
9252	Kauhai	Pū‘ohe, Ka‘ōhia, Kani‘ohale	4005	5.78
10070	Mioi	‘Ililoa, Kani‘ohale, Kukui‘ōmino	4003	4.4
10306	Nuole	Kani‘ohale	4006	5.25

	Awardee	*‘Ili*	R.P.	Acreage
10322	Nuhi	Makakiloi‘a	8054	4.75
10597	Puou	Kukui‘ōmino-nui, Kukui‘ōmino-iki	6235	4.12
10671	Pepe	‘Iliiloa, Haleolono, Kakui‘ōmino, Kani‘ohale	4007	4.96
10692	Paai	Pū‘ohu, ‘Iliiloa, Ka‘ōhia	4004	2.8
10950	Waiwaiole	Ka‘ōhia, Pū‘ohe	5123	2.0

4.3.3 Keahuolū: Konohiki Lands

The entire *ahupua‘a* of Keahuolū was awarded to Ane Keohokālole. Ane Keohokālole held two walled house lots “from very ancient times” along the shore. Keohokālole was the granddaughter of Kame‘eiamoku, an important chief who supported Kamehameha I. She was also the mother of the future King David Kalākaua, the future Queen Kamaka‘eha Lydia Lili‘uokalani, William Pitt Leleiōhoku, and Miriam Likelike. Ane Keohokālole later sold portions of her 15,000–20,000-acre grant to the government and other parties, with the remainder being passed on to her heir Lili‘uokalani. J.S. Emerson, a nineteenth century government surveyor, described the inland portion of Keahuolū as “rough pahoehoe, little vegetation,” similar to descriptions of the dry and barren lands of Kekaha. David Kalākaua further described these *kula* lands as suitable for livestock grazing (Donham 1990a). Within Keahuolū, seven *kuleana* claims were made of which six were awarded (Table 6). No *kuleana* grants were awarded in the inland portion (lower *kula* [plain] zone) of Keahuolū, and there is little historic information concerning traditional Hawaiian land use in the area.

The upper *kula* zone was historically the primary agricultural zone of the two *ahupua‘a.* Many *kuleana* awards were claimed for this area, indicating that dryland crops were grown here. The most common crop described in the claims was taro, with coffee and potatoes also mentioned. During the Māhele, few of these *kuleana* awards were granted; instead, these lands were generally awarded to the *konohiki* (lower chiefs and landlords), who used the lands for livestock grazing (Kelly 1983:67). No LCAs are within or in the vicinity of the project area.

Emerson described the boundary between the inland and upland forested areas in this transitional region as “lava covered with scattering forest and dense masses of *ki* [ti] root” (Kelly 1983:58). Lands below the forest edge were described as “rocks covered with grass” (Kelly 1983:58). Emerson estimated the forest edge boundary to be at 750 to 800 ft (228 to 244 m) elevation above sea level in Keahuolū.

Table 6. Land Commission Awards in Keahuolū

LCA	Awardee	*‘Ili*	R.P.	Acreage
7351	Kahuenui	Not available	N/A	2.9

LCA	Awardee	*‘Ili*	R.P.	Acreage
10345	Nahaalualu	Not available	N/A	N/A
10303	Maa	Maili	3981	2.25
10198	Mailewalewa	Ululele	N/A	1.9
10672	Paia	Koheloa, Puuokaliu	3980	1.9

4.4 Mid-Nineteenth to Twentieth Century

Oral history interviews (Maly and Maly 2002) relate that in the mid-1800s, only a few residences were on the coastal lands, in the uplands above 900 ft elevation, and in the vicinity of Māmalahoa Highway. The land between elevations of 900 ft to the coast was cattle, donkey, and goat pasturage. *Mauka* to *makai* trails through Kohanaiki, Kaloko, Kalaoa, and Honokōhau were utilized by upland families to access the coast to fish and gather water during upland droughts.

Despite these major changes, there were apparently still many people living in the area in the later nineteenth century, as indicated by the following extended testimony of J.W.H.I. Kihe, who was born at Honokōhau in 1854. Kihe talked about the area in 1870:

> Now [1924] the majority of those people are all dead. Of those things remembered and thought of by the people who yet remain from that time in 1870; those who are here 53 years later, we cannot forget the many families who lived in the various apana (land sections) of Kekaha. From the lands of Honokōhau, Kaloko, Kohanaiki, the lands of ‘O‘oma, Kalaoa, Haleohiu, Makaula, Kau, Puukala-Ohiki, Awalua, the lands of Kaulana, Mahaiula, Makalawena, Awakee, the lands of Kukio, Kaupulehu, Kiholo, Keawaiki, Kapalaoa, Puuanahulu, and Puuwaawaa. These many lands were filled with people in those days.
>
> There were men, women, and children, the houses were filled with large families. Truly there were many people [in Kekaha]. I would travel around with the young men and women in those days, and we would stay together, travel together, eat together, and spend the nights in homes filled with aloha. The lands of Honokōhau were filled with people in those days, there were many women and children with whom I traveled with joy in the days of my youth. Those families are all gone, and the land is quiet. There are no people, only the rocks remain, and a few scattered trees growing, and only occasionally does one meet with a man today (1924). One man and his children are all that remain.
>
> Kaloko was the same in those days, but now, it is a land without people. The men, the women, and the children are all gone, they have passed away. Only one man, J. W. Haau, remains. He is the only native child (keiki kupa) besides this author, who remains. Now the land is desolate, there are no people, the houses are quiet. Only the houses remain standing, places simply to be counted. [Maly and Maly 2002:341–342]

Maly (1993:29) explains that traditional accounts of Kaloko and Kohanaiki describe a lush environment that differs from its current state due to several factors. The Hualālai lava flow in 1801 covered the former agricultural and forested lands, residential areas, and fishponds. The loss of forests began the decrease in rainfall that was exacerbated by the introduction of livestock and ranching. Goats and cattle stripped the vegetation from the lands causing water resources to dry up. Thus, over the last 150 years, the environment has been significantly altered.

Another Native Hawaiian familiar with the area, J.P. Pu‘uokupa, wrote a letter to the Hawaiian language newspaper *Ka Nupepa Kuokoa* in 1875, reacting to (and disagreeing with) an earlier letter describing supposed famine-like conditions in the area:

> The people who live in the area around Kailua are not bothered by the famine. They all have food. There are sweet potatoes and taro. These are the foods of these lands. There are at this time, breadfruit bearing fruit at Honokōhau on the side of Kailua, and at Kaloko, Kohanaiki, ‘O‘oma and the Kalaoas where lives J. P. [the author]. All of these lands are cultivated. There is land on which coffee is cultivated, where taro and sweet potatoes are cultivated, and land livestock is raised. All of us living from Kailua to Kalaoa are not in a famine, there is nothing we lack for the well being of our bodies.
>
> Mokuola (a poetic reference to a place of life and well-being) is seen clearly upon the ocean, like the featherless back of the ukeke (shore bird). So it is in the uplands where one may wander gathering what is needed, as far as Kiholo which opens like the mouth of a long house into the wind. It is there that the bow of the boats may safely land upon the shore. The livelihood of the people there is fishing and the raising of livestock. The people in the uplands of Napuu are farmers, and as is the custom of those people of the backlands, they all eat in the morning and then go to work. So it is with all of the native people of these lands, they are a people that are well off . . .
>
> As was said earlier, coffee is the plant of value on this land, and so, is the raising of livestock. From the payments for those products, the people are well off and they have built wooden houses. If you come here you shall see that it is true. Fish are also something which benefits the people. The people who make the pai ai on Maui bring it to Kona and trade it. Some people also trade their poi for the coffee of the natives here . . . [J.P. Puuokupa, in *Ka Nupepa Kuokoa,* 27 November 1875; translated in Maly and Maly 2002:339]

4.4.1 Kaloko

Historical documents suggest that by the 1840s to 1850s, the coastal zone had been abandoned as a residential area, except for a house used by the fishpond’s caretaker. According to Cordy, this pattern would have changed from pre-historic and early historic times when many coastal residences were present (Cordy et al. 1991:288). By the 1870s and 1880s, housing seems to have become focused in the upland zone at the Kohanaiki Homesteads with some scattered houses across Kaloko along the road to Kailua and the upper Government Road (Figure 8). Cultivation may have shifted to cash crops like coffee and small-scale livestock raising may have taken place (Cordy et al. 1991).

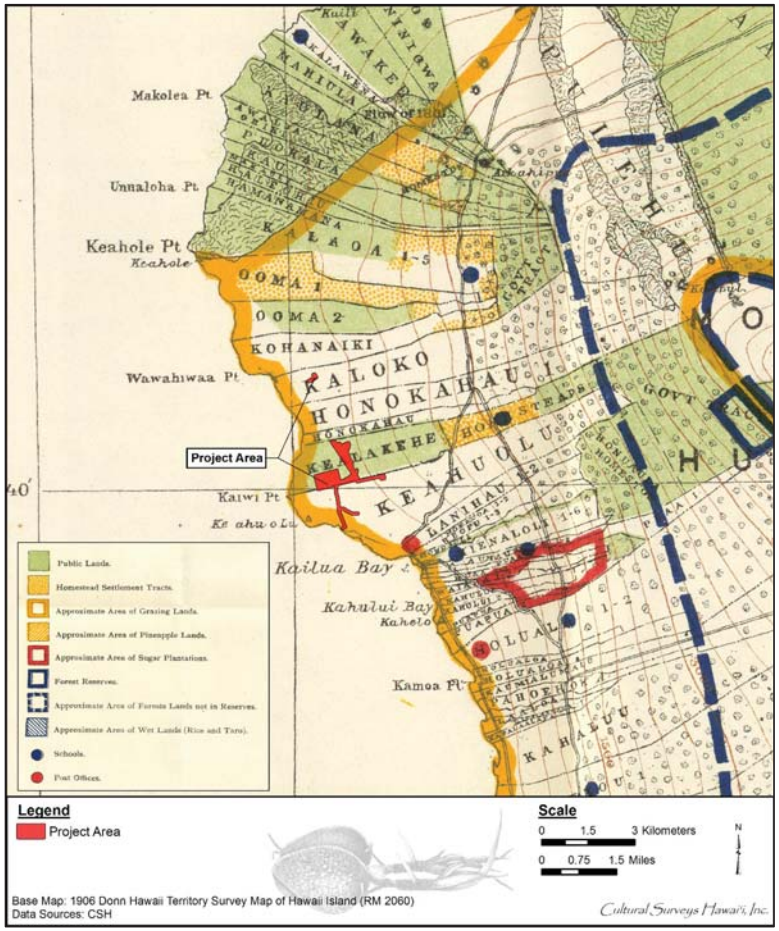

Figure 8. 1906 Donn Hawaii Territory Survey map of Hawai‘i with project area in red; note the majority of the project area spanned across Public Lands and the southern portion of the project area crossed into homestead lands

During the twentieth century, major developments focused on Kaloko Ahupua‘a with continuing commercial use of Kaloko Fishpond and increasing animal husbandry. Ranching steadily increased with the development of the *ahupua‘a* uplands into the Hu‘ehu‘e Ranch. Maly and Maly (2003) discuss the acquisition of these lands and the types of ranching that were common:

> In 1899, John A. Maguire, founder of Huehue Ranch applied for a Patent Grant on . . . lots in ‘O‘oma 2nd, but he only secured Grant No. 4536 . . . Maguire’s Huehue Ranch did secure General Lease No.s 1001 and 590 for grazing purposes on the remaining government lands in the Kohanaiki and ‘O‘oma vicinity. Thus, by the turn of the century, Huehue Ranch, utilized both the upper forest lands and lower kula lands to the shore for ranching purposes. Oral history interviews with elder former ranch hands record that this use extended across the Kapena and Huliko‘a grant lands of Kohanaiki, from the fee and leasehold lands of Kaloko and ‘O‘oma. Nineteenth century goat drives, gave way to formalized cattle drives and round ups on these lands. [Maly and Maly 2003:78]

Until the construction of the Queen Ka‘ahumanu Highway in the 1970s, access to the “*kula kai* (shoreward plains)” was limited to local residents (Maly and Maly 2003:101). The 1924 USGS map in Figure 9 shows “the road to the sea” connecting the Kohanaiki Homesteads with the Kaloko Fish Pond. In the first half of the twentieth century, the primary method of travel was “by foot or on horse or donkey, and those who traveled the land, were almost always native residents of Kalaoa, ‘O‘oma, Kohanaiki, Kaloko and Honokōhau” (Maly and Maly 2003:99). Hu‘ehu‘e Ranch bulldozed a jeep road to the shore around 1955 during the construction of the Kailua pier; this was used primarily by the ranch employees for duties or for going fishing along the coast.

Leased from Hu‘ehu‘e Ranch, the Kaloko Fishpond continued as a commercial fishing operation until the 1950s. During the 1970s, the pond was incorporated into the newly established Kaloko-Honokōhau National Historic Park.

4.4.2 Kealakehe

As government lands, portions of Kealakehe Ahupua‘a were subdivided as the Kealakehe Homesteads for purchase by homesteaders for residential development. Following the passage of the Hawaiian Homes Commission Act in 1921, portions of Kealakehe were designated Hawaiian Homelands “for Native Hawaiians to live on, farm, ranch, and engage in commercial, industrial, or any other activities.”

4.4.3 Keahuolū

A sisal (*Agave sisilana*) mill was constructed in Keahuolū sometime during the late 1890s; sisal was grown to make ropes and other fibers. The mill was located along the southern portion of the old Palani Road corridor. Operating until 1924, the mill was surrounded by sisal fields that covered an area of up to 1,000 acres in Keahuolū and Kealakehe *ahupua‘a* (Jensen 1990).

In the late 1890s and 1900s, the area around Pawai Bay was a fishing village with a canoe landing (Yent 1993:4). A large brackish pond was present *mauka* of the bay, and in addition to several planting pits utilized for the cultivation of primarily pineapple, multiple house sites were present around Pawai Bay (Neighbor Island Consultants 1973:45, 52). This area was inhabited by

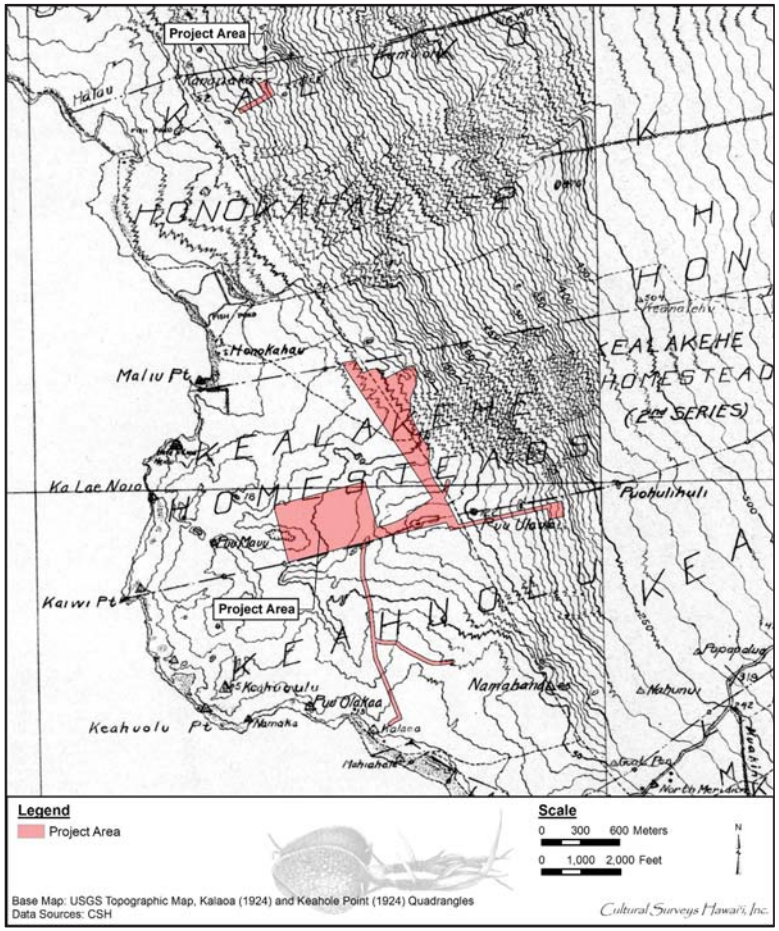

Figure 9. 1924 Kalaoa and Keahole Point USGS topographic quadrangles, depicting project area in red

the Kau‘a family until the construction of the airport in 1948. The coastal area of Maka‘eo was marked by a large coconut grove (Yent 1993:4), and the coastal trail that ran through Kailua Town turned to head *mauka* at Maka‘eo to join with the Māmalahoa Trail (Springer and Camara 1987:42).

In 1909, the Lili‘uokalani Trust was established to provide for children, especially orphans, of Hawaiian descent (Queen Lili‘uokalani Children’s Center 2004). Income was derived from real estate owned by Queen Lili‘uokalani. As a result of the will of Queen Lili‘uokalani, the lands of Keahuolū were placed in a trust. In the last few decades, the trustees have begun to develop the Keahuolū lands to generate revenue for their programs. The area around Palani Road is now occupied with shopping malls, bookstores, business offices, and residential subdivisions.

The construction of Kona Airport, or the Old Airport (Figure 10), began on 10 June 1948 (State of Hawai‘i Department of Transportation 1948). Development of the airport continued with the construction of the boundary fence in 1950 and various runway extensions completed over the years, with the last extension completed in 1967 (Neighbor Island Consultants 1973). The airport development included a passenger terminal, an access road, a parking lot, the runway and parking apron, as well as an airplane hangar. However, the commercial operations of Kona Airport ended with the opening of the new Keāhole Airport on 1 July 1970. Following the Kona Airport closure, the County of Hawai‘i took over management of the area for development as a park. In 1976, ownership of the Kona Airport lands was transferred to the Hawai‘i Island State Parks.

Figure 10. Photo of Kona Airport, ca. 1940s (courtesy of Hawaii Pictures)

4.5 Previous Archaeological Research

This section provides an overview of previous archaeological research conducted in the vicinity of the current project area. Section 4.5.1 is an overview of all previous archaeological studies in the vicinity. Section 4.5.2 provides discussions of those previous studies overlapping the current project area. Table 7 through Table 10 identifies the archaeological sites previously recorded in and near the current project area.

4.5.1 Previous Archaeological Studies in the Vicinity of the Project Area

Over the past century numerous archaeological studies have been conducted within and surrounding the current project area. This body of past work provides information about past land use that can be used to form a predictive model for the current project area. John F.G. Stokes and J.E. Reinecke conducted the earliest studies, which were coastal surveys. In 1906, Stokes was assigned by the Bishop Museum the task of recording the coastal *heiau* of Hawai‘i Island, building upon the preliminary work of Thomas G. Thrum. Visiting the sites of more than 100 *heiau* island-wide, he drew “plans of more than forty of the best preserved foundations, and collected as much oral data as possible” (Stokes and Dye 1991:12). Between Kealakehe and the Keahuolū-Lanihau boundary, Stokes documented five *heiau*; of these, the *heiau* of Kawaluna and Palihiolo at Pawai Bay in Keahuolū are in closest proximity to the current project area, though they do not overlap it.

In 1930, the Bishop Museum undertook an archaeological reconnaissance survey of portions of West Hawai‘i (Reinecke 1930). Reinecke broke the portion of his survey conducted between Kailua Kona and Kalahuipua‘a in South Kohala into four sections: “Lanihau adjoining Kailua village . . . ; Honokohau-kaloko . . . ; the remainder of the coast to Keahole Light; [and] the cursorily survey[ed] coast past the light” (Reinecke 1930:2). The “Lanihau” section appears to have included coastal Keahuolū; Reinecke documented several sites located *makai* of the current project area, along the shoreline fronting what is now Old Kona Airport Park/Kailua Park. He describes the “Honokohau-kaloko” section as having “considerable remains” (Reinecke 1930:2); unfortunately, the maps covering this section are illegible, however, the sites documented by Reinecke (1930) in this area are understood to have been located well *makai* of the current project area.

Table 7 contains summaries of previous archaeological studies; archaeological studies overlapping the current project area are identified using bold font. Previous studies in the vicinity of the Mauka and Makai Sections of the current project area are depicted on Figure 11, excluding those past studies located along the Queen Ka‘ahumanu Highway ROW. Previous studies in the vicinity of the Northern Section of the current project area are depicted on Figure 12, again excluding those past studies located along the Queen Ka‘ahumanu Highway ROW. Previous archaeological studies located along the Queen Ka‘ahumanu Highway ROW in the vicinity of the overall current project area are depicted on Figure 13. The Stokes (1906-1907) and Reinecke (1930) studies are not depicted as their coverage is not clearly defined.

Table 7. Previous archaeological studies in the vicinity of the project area

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Stokes 1906 (Stokes and Dye 1991)	Archaeological reconnaissance survey	Island of Hawai‘i	Identified numerous *heiau* and *ko‘a* (shrines) across the island; documented five *heiau* in current project *ahupua‘a*, none of which are within the current project area
Reinecke 1930	Archaeological reconnaissance survey	Coastal West Hawai‘i	Identified hundreds of sites along coast of West Hawai‘i, including a number of sites in vicinity of Old Kona Airport Park and Honokohau Bay
Ching and Rosendahl 1968	**Archaeological reconnaissance survey**	**Kailua-Kawaiahae Rd corridor** (Section II) **and Keāhole Point Airport, Honokōhau to Kau Ahupua‘a**	**Documented 14 sites (not assigned SIHP #s); three sites recorded in Honokōhau including a trail and burial; no sites documented in Kaloko**
Ladd 1968	Archaeological salvage (data recovery)	Honokōhau Harbor; Kaloko, Honokōhau, and Kealakehe Ahupua‘a	Salvage excavations for four sites previously identified by Bishop Museum in 1961 and not assigned SIHP #s: D11-3/1 (burial), D11-3/2 (burial), D11-3/3 (burial), and D11-4 (house site)
Newman 1970	Field inspection	Old Kona Airport State Park, Lanihau and Keahuolū Ahupua‘a	Documented several features in Lanihau portion of Old Kona Airport, later assigned as SIHP #s -02000 (petroglyphs), -02001 (petroglyphs, *papamū* [stone on which the checker-like game, *kōnane*, was played], and bait cups), and -02002 (house site)
Emory and Soehren 1971	Archaeological and historical survey	Coastal Kaloko, Honokōhau, and Kealakehe Ahupua‘a	Documented 72 sites across three *ahupua‘a*, not assigned SIHP #s; site types included house sites, *ahu* (cairns), fishing *ko‘a*, terraces, enclosures, walls, *papamū*, burial grounds and platforms, *hōlua* (sled; sled course) slides, Makaopi‘o Heiau, Hale O Kāne Heiau, Pu‘uoina Heiau, ‘Aimakapa Pond, petroglyphs; study included search for sites and plane table surveys documented by Bishop Museum in 1961

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Renger 1971	Intensive survey	Kaloko and Kukio Ahupua‘a, *makai* of Queen Ka‘ahumanu Hwy	Documented 89 sites in Kaloko, not assigned SIHP #s; site types included fishponds, house sites, burials, trails, lava tubes, walls, platforms, petroglyphs, enclosures, etc.
Neighbor Island Consultants 1973	**Archaeological reconnaissance survey**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a**	**Documented 19 sites not assigned SIHP #s; site types included planting pits, house sites, burials, and petroglyphs; two sites (KA14, petroglyph; KA15, petroglyph and house site) recorded in *mauka* portion of property near southern terminus of Makai Section of current project area**
Sinoto 1975	Archaeological reconnaissance survey	Honokōhau Small Boat Harbor; Kealakehe Ahupua‘a	Documented three previously identified sites, not assigned SIHP #s: D11-27 (house site), D12-3 (salt pans), and a *papamū*
Sinoto 1977	**Archaeological reconnaissance survey**	**Kealakehe Ahupua‘a, *mauka* of Queen Ka‘ahumanu Hwy; TMK [3] 7-4-008:017 por.**	**Documented four newly identified sites: SIHP #s 50-10-28-05011 (*ahupua‘a* wall possibly overlapping current project area at Kealakehe and Keahuolū boundary), -05012 (lava tube shelter), -05013 (lava tube shelter), and -05014 (lava tube shelter)**
Ching 1978	**Reconnaissance survey**	**987 acres in Keahuolū Ahupua‘a**	**Documented 59 sites with 140 features, predominately located at coast; sites assigned SIHP numbers (SIHP #s -06490 through -06548) which may be problematic; cluster of sites within proximity to Makai Section of current project area: SIHP #s -06528 (two platforms), -06529 (three platforms), -06530 (four *ahu*), -06531 (single *ahu*), -06532 (single *ahu*), -06533 (petroglyphs), -06534 (two *ahu*), -06535 (single *ahu*), and -06536 (enclosure)**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Rosendahl 1979	Reconnaissance survey	Approx. 212 acres in Keahuolū Ahupua‘a; TMKs [3] 7-04-008:001 por., 002 por. and 012 por.	Documented 13 sites, not assigned SIHP numbers, including two large modified lava bubble sinkholes, two long sections of stone wall (Kuakini Wall), a cairn, overhang rock shelter, petroglyph, *papamū* and petroglyphs, and a walled enclosure
Estioko-Griffin and Lovelace 1980	**Reconnaissance survey**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a**	**Identified 35 sites not assigned SIHP #s; site types included house sites, petroglyphs, burials, and multiple lava shelters and sinkholes; study area minimally overlaps *makai* terminus of Makai Section of current project area; no sites identified in proximity to current project area**
Folk 1980	Archaeological survey and subsurface testing	Three *kīpuka* within QLT Lands, Keahuolū Ahupua‘a	Documented 21 sites: SIHP #s -06444 through -06447, -06498, -06522, -06524, -06666 through -06669, -06671 through -06679, -06502, and -06503; site types included pavements, caves, habitation complexes, an enclosure, a platform, a shrine, and historic-era campsites; testing in one *kīpuka* exposed a buried cultural layer; archaeological salvage recommended for all sites
Neller 1980	**Archaeological reconnaissance survey**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a**	**Survey focus on documenting areas of human remains exposed by stormy seas; also documented a number of previously identified sites at park including SIHP #s -02001 and -02002 and areas of petroglyphs; no sites identified in proximity to current project area (Makai Section)**
Soehren 1980	**Archaeological reconnaissance survey**	**Kailua Wastewater Treatment Site, Kealakehe Ahupua‘a, TMK: [3] 7-4-008:003 (por.)**	**Documented SIHP # -07704, a north-south oriented trail located just west of existing WWTP and western boundary of Makai Section of current project area**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Soehren 1980a	**Archaeological reconnaissance survey**	**Approx. 90 acres in Kaloko Ahupua‘a; TMK: [3] 7-3-009:001 por.**	**Documented a single waterworn stone near Queen Ka‘ahumanu Hwy (possible sling stone), not assigned a site number; noted potential for “graves” within property**
Soehren 1980b	Archaeological reconnaissance survey	Kaloko Ahupua‘a; TMK: [3] 7-3-009:001 por.	Documented stepping-stone trails, a possible burial, a lava tube containing a cultural deposit, and a lava tube used for temporary habitation, water collection, and possibly refuge; no SIHP numbers assigned
Soehren 1981	Archaeological reconnaissance survey	Kealakehe Ahupua‘a, TMK: [3] 7-4-008:003 por.	Documented three previously recorded sites near coast in proposed ocean outfall alignment for Kealakehe WWTP: SIHP #s -01888 (shrine and/or house site), -01889 (remnant house site or platform), -01890 (burial platform and remnant house sites)
Bonk 1987	**Preliminary archaeological reconaissance survey**	**Lower Kealakehe Ahupua‘a (coast up to 630 ft amsl)**	**Noted findings within three general areas: 1) Honokōhau Harbor vicinity; 2) 1,000-m-wide coastal strip, both found to contain numerous archaeological features; and 3) everything *mauka* of these coastal areas, found to contain ranching and homesteading features; only site noted within bounds of current project area is Māmalahoa Trail (SIHP # -00002)**
Rosendahl 1989	**Archaeological inventory survey**	**Kaloko Ahupua‘a; TMK: [3] 7-3-010:017 por.**	**Documented SIHP # -13493, segment of a stepping-stone trail located just northeast of Northern Section of current project area**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Donham 1990a	**Archaeological inventory survey**	**950 acres in Kealakehe and Keahuolū Ahupua‘a, TMKs: [3] 7-4-008:017, 012 por.**	**Documented four previously identified sites including SIHP #s -00002 (Māmalahoa Trail) and -05011 (*ahupua‘a* wall), and 78 new sites comprising 840 individual features, predominately agricultural in function; assigned 80 new SIHP #s: -13175 through -13254; of these, six (SIHP #s -00002, -05011, -13182, -13194, -13195, and -13253) are indicated in proximity to Mauka Section of current project area**
Donham 1990b	**Archaeological inventory survey**	**Kealakehe and Keahuolū Ahupua‘a, TMKs: [3] 7-4-008:017, 012 por.**	**Addendum to Donham 1990a study reported on finds of Donham 1990c AIS in QLT lands in Keahuolū Ahupua‘a; notes 24 sites comprising 250 features (SIHP #s -13420 through -13440 and -13447 through -13449); sites not in proximity to current project area**
Donham 1990c	**Archaeological inventory survey**	**1100 acres in QLT Lands; Keahuolū Ahupua‘a, TMKs: [3] 7-4-008:002 por. and 012**	**Documented 239 sites comprising over 1,810 individual features similar to those observed by Donham (1990a); of these, two previously documented: SIHP # -00002 (Mamalaohoa Trail) and SIHP # -07276 (Kuakini Wall); a number of sites initially documented by Ching (1978) likely confirmed but assigned new SIHP numbers; 237 new SIHP designations include SIHP #s 50-10-[27 or 28]-13255 through -13491; seven sites are in proximity to Mauka Section of current project area: SIHP #s -00002, -13315, -13321, -13326 through -13328, and -13482; 13 sites in proximity to Makai Section of project area: SIHP #s -13284, -13286, -13288 through -13298, and -13353; radiocarbon testing yielded evidence of occupation as early as fifteenth century**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Pietrusewsky 1990	**Osteological analysis**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a**	**Examination of skeletal remains of one female individual collected from park, which technically overlaps *makai* terminus of Makai Section of current project area; exposure location and subsequent reinterment location not in proximity to current project area**
Rosendahl and Walker 1990	**Archaeological inventory survey**	**Kaloko Ahupua‘a; TMK: [3] 7-3-010:017 por.**	**Attempted recording additional information about SIHP # -13493 (stepping-stone trail); no additional information obtained**
Smith and Yent 1990	Archaeological inventory survey and data recovery	**25 acres at Old Kona Airport Park, Lanihau Ahupua‘a; TMK: [3] 7-5-005:007**	Documented six sites: two previously identified by Estioko-Griffin and Lovelace (1980) comprising a wall and numerous *ahu*; and four newly documented sites including a wall, platform, and filled crevices; sites not assigned SIHP numbers
Borthwick and Hammatt 1992a	**Archaeological assessment (negative finds AIS)**	**Kealakehe and Keahuolū Ahupua‘a, TMK: [3] 7-5-004:067, 7-5-05:007, 7-4-008:002**	**Documented ten previously recorded sites (including three without SIHP numbers at Old Kona Airport Park, and SIHP #s -13266, -13291 through -13294, -13296, -13298 recorded by Donham 1990c) and four newly recorded sites (SIHP #s -17167 through -17170); of these, six are in proximity to Makai Section of current project area (SIHP #s -13291, -13292, -13294, -13298, -17168, and -17169)**
Borthwick and Hammatt 1992b	**Archaeological field inspection and interim preservation plan**	**Kealakehe Ahupua‘a; TMK [3] 7-1-008:017 por.**	**Documented two newly identified sites in Donham (1990a)/Burgett and Rosendahl (1992) project area: SIHP #s -15537 (lava tube) and -15538 (terrace); recommends further mitigation at SIHP # -00002 and two stepping-stone trails (SIHP #s -13194 and -13197)**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Burgett and Rosendahl 1992	**Archaeological inventory survey**	**Kealakehe and Keahuolū Ahupua‘a, TMK: [3] 7-4-008:017, 012 por.**	**Addendum to Donham (1990a) AIS documented 44 newly identified sites comprising 225 features (SIHP #s -16001 through -16044), and 103 additional features associated with Donham (1990a and b) sites; of these, only one (SIHP # -13253) is indicated in proximity to Mauka Section of current project area**
Yent 1992	Archaeological field inspection	Old Kona Airport Park, Lanihau Ahupua‘a; TMK: [3] 7-7-005:005 por.	Documented a partial anthropomorphic petroglyph (State Park Site #1992-40), not assigned a SIHP #
Borthwick et al. 1993	**Archaeological reconnaissance survey**	**Kealakehe and Honokōhau Ahupua‘a**	**Documented 43 new sites (no SIHP #s assigned); identified 44 previously documented sites (with SIHP designations from multiple different studies); two sites documented in proximity to Mauka Section of current project area include trail sites SIHP #s -00002 and -13194**
Fager and Graves 1993	Archaeological inventory survey	15+ acres at Kaloko Industrial Park, Kaloko Ahupua‘a; TMK: [3] 7-3-051:001 por.	Documented 17 sites comprising 60 component features: SIHP #s 50-10-28-15335 through -15351; feature types included terraced, modified outcrops, mounds, walls, lava tubes, *pāhoehoe* excavations, *ahu*, filled cracks, enclosures, and a stepping-stone trail; assessments of function included agriculture, animal husbandry, temporary habitation, marker, quarry, and transportation; a charcoal sample yielded a probable age of AD 1617–1884

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Henry and Graves 1993	**Archaeological inventory survey**	**Queen Ka‘ahumanu Hwy and Kaiwi St ROW, Keahuolū to Kalaoa Ahupua‘a**	**Phase 1 AIS (site identification) documented 25 sites comprising 60 features; of these, five previously identified (SIHP #s -00002, -06432 [*ahupua‘a* boundary wall], -13194 [trail], -13195 [trail], and -13334 [complex]); newly identified sites assigned as SIHP #s -15314 through -15333**
O’Hare and Rosendahl 1993	Archaeoloigcal inventory survey	100 acreas of QLT lands, Keahuolū Ahupua‘a; TMK: [3] 7-4-008:002 por.	Documented 18 sites comprising 38 features: one previously identified (SIHP # -00002, Māmalahoa Trail) and 17 newly identified (SIHP #s 50-10-28-18502 through -18518) used for agriculture, temporary habitation, temporary habitation/possibly ceremonial, burial, historic dump, transportation, quarry, and marker
Barr et al. 1994	**Archaeological inventory survey**	**206 acres in Kealakehe and Honokōhau Ahupua‘a; TMKs: [3] 7-4-008:003 por., 005 por., 017 por., and 034 por.**	**Documented 83 sites including 33 newly recorded sites and 50 previously identified sites (with SIHP designations from multiple studies); two sites documented in proximity to Mauka Section of current project area include trail sites SIHP #s -00002 and -13194; charcoal samples yielded ages generally within between 1600s–1890s, though one sample dated to AD 1439-1693**
O’Hare and Goodfellow 1994	**Archaeological data recovery**	**800 acres in Kealakehe Ahupua‘a; TMKs: [3] 7-4-008:012 por., and 017**	**Documented 422 archaeological features within Donham (1990a) survey area; excavated 88 test units; conducted laboratory analysis on soil, artifact, and charcoal samples; majority of features found to be agricultural in nature; radiocarbon analysis indicated majority of sampled habitation and agricultural features ranged in age from AD 1400-1850**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Carpenter 1995	**Burial recovery and reinterment**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a, TMK: [3] 7-5-005:007**	**Included collection of human remains from 24 individuals exposed by high surf and subsequent reinterment at park, which technically overlaps *makai* terminus of Makai Section of current project area; exposure locations and subsequent reinterment location not in proximity to current project area**
Head and Rosendahl 1995	Archaeological data recovery	Keahuolū Ahupua‘a; TMKs: [3] 7-04-008:002 por., 012 por.	Data recovery conducted at SIHP #s -00002 (Māmalahoa Trail) and 50-10-28-18506 (complex); efforts at SIHP # -00002 involved documentation of construction techniques at seven sample areas; test excavations at SIHP # -18506 yielded a radiocarbon date of AD 1453-1824
Walsh and Hammatt 1995	**Archaeological inventory survey**	**Queen Ka‘ahumanu Hwy, Keahuolū to Kalaoa Ahupua‘a**	**Documented 17 sites comprising 29 individual features; five sites previously recorded (SIHP #s -00002, -02238, -06432, -13194, and -15324) and 12 sites newly recorded (SIHP #s -19943 through 19954); of documented sites, only SIHP #s -00002 and -13194 in proximity to current project area**
Colin et al. 1996	**Archaeological inventory survey and limited subsurface testing**	**224 acres in Kaloko and Kohanaiki Ahupua‘a; TMKs: [3] 7-3-009:002 por. and 017**	**Documented 55 sites comprising 93 features, including two previously identified sites (SIHP #s -13493 and -15324) and 53 newly identified sites (SIHP #s -20696 through -20722 and -20724 through -20749), of which six are in proximity to Northern Section of current project area (SIHP #s -13493, -20722, -20744, -20745, 20726, and -20728); documented sites included *ahu*, simple agricultural features, recurrent and temporary habitation sites, trails, enclosures, walls, and a quarry; subsurface testing conducted at eight sites; two charcoal samples yielded date ranges falling between AD 1670-1945**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Hammatt et al. 1999	Archaeological data recovery	Queen Ka‘ahumanu Hwy, Honokōhau Ahupua‘a	Data recovery at SIHP # -00002 (Māmalahoa Trail) and -19953 (*mauka-makai* trail) involved production of archival-quality photo documentation and cross-sectional drawings of portions of subject trails to be impacted by construction
Wolforth 1999	**Archaeological monitoring**	**Queen Ka‘ahumanu Hwy and Kaiwi St ROW, Keahuolū to Kalaoa Ahupua‘a**	**Involved inspection of 31 previously documented sites (including those documented by Henry and Graves 1993 in proximity to current project area) and documentation of eight newly recorded sites: SIHP #s -21252 through -21258 and -21756; portions of a 3.3-km section of SIHP # -00002 within the 1999 mapped and described area**
Haun and Henry 2000	Archaeological inventory survey	102 acres at Kaloko Industrial Park, Kaloko Ahupua‘a; TMK: [3] 7-3-051:60	Documented 45 sites comprising 81 individual features: nine previously identified, of which five found to be disturbed; and 36 newly identified sites; site types and functions conform to those expected within subject elevational/zonal settlement pattern
Haun and Henry 2001	Archaeological inventory survey	Kealakehe Ahupua‘a, TMK: [3] 7-4-008:003 por.	Located directly adjacent to but not overlapping current project area; documented 58 sites comprising 123 features (SIHP #s -23007 through -23062); feature types included *pāhoehoe* excavations, stone alignments, *ahu*, mounds, petroglyphs, enclosures, trails, and a cave, overhang, and platform; functional categories included quarrying, markers, agriculture, rock art, temporary habitation, transportation, possible ceremony, indeterminate; several sites located in proximity to Mauka and Makai Sections of current project area (SIHP #s -23020, -23023, -23026, -23029, -23033, -23047, -23048)

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Gmirkin and Bond 2002	Archaeological inventory survey	Kaloko-Honokōhau National Historical Park	Located directly adjacent to but not overlapping current project area; documented four sites in one area (SIHP #s -19954, -23352 through -23354), and ten in another area (assigned temporary site numbers NPS SP-1 through 10); of these, sites SP-1 through -10 in proximity to Mauka Section of current project area
Rechtman and Escott 2002	**Archaeological inventory survey**	**40 acres in Kealakehe Ahupua‘a; TMK: [3] 7-4-008:003 por.**	**Documented eight sites: three previously identified (SIHP #s -23020, *pāhoehoe* excavation; -23021, lava tube; and -23023, trail segment) and five newly identified (SIHP #s -23549, C-shaped enclosure; -23550 and -23552, *pāhoehoe* excavations; -23551, modified lava blister; and -23554, trail segment; all eight sites located within or in proximity to Mauka or Makai Sections of current project area; all recommended for no further work**
Haun et al. 2003	Archaeological data recovery	Kaloko Industrial Park, Kaloko Ahupua‘a; TMK: [3] 7-3-051:60	Data recovery efforts at SIHP #s -21999, -22010, -22014, -22016, -22017, -22018, -22023, and -22032 involved determinations of site age and function; all sites determined to have functioned for temporary habitation and associated activity; radiocarbon analyses indicated occupation between AD 1445 and the early 1800s
Pestana and Spear 2005	Archaeological assessment (no finds AIS)	Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a, TMK: [3] 7-5-005:007 por.	Survey effort involved hand excavation of 22 shovel tests and three test units; no cultural materials identified

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Haun and Henry 2006	**Archaeological inventory survey**	**370 acres in Kealakehe and Keahuolū Ahupua‘a; TMKs: [3] 7-4-008:002 por., 003 por., 071 por., and 072 por.**	**Documented 127 sites comprising 432 features; 23 sites previously identified (with SIHP designations from multiple studies); 104 sites newly identified (SIHP #s -25549 through -25653); feature types included *pāhoehoe* excavations, *ahu*, alignments, overhangs, lava blisters, enclosures, terraces, platforms, trails, walls, pavements, midden scatters, mounds, sand areas, filled cracks, lava tubes, C-shapes, a metal tower, and an upright; sites occur as expected following elevational/zonal settlement patterns; SIHP #s -07704, -23033, -25643, -25556, -25557, -25558 indicated to be within or in close proximity to current project area**
Rosendahl 2006	Historic preservation review	Kealakehe Ahupua‘a; TMK: [3] 7-4-008 por.	Noted two previously recorded sites: SIHP #s -13180 (complex of land division, ranching, and agriculture features) and -16010 (agricultural complex); both sites fully mitigated in previous work
Bell et al. 2008	Archaeological inventory survey	224 acres in Kaloko and Kohanaiki Ahupua‘a; TMK: [3] 7-3-009:017	Located directly adjacent to but not overlapping current project area; documented 59 sites, including 53 previously identified (with SIHP designations from multiple studies) and six newly identified (SIHP #s -26259 through -26264); distribution of sites corresponds with expectations according to elevation, with sites most frequent on ridges, tumuli or in lava tubes; SIHP #s -13493, -15329, -20722, -20726, -20728, -20744, and -20745 indicated in proximity to Northern Section of current project area
Hammatt and Shideler 2008	Documentation of damage	TMKs: [3] 7-4-020:009 and 010	Assessed damage to a portion of SIHP # -00002 (Māmalahoa Trail)
Hammatt et al. 2008	Mitigation implementation	TMKs: [3] 7-4-020:009 and 010	Reported on renaturalization and restoration efforts at a disturbed portion of SIHP # -00002 (Māmalahoa Trail)

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Clark and McCoy 2009	Archaeological assessment (no finds AIS)	Kalaoa 5 Ahupua‘a; TMK: [3] 7-03-043:003 por.	Area of Potential Effect (APE) included existing facility in Keahuolū; no archaeological features identified
Simonson et al. 2010	**Archaeological literature review and field inspection**	**Old Kona Airport Park, Lanihau and Keahuolū Ahupua‘a, TMKs: [3] 7-5-005:007 and 083**	**Confirmed location of numerous previously identified sites and documented four new sites, not assigned SIHP #s; many previously identified sites not confirmed; study area minimally overlaps *makai* terminus of Makai Section of current project area; no sites identified in proximity to current project area**
Wilkinson et al. 2011	**Archaeological literature review and field inspection**	**Keahuolū through Kaloko Ahupua‘a; TMKs: [3] 7-3-009:025; 7-4-008:005; 7-4-020: 003, 004, 007, 010; 7-4-021:008, 023**	**Study confirmed 11 previously recorded sites; similar number of previously recorded sites not confirmed; several new features observed including *pāhoehoe* and *‘a‘ā* excavations, possible trails, a lava tube opening, a bulldozed concentration of waterworn stones and artifacts, and a potentially historic fence line; one site located in proximity to Mauka Section of current project area (SIHP # -13194, trail)**
Monahan et al. 2012	**Archaeological inventory survey**	**Queen Ka‘ahumanu Hwy, Kealakehe to Kalaoa Ahupua‘a; TMKs: [3] 7-4-008, 7-3-009, and 7-3-043**	**Documented 75 sites: 20 previously documented (with SIHP designations from multiple different studies) and 55 newly recorded; feature types included trails, *pāhoehoe* and *‘a‘ā* excavations, mounds, *ahu*, walls, modified outcrops, petroglyphs, lava tubes, enclosures, leveled areas, filled crevices, modified depressions and blisters, and a burial platform; SIHP #s -10714, -28794, -28796, and -29344 indicated in proximity to current project area (Northern Section)**

Reference	Type of Study	Location	Results (SIHP # 50-10-27**** unless otherwise noted)
Reeve et al. 2012	**Archaeological inventory survey**	**628 acres in Keahuolū; TMK: [3] 7-4-008:002**	**Documented 322 sites comprising 464 component features, as well as 139 *pāhoehoe* excavations not assigned SIHP designations; some sites previously recorded by Ching (1978) and/or Folk (1980); new site designations include SIHP #s -27273 through -27419, -27421 through -27542, and -27559 through -27569; 48 sites indicated within proximity to Makai Section of current project area; site density highest at coast, where excavations at habitation sites yielded wide variety of cultural materials; radiocarbon dating of charcoal samples provided evidence of occupation from as early as sixteenth century**
Lizama et al. 2015	Archaeological monitoring	Keahuolū Ahupua‘a; TMK: [3] 7-4-008:002	Ensured protection of SIHP #s -06492 (enclosure) and -27384 (cemetery); documented a new site, SIHP # -30224 (buried cultural deposit)
Yucha et al. 2016	Archaeological inventory survey	Kealakehe and Keahuolū Ahupua‘a; TMKs: [3] 7-4-020:003, 010 por., 023 por., 024 por.	Documented ten sites, including three previously identified (SIHP #s -13308, -13310, and -16013) and seven newly identified (SIHP #s -29892 through -29894, -29896, -29898, -30196, and -30197); feature types included trails, *ahu*, modified outcrops, terraces, and *pāhoehoe* excavations; SIHP # -13310 found to represent modern bulldozer track
Wilkinson et al. 2017	**Archaeological inventory survey**	**Queen Ka‘ahumanu Hwy, Kealakehe to Kalaoa Ahupua‘a; TMKs: [3] 7-2-005; 7-3-009, 043, 049, 051, 058; 7-3-043:091, 083; 7-4-020**	**Supplemental survey documented two segments of SIHP # -00002 (Māmalahoa Trail) located adjacent to intersection of Kealakehe Pkwy and Queen Ka‘ahumanu Hwy; one segment within Mauka Section of current project area**

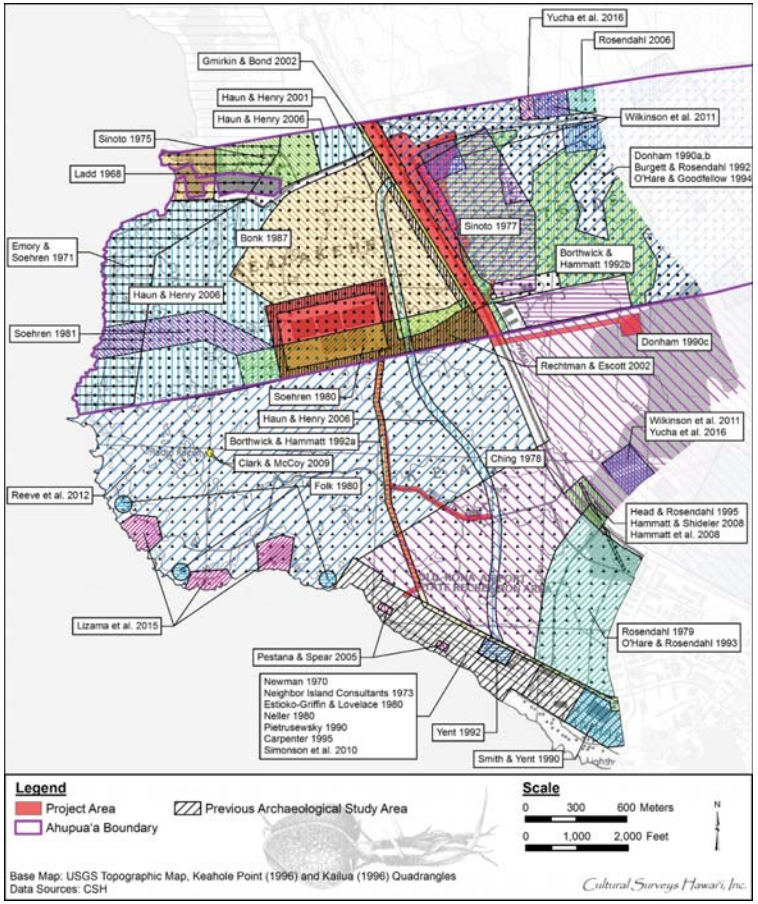

Figure 11. Portions of the 1996 Keahole Point and Kailua USGS 7.5-minute topographic quadrangles showing previous archaeological studies in the vicinity of the Mauka and Makai Sections of the project area (in red); this map does not include previous studies along Queen Ka‘ahumanu Highway (see Figure 13)

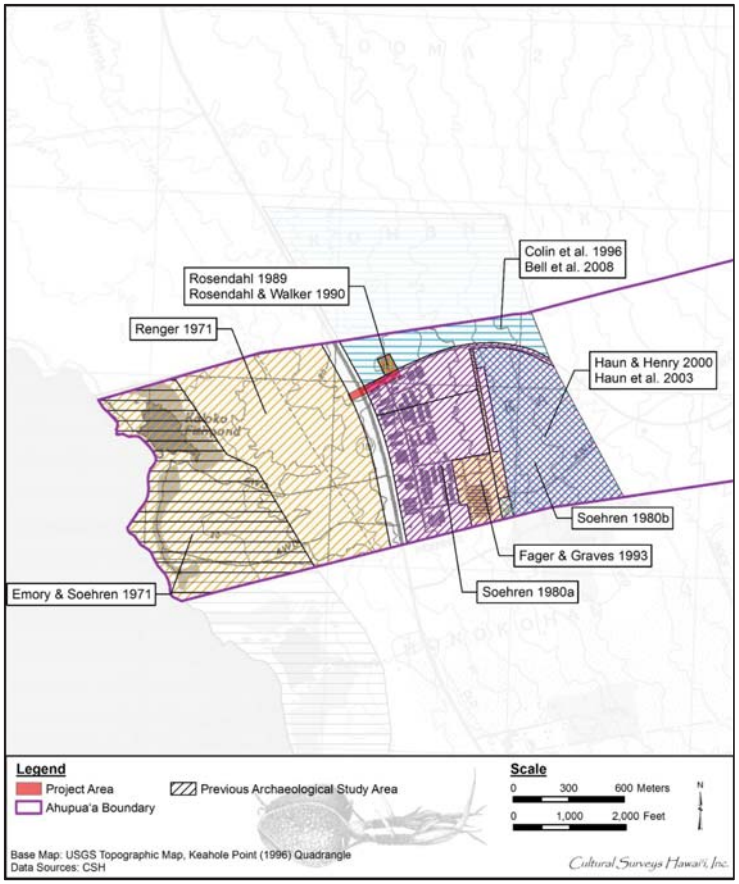

Figure 12. Portion of the 1996 Keahole Point USGS 7.5-minute topographic quadrangle showing previous archaeological studies in the vicinity of the Northern Section of the project area (in red); this map does not include previous studies along Queen Ka‘ahumanu Highway (see Figure 13)

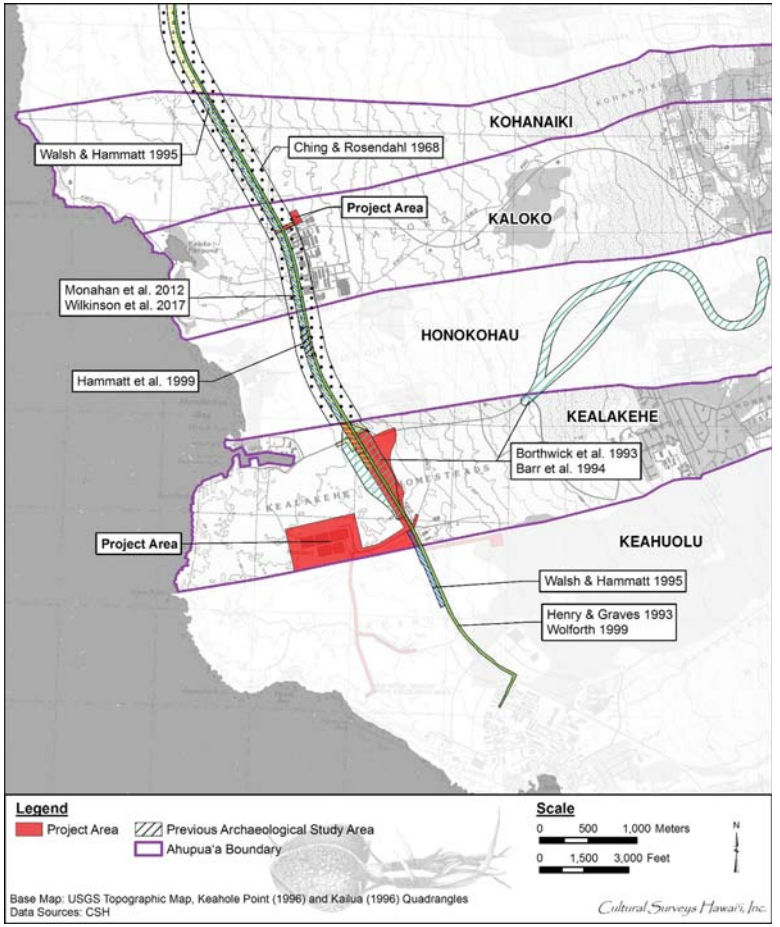

Figure 13. Portions of the 1996 Keahole Point and Kailua USGS 7.5-minute topographic quadrangles showing previous archaeological studies along the Queen Ka‘ahumanu Highway in relation to the overall project area (in red)

Table 8. Previously documented archaeological sites in or near the vicinity of the Mauka Section of the project area (site numbers prefixed "50-10-27" unless otherwise noted)

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
00002	–	Bonk 1987; Donham 1990a and c; Borthwick and Hammatt 1992b, Borthwick et al. 1993; Henry and Graves 1993; Barr et al. 1994; O'Hare and Goodfellow 1994; Head and Rosendahl 1995; Walsh and Hammatt 1995; Hammatt et al. 1999; Wolforth 1999; Hammatt and Shideler 2008; Hammatt et al. 2008; Monahan et al. 2012; Wilkinson et al. 2017	Trail (Māmalahoa Trail)	–	Transportation	Historic	Data recovery (archival research) and partial preservation	Māmalahoa Trail has been impacted in multiple locations by various developments; extant portions in fair to reconstructed condition; various portions in active preservation and/or ongoing mitigation, including portions overlapping current project area
50-10-28-05011 -21756	50-Ha-D11-29; Site 1 (Sinoto 1977); T-9 4 (Donham 1990a); 927-25,39 (Burgett and Rosendahl 1992)	Sinoto 1977; Donham 1990a; Burgett and Rosendahl 1992; O'Hare and Goodfellow 1994; Wilkinson et al. 2011	Wall	–	*Ahupua'a* boundary	Historic	Further data collection (Burgett and Rosendahl 1992); no further work (?) (O'Hare and Goodfellow 1994)	Good condition
13182	T-8	Donham 1990a	Complex	2	Agriculture, marker	Indeterminate	No further work	Good condition
13194	T-2 1	Donham 1990a; Borthwick and Hammatt 1992b; Borthwick et al. 1993; Henry and Graves 1993; Barr et al. 1994; O'Hare and Goodfellow 1994; Walsh and Hammatt 1995	Stepping-stone trail	–	Transportation	Prehistoric	Preservation	Disturbed to fair condition
13195	T-22	Donham 1990a; Borthwick and Hammatt 1992b; Henry and Graves 1993	Complex	3	Marker	Historic	No further work	Fair condition
13253	T-9 6 (Donham 1990a)	Soehren 1976; Donham 1990a; Burgett and Rosendahl 1992; O'Hare and Goodfellow 1994	Complex	24	Burial, temporary habitation	Prehistoric	Preservation	Fair to good condition
13253K	Site 1 (Soehren 1976); T-9 6 (Donham 1990a)	Soehren 1976; Donham 1990a	Stepping-stone trail	–	Transportation	Prehistoric	Preservation	Fair to good condition; trail impacted by bulldozing sometime after 1976
13315	T-6 8	Donham 1990c	Rubble wall	1	Indeterminate	Prehistoric, historic	Further data collection	Fair condition
13321	T-7 4	Donham 1990c	Boulder concentration	1	Agriculture	Prehistoric	No further work	Good condition
13326	T-8 5	Donham 1990c	Platform	1	Agriculture	Prehistoric	No further work	Good condition
13327	T-8 8	Donham 1990c	*Pāhoehoe* excavation	2	Quarry	Prehistoric	No further work	Good condition
13328	T-8 9	Donham 1990c	Cave	1	Habitation	Prehistoric	Further data collection necessary	Fair condition
13482	T-8 7	Donham 1990c	*Pāhoehoe* excavation	1	Quarry	–	No further work	–
21588	SP-9	Emory and Soehren 1971; Cluff 1977; Durst 1999; Gmirkin and Bond 2002	Trail	–	Transportation	Historic	Preservation/avoidance during construction	Disturbed to excellent condition
23020	7 (Haun and Henry 2001)	Haun and Henry 2001; Rechtman and Escott 2002	*Pāhoehoe* excavation	1	Quarry	Pre-Contact	No further work	Good condition
23021	6 (Haun and Henry 2001)	Haun and Henry 2001; Rechtman and Escott 2002	Cave	1	Temporary habitation	Pre-Contact	No further work	Good condition

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
23023	2 (Haun and Henry 2001)	Haun and Henry 2001; Rechtman and Escott 2002	Trail	1	Transportation	Pre-Contact	No further work	–
23026	3 (Haun and Henry 2001)	Haun and Henry 2001	Complex	5	Marker	–	No further work	Good condition
23029	4 (Haun and Henry 2001)	Haun and Henry 2001	*Pāhoehoe* excavation	1	Quarry	–	No further work	Good condition
23552	–	Rechtman and Escott 2002	*Pāhoehoe* excavation	1	Quarry	Pre-Contact	No further work	–
23553A	–	Rechtman and Escott 2002	Trail	2	Transportation	Pre-Contact	No further work	–
25549	–	Haun and Henry 2006	Trail	–	Transportation	–	No further work	Fair to good condition
25552	–	Haun and Henry 2006	L-shaped wall	1	Temporary habitation	–	No further work	Fair condition
25553	–	Haun and Henry 2006	Cairn	1	Marker	–	No further work	Fair condition
25554	–	Haun and Henry 2006	Enclosure	1	Permanent habitation	–	No further work	Fair condition
–	SP-1	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-2	Gmirkin and Bond 2002	Battering	1	–	–	Avoidance and monitoring during construction	–
–	SP-3	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-4	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-5	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-6	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-7	Gmirkin and Bond 2002	Wall	1	–	–	Avoidance and monitoring during construction	–
–	SP-8	Gmirkin and Bond 2002	*Pāhoehoe* excavation	1	–	–	Avoidance and monitoring during construction	–
–	SP-10	Gmirkin and Bond 2002	Stone mound	1	–	–	Avoidance and monitoring during construction	Poor condition

Table 9. Previously documented archaeological sites in or near the vicinity of the Makai Section of the project area (site numbers prefixed "50-10-27" unless otherwise noted)

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
06531	T-153	Ching 1978, Reeve et al. 2012	Complex	2	Habitation/marker	Traditional	Data recovery	Poor condition
06532	T-197	Ching 1978, Reeve et al. 2012	Stone mound	1	Burial	Traditional	Preservation	Fair condition
07704	–	Soehren 1980, Haun and Henry 2006	Trail	27	Transportation	Historic	No further work	Trail marked by 26 associated cairns
13284	T-32	Donham 1990c	Complex	4	Agriculture	Prehistoric	No further work	Good condition
13286	T-34	Donham 1990c	Complex	10	Indeterminate/ markers/ possible agriculture	Prehistoric, early historic	No further work	Good condition
13288	T-37	Donham 1990c	Retaining wall/terrace	1	Loading ramp	Historic	No further work	Fair to good condition
13289	T-38	Donham 1990c	Complex	15	Quarry/ possible agriculture	Prehistoric, early historic	Further data collection	Good condition
13290	T-39	Donham 1990c	Complex	6	Quarry/ agriculture	Prehistoric, early historic	Further data collection	Good condition
13291	T-40	Donham 1990c; Borthwick and Hammatt 1992a	Complex	6	Quarry	Prehistoric, early historic	Preservation	Fair condition
13292	T-41	Donham 1990c; Borthwick and Hammatt 1992a	Complex	18	Quarry/ possible agriculture	Prehistoric, early historic	No further work	Good condition
13293	T-42	Donham 1990c; Borthwick and Hammatt 1992a	Complex	9	Quarry/ possible agriculture	Prehistoric	No further work	Good condition
13294	T-43	Donham 1990c; Borthwick and Hammatt 1992a	Complex	73	Agriculture	Indeterminate/ Prehistoric, historic	Preservation	Good condition
13295	T-44	Donham 1990c	Complex	10	Quarry	Prehistoric, early historic	Further data collection	Good condition
13297	T-47	Donham 1990c	Complex	9	Quarry/ possible agriculture	Prehistoric	No further work	Good condition
13298	T-48	Donham 1990c; Borthwick and Hammatt 1992a	Complex	7	Quarry/ agriculture/ temporary habitation	Prehistoric	No further work	Good condition
13353	T-128	Donham 1990c	Complex	3	Rock art, aquaculture, bathing	Prehistoric, early historic	Further data collection	Good condition
17167	CSH1	Borthwick and Hammatt 1992a	Modified sink	1	Shelter	Prehistoric	Preserve	Good condition with fair excavation potential
17168	CSH2	Borthwick and Hammatt 1992a	Modified sink	1	Shelter	Prehistoric	Preservation	Fair to good condition with poor excavation potential
17169	CSH3	Borthwick and Hammatt 1992a	Modified blister	1	Shelter	Prehistoric	No further work	Poor condition with poor excavation potential
23033	80	Haun and Henry 2001; Haun and Henry 2006	Overhang	1	Temporary habitation	–	Data recovery	Good condition
23047	55	Haun and Henry 2001	Cairn	1	Marker	–	No further work	Good condition
23048	74	Haun and Henry 2001	*Pāhoehoe* excavation	1	Quarry	–	No further work	Good condition
23549	–	Rechtman and Escott 2002	C-shaped enclosure	1	Temporary habitation	Pre-Contact	No further work	Good condition
23550	–	Rechtman and Escott 2002	Pahoehoe excavation	1	quarry	Pre-Contact	No further work	Good condition
23551	–	Rechtman and Escott 2002	Modified blister, cairn	2	Temporary habitation, marker	Pre-Contact	No further work	Good condition
25556	–	Haun and Henry 2006	Alignment	1	Indeterminate	–	No further work	Fair condition
25557	–	Haun and Henry 2006	Alignment	1	Indeterminate	–	No further work	Fair condition
25558	–	Haun and Henry 2006	Alignment	1	Indeterminate	–	No further work	Fair condition

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
25643	–	Haun and Henry 2006	Alignment	1	Indeterminate	--	No further work	Fair condition
27279	T-009	Reeve et al. 2012	Modified overhang	1	Storage	Traditional	Data recovery	Fair condition
27280	T-010	Reeve et al. 2012	Filled crevice	1	Indeterminate	Traditional	Data recovery	Good condition
27282	T-012	Reeve et al. 2012	Sinkhole	1	Indeterminate	Traditional	Data recovery	Good condition
27285	T-016	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27298	T-030	Reeve et al. 2012	Stone mound	2	Marker	Traditional	Preservation	Feature A: fair condition; Feature B: poor condition
27299	T-031	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27300	T-032	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27301	T-033	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27302	T-036	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Poor condition
27304	T-039	Reeve et al. 2012	Battering	1	Processing	Traditional	Data recovery	Fair condition
27305	T-040	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27308	T-045	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Poor condition
27378	T-116	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Poor condition
27379	T-117	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Preservation	Fair condition
27380	T-118	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Preservation	Fair condition
27381	T-119	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Poor condition
27382	T-123	Reeve et al. 2012	Stone mound	1	Marker	Historic	Data recovery	Fair condition
27398	T-154	Reeve et al. 2012	Stone mound	1	Marker	Modern	Data recovery	Good condition
27400	T-156	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27401	T-157	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27402	T-158	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Poor condition
27403	T-159	Reeve et al. 2012	Complex	2	Marker	Traditional	Data recovery	Fair condition
27404	T-160	Reeve et al. 2012	Stone mound	1	Marker	Traditional	Data recovery	Fair condition
27405	T-161	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27406	T-162	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27407	T-163	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Poor condition
27408	T-164	Reeve et al. 2012	U-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27409	T-165	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27410	T-166	Reeve et al. 2012	Enclosure	1	Indeterminate	Traditional	Data recovery	Fair condition
27411	T-167	Reeve et al. 2012	Enclosure	1	Indeterminate	Traditional	Data recovery	Fair condition
27412	T-168	Reeve et al. 2012	Modified overhang	1	Habitation	Traditional	Data recovery	Fair condition
27413	T-169	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27414	T-170	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27415	T-171	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition
27416	T-172	Reeve et al. 2012	Complex	2	Habitation	Traditional	Data recovery	Feature A: fair condition; Feature B: poor condition
27417	T-173	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27421	T-177	Reeve et al. 2012	Modified crevice	1	Indeterminate	Traditional	Data recovery	Fair condition

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Fea.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
27422	T-178	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Poor condition
27439	T-198	Reeve et al. 2012	Wall segment	1	Indeterminate	Traditional	Data recovery	Fair condition
27440	T-199	Reeve et al. 2012	Complex	3	Habitation	Traditional	Data recovery	Fair condition
27441	T-200	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27442	T-201	Reeve et al. 2012	Scatter	1	Activity area	Traditional	Data recovery	Good condition
27447	T-208	Reeve et al. 2012	Enclosure	1	Habitation	Traditional	Data recovery	Fair condition
27559	–	Reeve et al. 2012	C-shaped wall	1	Habitation	Traditional	Data recovery	Fair condition

Table 10. Previously documented archaeological sites in or near the vicinity of the Northern Section of the preject area (site numbers prefixed "50-10-27" unless otherwise noted)

SIHP # 50-10-27-	Other Site Numbers	Previous Archaeological Reference(s)	Site Type	# of Feat.	Site Function	Site Age	Most Current Recommendation	Most Recent Observed Status and Other Comment(s)
10714A, B	A: T-091010-4, B: T-091010-5 (Monahan et al. 2012)	Renger 1971; Monahan et al. 2012	Trail system (*mauka-makai*)	3	Transportation	Prehistoric, historic	Data recovery (archival research) and partial preservation	Part of the Road to the Sea trail system; absorbed SIHP # -28796 (trail marker)
13493	PHRI 547-1	Rosendahl 1989; Rosendahl and Walker 1990; Colin et al. 1996; Bell et al. 2008	Trail	–	Transportation	Prehistoric	No further work	–
15329	PHRI 92-1118-18	Henry and Graves 1993; Bell et al. 2008	Modified tumulus	1	Temporary habitation	Pre-contact	No further work	Fair condition
20722	–	Colin et al. 1996; Bell et al. 2008	Trail	1	Transportation	Pre-contact	No further work	Fair condition
20726	–	Colin et al. 1996; Bell et al. 2008	Trail	2	Transportation	Pre-contact	No further work	Fair condition
20728	–	Colin et al. 1996; Bell et al. 2008	Enclosure	1	Temporary habitation	Pre-contact	No further work	Fair condition
20744	–	Colin et al. 1996; Bell et al. 2008	Trail	1	Transportation	Pre-contact	No further work	Poor condition
20745	–	Colin et al. 1996; Bell et al. 2008	Trail	1	Transportation	Pre-contact	No further work	Fair condition
28794	T-091010-7	Monahan et al. 2012	Filled crevice	1	Indeterminate; possible agricultural clearing feature	Indeterminate	Avoidance during construction	–
28796 (see 10714)	T-091010-6	Monahan et al. 2012	Stacked boulders	1	Marker	–	–	Absorbed by SIHP # -10714 as a marker of Feature B trail
29344	Excavation 0 (Monahan and Yucha 2012)	Monahan et al. 2012	Excavated pit	1	Indeterminate; possible quarry or sweet potato planter or bird pit	Indeterminate—probably prehistoric (pre-Contact)	Data recovery	–
–	50-Ha-D13-81	Renger 1971	Trail	–	Transportation	–	–	–

4.5.2 Previous Archaeological Studies Overlapping the Project Area

All the SIHP numbers listed in this section are prefixed "50-10-27," unless otherwise noted.

4.5.2.1 Ching and Rosendahl 1968

In 1968, the Department of Land and Natural Resources (DLNR) reported on the results of a reconnaissance survey conducted for a section of the proposed Kailua-Kawaihae Road (present Queen Ka'ahumanu Highway) located between Honokōhau and Kau Ahupua'a/Keāhole Point, and for the proposed new airport at Keāhole (Ching and Rosendahl 1968; see Figure 13). Fourteen sites were documented but not assigned SIHP numbers. Three sites (T1–T3) were documented in Honokōhau Ahupua'a, not in the vicinity of the current project area. T3 is described as a kerbstone, *mauka-makai* trail. The descriptions of T2 and T3 are missing from the report, but a photo caption indicates T2 was a grave of some sort. No sites were documented in Kaloko, where the Northern Section of the project area is located.

4.5.2.2 Neighbor Island Consultants 1973, Estioko-Griffin and Lovelace 1980

In 1973, Neighbor Island Consultants carried out a reconnaissance survey of Old Kona Airport Park, minimally overlapping the southern terminus of the Makai Section of the current project area (see Figure 11). Nineteen sites were documented but not assigned SIHP numbers, consisting of house sites—including a historic habitation complex, bait mortars, planting pits, lava cave shelters, enclosures, petroglyphs, and a number of burial sites. Two sites (KA14, petroglyph; KA15, petroglyph and house site) were recorded in the *mauka* portion of the property near the southern terminus of the Makai Section of the current project area, but were not confirmed during later surveys.

In 1980, State Parks archaeologists conducted an updated reconnaissance survey of Old Kona Airport Park, minimally overlapping the southern terminus of the Makai Section of the current project area (Estioko-Griffin and Lovelace 1980; see Figure 11). The survey identified 35 sites, some of which were previously recorded by Neighbor Island Consultants (1973). The sites were designated 1980-1 through 1980-35 and included enclosures, lava tube shelters, lava "pits," rock mounds or *ahu*, burials, bait mortars, salt pans, petroglyphs, building foundations, subsurface deposits, a wall, a *papamū*, a cistern, and a *lua* or outhouse. None of the identified sites are in proximity to the current project area.

4.5.2.3 Sinoto 1977

In 1977, the Bishop Museum conducted an archaeological reconnaissance survey of portions of Kealakehe, overlapping the Mauka Section of the current project area (Sinoto 1977; see Figure 11). Four new historic properties were identified, including one that may partially overlap the current project area: SIHP # 50-10-28-05011, wall delineating the Kealakehe and Keahuolū *ahupua'a* boundary (see Table 10). The site was recommended for preservation and/or monitoring (Sinoto 1977:3). The other three sites, SIHP #s -05012 through -05014, are lava tube shelters located *mauka* of the current project area.

4.5.2.4 Ching 1978

In 1978, Archaeological Research Center Hawai'i, Inc. (ARCH) undertook an archaeological reconnaissance of 987 acres in Keahuolū Ahupua'a *makai* of Queen Ka'ahumanu Highway, overlapping the Makai Section of the project area (Ching 1978; see Figure 11). A total of 59 sites

comprising 140 features were documented, and were concentrated at the coast. The sites were assigned SIHP numbers but a notation in the report states many of the numbers were reassigned. The site distribution map included in the report indicates a cluster of sites documented by Ching (1978) are within proximity of the southwestern boundary of the existing WWTP facility: SIHP #s -06528 (two platforms), -06529 (three platforms), -06530 (four *ahu*), -06531 (single *ahu*), -06532 (single *ahu*), -06533 (petroglyphs), -06534 (two *ahu*), -06535 (single *ahu*), and -06536 (enclosure) (see Table 10).

4.5.2.5 Neller 1980, Pietrusewsky 1990, and Carpenter 1995

In 1980, DLNR conducted a reconnaissance survey at Old Kona Airport Park, which may have minimally overlapped the southern terminus of the Makai Section of the current project area (Neller 1980; see Figure 11). The survey was undertaken in response to reports of multiple exposed burials along the shoreline following a winter storm event. The survey identified the presence of several areas of exposed human burials, and other areas containing cultural deposits, petroglyphs, and hearths. Previously recorded SIHP #s -02001 and -02002 were also confirmed. None of the burial areas or other sites or features are in proximity to the current project area. The 1980 report asserts that a comprehensive archaeological study should be conducted at the park.

In following years, additional studies were undertaken at the park in response to exposure of human remains following storm events (Pietrusewsky 1990, Carpenter 1995). Since the “project area” for these studies is designated as the overall park parcel, these studies are illustrated on Figure 11 as overlapping the southern terminus of the Makai Section of the current project area; however, the burial find locations and their subsequent reinterment locations are not in proximity to the current project area.

4.5.2.6 Soehren 1980

In 1980, Lloyd J. Soehren completed an archaeological reconnaissance survey for the Kailua Wastewater Treatment Site in Kealakehe, overlapping the existing WWTP site in the Makai Section of the current project area (Soehren 1980; see Figure 11). The survey identified a north-south oriented trail (SIHP # -07704) located just *makai* of the existing WWTP and western boundary of the Makai Section of the current project area. According to Soehren (1980:2), “The trail appears to join the village and pond at Honokohau with the small settlement at Pawai in Keahuolu.” Based on its construction, the trail likely “represents a ‘preliminary route selection’ for a nineteenth century horse trail (Apple 1965) subsequently abandoned, perhpas [*sic*] in favor of the ‘Old Mamalahoa Trail’ farther inland. It would, therefore, seem to be of interest primarily to the historian and of little or no interpretive value to the public” (Soehren 1980:2).

4.5.2.7 Soehren 1980a

In 1980, Soehren undertook an archaeological reconnaissance survey of approximately 90 acres in Kaloko Ahupua‘a *mauka* of the Queen Ka‘ahumanu Highway, overlapping the Northern Section of the current project area along the Hina Lani Street ROW (Soehren 1980a; see Figure 12). No archaeological features were identified, though the reconnaissance appears to have been limited to transects along the project area boundaries. Soehren (1980:1–2) notes, “In my opinion, there is little liklihood [*sic*] that any archaeological features will be found in the area with the possible exception of graves. These may be concealed in lava flows and can be exceedingly difficult to

find. Some may be marked with stone cairns but none were seen.” A waterworn pebble was found “near the highway” which Soehren (1980a:1) described as a probable slingstone.

4.5.2.8 Bonk 1987

In 1987, the University of Hawai‘i at Hilo conducted a preliminary archaeological reconnaissance (termed a “walk-through” survey) of “lower” Kealakehe, between the coast and approximately 630–730 ft amsl (Bonk 1987). The 1987 study area overlaps the portions of the Makai and Mauka Sections of the current project area in Kealakehe (see Figure 11). The study organizes its preliminary findings into three general areas:

1. According to Bonk (1987:7), “The area north of the [Honokōhau] harbor, along the ahupua‘a border, and into the adjacent ahupua‘a of Honokohau, has a good deal of prehistoric as well as historic remains,” including such significant sites as Puuoina Heiau.
2. Bonk (1987:7) describes “A coastal tract of land, extending up to 1,000 feet in depth and running the full width of the ahupua‘a of Kealakehe” containing numerous significant sites previously recorded by Reinecke (1930) and Emory (1971), and including such significant sites as Makaopi‘o Heiau and Hale O Kane Heiau.
3. While no sites were observed “in the area between the above mentioned coastal strip and the [Queen Ka‘ahumanu] highway,” the Māmalahoa Trail was noted just *mauka* of the highway; further *mauka*, features associated with historic ranching and homesteading were observed (Bonk 1987:11).

Additional research was recommended for all the areas covered by the walk-through survey. Except for Māmalahoa Trail (SIHP # -00002), no historic properties were explicitly identified by Bonk (1987) within the bounds of the current project area.

4.5.2.9 Rosendahl 1989, Rosendahl and Walker 1990

In 1989 and 1990, Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed archaeological inventory surveys for a water tank site located on the north side of Hina Lani Street (Rosendahl 1989, Rosendahl and Walker 1990; see Figure 12). This water tank site is the present location of the unused potable water storage tank proposed to be recommissioned for R-1 service in the Northern Section of the current project area. The 1989 survey identified a 7.5-m segment of a stepping-stone trail (SIHP # -13493) crossing the *‘a‘ā* lava in a northeast-southwest orientation. According to Rosendahl (1989:1), “The trail appears to be prehistoric, and appears to have been used as a secondary transportation route.” The location of SIHP # -13493 is indicated just northeast of the Northern Section project area boundary (see Table 10).

The following year, PHRI conducted an addendum AIS at the water tank site at the request of SHPD (Rosendahl and Walker 1990; see Figure 12). The purpose of the addendum study was to obtain additional information for SIHP # -13493 through both fieldwork and archival research. These efforts did not yield any additional information about the trail.

4.5.2.10 Donham 1990a, Donham 1990b, Burgett and Rosendahl 1992, and O’Hare and Goodfellow 1994

In 1990, PHRI reported on the results of archaeological inventory survey of the 950-acre proposed Kealakehe Planned Community project area, located in Kealakehe and Keahuolū Ahupua‘a and overlapping the Mauka Section of the current project area (Donham 1990a; see

Figure 11). The survey fieldwork consisted of an aerial reconnaissance and 100%-coverage pedestrian survey. Four previously identified sites were confirmed; of these, two had been previously assigned SIHP designations (SIHP # -00002, Māmalahoa Trail, and SIHP # -05011, *ahupua‘a* boundary wall), and two were newly assigned SIHP designations. A total of 78 sites were newly identified and assigned SIHP designations. The 80 newly obtained SIHP numbers included SIHP #s -13175 through -13254. Six of the documented sites are located in proximity to the current project area (see Table 10): SIHP #s -00002, -05011, -13182, -13194, -13195, and 13253. Donham (1990a:i) noted a predominance of agricultural features including rock mounds, *pāhoehoe* excavations, modified outcrops, terraces, small enclosures and low mounded walls. Twenty-one sites were recommended for no further work, data recovery was recommended for 42 sites, and the remainder were recommended for preservation upon further data collection or “as is” (Donham 1990a:i).

Later that year, PHRI prepared an addendum AIS report for an expansion of the Kealakehe Planned Community project into Keahuolū (Donham 1990b; not visible on Figure 11). The expansion area overlapped another concurrent PHRI survey area in Keahuolū (Donham 1990c), and therefore summarized the findings of the Donham (1990c) survey within the addendum project area, in which 24 sites had been documented: SIHP #s -13420 through -13440 and -13447 through -13449. Like those documented by Donham (1990a) in Kealakehe, the site types included predominately agricultural features with associated habitation, transportation, and miscellanea. Because the addendum AIS area was well upslope of the Mauka Section of the current project area, none of the sites are in proximity.

In 1992, PHRI prepared a report for another addendum AIS, this one located within the Donham 1990a survey area but focused on examination of proposed roadways associated with the planned community (Burgett and Rosendahl 1992; see Figure 11). This addendum AIS study documented 44 newly identified sites comprising 225 features (SIHP #s -16001 through -16044), and 103 additional features associated with Donham (1990a and b) sites. Of these, only one (SIHP # -13253) is indicated in proximity to the Mauka Section of the current project area (see Section Table 10).

Two years later, PHRI reported on data recovery efforts conducted at 800 acres within the Kealakehe Planned Community project area, also overlapping the Mauka Section of the current project area (O’Hare and Goodfellow 1994; see Figure 11). The data recovery effort included transit recordation of site locations, additional description and mapping, and excavation of 88 test units. Over 40 soil, pollen, and charcoal samples were collected and submitted for specialized analysis. All but eight of the 422 documented features were found to be agricultural in nature. The results of pollen analysis and wood taxa identification were found to “support the model of different environmental zones corresponding with the different elevation zones at Kealakehe” (O’Hare and Goodfellow 1994:ii). The majority of the habitation and agricultural features in the project area were dated to AD 1400-1850.

4.5.2.11 Donham 1990c

Also in 1990, PHRI reported on an AIS conducted on 1,100 acres of Queen Lili‘uokalani Trust lands in Keahuolū overlapping portions of both the Mauka and Makai Sections of the current project area (Donham 1990c; see Figure 11). The survey fieldwork consisted of an aerial reconnaissance and 100%-coverage pedestrian survey. A total of 239 sites comprising over 1,810

individual features were documented. Two of the sites, SIHP # -00002 (Māmalaohoa Trail) and SIHP # -07276 (the Kuakini Wall) had been previously recorded and assigned site numbers; a number of additional sites initially documented by Ching (1978) *makai* of Queen Ka‘ahumanu Highway were likely confirmed but were assigned new SIHP numbers as correlation proved difficult. The 237 new SIHP designations included SIHP #s 50-10-[27 or 28]-13255 through -13491. Seven sites identified by Donham 1990c (and 1990b) are in proximity to the southern portion of the Mauka Section of the current project area (see Table 10): SIHP #s -00002, -13315, -13321, -13326 through -13328, and -13482 (see Table 10). Thirteen sites identified by Donham (1990c) are in proximity to the Makai Section of the project area: SIHP #s -13284, -13286, -13288 through -13298, and -13353 (see Table 10). Predominate feature types are listed as *pāhoehoe* excavations, rock mounds, and modified blisters and outcrops. An agricultural function is assigned to 85-90% of all identified features. Other functional types included temporary habitation, transportation, aquaculture, water collection, ceremony, cave shelters, and burials. Several charcoal samples were submitted for radiocarbon dating, indicating possible occupation as early as the mid-fifteenth century. Eighty-four sites were recommended for no further work; data recovery was recommended for 123 sites; the remainder were recommended for preservation upon further data collection or “as is” (Donham 1990c:ii).

4.5.2.12 Borthwick and Hammatt 1992a

In 1992, CSH conducted an archaeological assessment (AIS with negative finds) for the proposed Kealakehe Sewer Force Main and Pump Station, comprising an inventory-level surface survey and review of pertinent literature (Borthwick and Hammatt 1992a). The study area, which consisted of a 100-ft-wide, 9,300-ft-long force main corridor and rectangular 1-acre pumping station, overlaps the Makai Section of the current project area along the proposed R-1 line extending to Old Kona Airport Park (see Figure 11). The survey documented ten previously recorded sites: two caves and a petroglyph not assigned SIHP numbers and located within the *mauka* portion of Old Kona Airport Park; and SIHP #s -13266, -13291 through -13294, -13296, -13298 recorded by Donham 1990c, which generally represent quarrying, agricultural, and temporary habitation complexes. Four sites were newly recorded: SIHP #s -17167 and -17168 (modified sink shelters), -17169 (modified blister shelter), and -17170 (clearing mounds). Of the 14 documented sites, all are described as pre-Contact in age except for SIHP # -17170 which is an historic-era site. Six of the 14 sites are in proximity to the Makai Section of the current project area (SIHP #s -13291, -13292, -13294, -13298, -17168, and -17169) (see Section Table 10). Six sites were recommended for no further work, one was recommended for subsurface testing, and the remainder were recommended for preservation.

4.5.2.13 Borthwick and Hammatt 1992b

Also in 1992, CSH conducted a field inspection with an associated preservation plan for a proposed golf course in the Kealakehe Planned Community project area, slightly overlapping the Mauka Section of the current project area (Borthwick and Hammatt 1992b; see Figure 11). The study was intended to confirm sites previously documented by Donham (1990a) and/or Burgett and Rosendahl (1992) in the area and document any newly discovered sites. Ten previously recorded sites comprising trails, *ahu*, and agricultural features were confirmed (SIHP #s -00002, -13193 through -13198, -13201, -16003, and -16025) and two sites were newly recorded and assigned as SIHP #s -15537 (lava tube cave) and -15538 (terrace). Three sites (SIHP #s -00002,

-13194, and -13195) are within the current project area (see Table 10). The preservation plan component of the study recommended preservation measures for three trail sites (SIHP #s -00002, -13194, and -13197).

4.5.2.14 Borthwick et al. 1993, Barr et al. 1994

In 1993, CSH undertook an archaeological reconnaissance for the proposed Kealakehe Parkway Extension (Borthwick et al. 1993). The project area comprised four discrete areas including an interchange along Queen Ka‘ahumanu Highway, an area of alternative road alignments in *mauka* Kealakehe and Honokōhau, an area where the two *mauka* road alignments are converged, and an area near the Palani Road and Māmalahoa Highway intersection in *mauka* Honokōhau. Of these, only the proposed interchange area is in proximity to the current project area, along the Mauka Section (see Figure 13). Forty-four previously identified and 43 newly identified sites were documented, comprising pre-Contact and historic habitations, lava tubes, *heiau*, and both confirmed and possible burial sites. Agricultural features were typically not documented though they were commonly present, particularly in the more *mauka* areas. Sites identified in proximity to the current project area included SIHP #s -00002 and -13194 (see Table 10), the latter noted to be bisected by SIHP # -00002 and Queen Ka‘ahumanu Highway. Many of the documented sites were recommended for either data recovery or preservation.

The following year, CSH conducted an AIS for the Kealakehe extension project (Barr et al. 1994). The AIS largely overlapped the 1993 reconnaissance project area, with the exception of the alternative road alignments which had been redrawn. Like the 1993 reconnaissance project area, only the proposed interchange along Queen Ka‘ahumanu Highway is in proximity to the current project area (see Figure 13). A total of 83 sites were documented, of which 50 were previously recorded comprising a wide variety of site types. Almost all the sites were documented in the *mauka* road alignment areas, with only previously identified SIHP #s -00002 and -13194 in proximity to the current project area (see Table 10). Eight charcoal samples were submitted for radiocarbon dating. Age ranges were generally found to be within the late prehistoric to late historic time periods (i.e., 1600s to 1890s), though one sample collected from a lava tube yielded a date range of AD 1439-1693 at 83% probability (Barr et al. 1994:248). Sixty sites were recommended for data recovery, seven sites were to be preserved, and no further work was warranted for the remaining 16 sites (Barr et al. 1994:i).

4.5.2.15 Henry and Graves 1993, Wolforth 1999

In 1993, PHRI undertook a Phase 1 AIS, comprising surface site identification only, for the Keahole-Kailua 69kV Transmission Line project located along the Queen Ka‘ahumanu Highway and Kawiwi Street ROW (Henry and Graves 1993). The project area corridor ranged from 50-100 ft wide and extended from Keahuolū to Kalaoa Ahupua‘a, overlapping the Mauka and Northern Sections of the current project area (see Figure 13). The Phase 1 survey conducted 100% pedestrian coverage within previously unsurveyed areas; in the portions of Kealakehe and Keahuolū previously surveyed by Donham (1990a and c), the survey work focused on confirming previously documented sites. The Phase 1 survey documented 25 sites comprising 60 component features. Of these, five were previously identified, including SIHP #s -00002 (Māmalahoa Trail), -06432 (*ahupua‘a* boundary wall), -13194 (trail), -13195 (trail), and -13334 (complex). The 20 newly identified sites were assigned as SIHP #s -15314 through -15333. The 25 documented sites represented a wide veriety of feature types. Assessments of function included agriculture, marker,

transportation, boundary, habitation, quarry, storage, and indeterminate. Sites indicated in proximity to the current project area include SIHP #s -00002, -13194, and -13195 in the Mauka Section and SIHP # -15329 located just northwest of the Northern Section (see Table 10). A significant amount of prior disturbance was noted in the project area, including an access roadway extending along most of the transmission line corridor and modern industrial and agricultural developments.

Several years later, PHRI conducted archaeological monitoring for the Keahole-Kailua 69kV Transmission Line installation, once again overlapping the Mauka and Northern Sections of the current project area (Wolforth 1999; see Figure 13). The monitoring involved inspection of 31 previously documented sites (including those documented by Henry and Graves 1993 in proximity to the current project area) and documentation of eight newly recorded sites: SIHP #s -21252 (filled lava blister), -21253 through -21255 (modified outcrops), -21256 (cupboards and modified lava tube), -21257 and -21258 (trails), and -21756 (boundary wall). Portions of the approximately 3.3-km section of SIHP # -00002 within the transmission line project area were mapped and described in detail—possibly including parts of the site within the current project area. Wolforth (1999:ii) concluded that “The relationship of the Mamalahoa Trail to other sites and trails suggests that Mamalahoa Trail was built over, and incorporates parts of a prehistoric trail.”

4.5.2.16 Walsh and Hammatt 1995, Hammatt et al. 1999

In 1995, CSH undertook an AIS for a proposed expansion of the Queen Ka‘ahumanu Highway ROW, located between Palani Road and the Keahole Airport entrance road (Walsh and Hammatt 1995). The project area corridor averaged 309 ft wide and extended from Keahuolū to Kalaoa, overlapping the Mauka and Northern Sections of the current project area (see Figure 13). A total of 17 sites comprising 29 individual features were identified, including five previously documented sites (SIHP #s -00002, -02238, -06432, -13194 and -15324) and 12 newly identified sites (SIHP #s -19943 through -19954). Of these, only SIHP #s -00002 and -13194 are in proximity to the current project area (Mauka Section; see Table 10). Formal site and feature types included trails, modified outcrop, *ahu*; walls, mounds, petroglyphs, enclosures, and a road, terrace alignment, ash deposit, midden scatter, and *pāhoehoe* excavation. Functional types included transportation, temporary habitation, boundary/ranching, markers, symbolism, quarry, agriculture, and indeterminate. Three features were tested for human remains; none were found. Eight sites were recommended for data recovery, four were recommended for preservation following data recovery, and five were recommended for no further work.

4.5.2.17 Colin et al. 1996

In 1996, CSH conducted an AIS of a 224.43-acre parcel in Kaloko and Kohanaiki Ahupua‘a bounding the *mauka* shoulder of Queen Ka‘ahumanu Highway (Colin et al. 1996). The study area overlapped the Northern Section of the current project area (see Figure 12). Fifty-five sites comprising 93 features were documented, including two previously identified sites (SIHP #s -13493 and -15324) and 53 newly identified sites (SIHP #s -20696 through -20722 and -20724 through -20749); six of these are in proximity to the Northern Section of the current project area (SIHP #s -13493, -20722, -20744, -20745, 20726, and -20728; see Table 10). The documented features comprised a wide variety of feature types associated with agriculture, habitation, transportation, boundary, and resource collection. Two charcoal samples were obtained from subsurface excavations that yielded date ranges falling between AD 1670-1945. Forty sites were

recommended for data recovery, ten were recommended for preservation, one site was recommended for both data recovery and preservation, and no further work was recommended for the remaining four sites.

4.5.2.18 Rechtman and Escott 2002

In 2002, Rechtman Consulting conducted an AIS of approximately 40 acres for an extension of the Kealakehe WWTP, overlapping the Makai Section of the current project area (Rechtman and Escott 2002; see Figure 11). The survey documented eight sites within and adjacent to the 2002 project area, of which three were previously identified (SIHP #s -23020, *pāhoehoe* excavation; -23021, lava tube; and -23023, trail segment) and five were newly identified. The five new sites included SIHP #s -23549 (C-shaped enclosure), -23550 and -23552 (*pāhoehoe* excavations), -23551 (modified lava blister), and -23554 (trail segment). All eight sites are located within or in proximity to the Mauka or Makai Sections of the current project area (see Table 10); all were recommended for no further work (Rechtman and Escott 2002:22).

4.5.2.19 Haun and Henry 2006

In 2006, Haun and Associates undertook an AIS of approximately 370 acres (Haun and Henry 2006). The survey examined two discrete areas in Kealakehe Ahupua‘a, and a corridor extending through both Kealakehe and Keahuolū Ahupua‘a; the corridor crossed the Makai Section of the current project area, terminating adjacent to the Queen Ka‘ahumanu Highway ROW and the Mauka Section, and another portion of the 2006 project area also abutted the highway ROW and the Mauka Section of the current project area (see Figure 11). A total of 127 sites comprising 432 features were documented. Of these, 23 sites were previously identified (with SIHP designations from multiple different studies) and 104 sites were newly identified (SIHP #s -25549 through -25653). Documented feature types included *pāhoehoe* excavations, *ahu*, alignments, overhangs, lava blisters, enclosures, terraces, platforms, trails, walls, pavements, midden scatters, mounds, sand areas, filled cracks, lava tubes, C-shapes, a metal tower, and an upright. The distribution of the features and their associated functions were found to be as expected following elevational/zonal settlement patterns. Forty-seven sites were recommended for data recovery, 27 for preservation, and 54 for no further work. SIHP #s -07704, -23033, -25643, -25556, -25557, and -25558 are indicated to be within or in close proximity to the current project area (see Table 10).

4.5.2.20 Simonson et al. 2010

In 2010, CSH prepared a literature rievew and field inspection report for the 117-acre Old Kona Airport Park, which had transferred ownership from the State of Hawai‘i to the County of Hawai‘i in 2009 and was renamed “Kailua Park” (Simonson et al. 2010). The 2010 project area minimally overlaps the southern terminus of the Makai Section of the current project area (see Figure 11). The field inspection effort confirmed numerous previously identified sites (only some of which had been previously assigned SIHP designations) and documented four new sites (which were not assigned SIHP designations). A number of other previously identified sites were not confirmed. None of the identified sites are in proximity to the current project area.

4.5.2.21 Wilkinson et al. 2011

In 2011, CSH prepared a literature review and field inspection of approximately 70 acres in Keahuolū through Honokōhau Ahupua‘a for a proposed judiciary site (Wilkinson et al. 2011). The

project area comprised seven non-contiguous candidate development sites; of these, one candidate site in Kealakehe overlapped the Mauka Section of the current project area. The field inspection effort confirmed 11 previously identified sites (SIHP #s -05011, -13179, -13180, -13308, -13323, -26291, -26292, -26303, -26307, -26308, and -27855). A similar number of previously identified sites expected within the project area could not be confirmed; this result was attributed to inaccuracies in previous site distribution maps and typically low ground visibility. In addition, several new features were observed (but not assigned SIHP designations), including modified outcrops, *pāhoehoe* and *‘a‘ā* excavations, possible trails, a lava tube opening, a bulldozed concentration of waterworn stones and artifacts, and a potentially historic fence line. One previously recorded site (SIHP # -13194, trail) was indicated in proximity to the current project area (see Section Table 10); the documented portion of SIHP # -05011 was located well upslope.

4.5.2.22 Monahan et al. 2012, Wilkinson et al. 2017

In 2012, CSH completed an AIS report for the Queen Ka‘ahumanu Highway Widening Phase 2 project, located between Kealakehe and Kalaoa Ahupua‘a and overlapping the Northern Section of the current project area (Monahan et al. 2010; see Figure 13). The survey documented 75 sites, including 20 previously documented sites (with SIHP designations from multiple different studies) and 55 newly recorded sites. Feature types included trails, *pāhoehoe* and *‘a‘ā* excavations, mounds, *ahu*, walls, modified outcrops, petroglyphs, lava tubes, enclosures, leveled areas, filled crevices, modified depressions and blisters, and a burial platform. Of these, SIHP #s -10714, -28794, and -29344 are indicated in proximity to the current project area (see Table 10). Another feature indicated in proximity was initially assigned as SIHP # -28796, but was ultimately absorbed as a component of SIHP # -10714, since it is a small cairn marking the Feature B trail routes. As such, the report does not contain a separate site description for SIHP # -28796. Only two of the 75 documented sites were recommended for no further work; the remainder were recommended for data recovery, preservation, and/or relocation.

In 2017, CSH prepared a supplemental AIS addressing an expansion of the 2012 project area (Wilkinson et al. 2017). The revised project area overlapped the Northern and Mauka Sections of the current project area, along the Hina Lani Street ROW and in the highway ROW surrounding the Kealakehe Parkway intersection (see Figure 13). The supplemental survey documented two segments of SIHP # -00002 (Māmalahoa Trail) adjacent to Kealakehe Parkway, one of which is located within the Mauka Section of the current project area (see Table 10). Both documented portions of the trail were recommended for preservation.

4.5.2.23 Reeve et al. 2012

In 2012, Pacific Legacy, Inc. completed an AIS report for the 628-acre conservation portion of QLT lands in Keahuolū Ahupua‘a, overlapping the Makai Section of the current project area (Reeve et al. 2012; see Figure 11). The survey documented 322 archaeological sites comprising 464 component features. Of these, a number were found to correspond to sites documented by Ching (1978) and Folk (1980); correlation issues are addressed in the report. The report provides somewhat contradictory information on the total numbers of previously recorded vs. newly recorded sites. New site number designations included SIHP #s -27273 through -27419, -27421 through -27542, and -27559 through -27569. The designated sites did not include an additional 139 *pāhoehoe* excavations documented throughout the project area, which were attributed to possible quarrying activites (Reeve et al. 2012:i). The documented feature types were as expected

for the area and were largely assessed as pre-Contact in age. Forty-eight of the sites documented by Reeve et al. (2012) are indicated to be located within or in proximity to the Makai Section of the current project area (see Table 10).

Site distribution indicated two distinct zones of land use based on elevation and distance from the coast: a coastal zone "which stretches from the high surf line inland for approximately 200 meters" containing an abundance of archaeological features; and an inland area characterized by a markedly lower density of archaeological features, with almost a complete absence of sites in the inlandmost portions of the study area (Reeve et al. 2012:37–38). Excavations at coastal habitation sites

> yielded an abundance of cultural material including traditional artifacts and food remains. The presence of fishhooks and other fishing gear within the artifact assemblage at these sites, as well as the abundance of shell fish and fish remains recovered from them, indicates the close relationship between the residents of coastal Keahuolū and the sea. [Reeve et al. 2012:i]

Eight charcoal samples collected from coastal habitation sites were subjected to radiocarbon analysis. While most of the results suggested late pre-Contact to early historic occupation, two samples indicated possibility of occupation from the sixteenth century. The relatively late settlement dates are suggested to support "ethnohistoric documentation indicat[ing] that the main loci of settlement within coastal Keahuolū was toward the southern portion of the *ahupua‘a* in the area now occupied by the Old Kona Airport Park" (Reeve et al. 2012:139). All the documented sites were recommended for either preservation or data recovery.

Section 5 Community Consultation

5.1 Introduction

Throughout the course of this assessment, an effort was made to contact and consult with Native Hawaiian Organizations (NHO), agencies, and community members including descendants of the area, in order to identify individuals with cultural expertise/and or knowledge of the *ahupua‘a* where the project areas are located. CHS initiated its outreach effort in June 2017 through letters, email, telephone calls, and in-person contact. CSH is currently in the process of completing consultations.

5.2 Community Contact Letter

Letters (Figure 14 and Figure 15) along with a map and aerial photograph of the project were mailed with the following text:

> At the request of Wilson Okamoto Corporation (WOC), on behalf of the County of Hawai‘i – Department of Environmental Management (DEM), Cultural Surveys Hawai‘i, Inc. (CSH) is conducting a cultural impact assessment (CIA) for the proposed Kealakehe Wastewater Treatment Plant (WWTP) Master Plan EIS; Kohanaiki, Kaloko, Honokōhau, Kealakehe, Keahuolū Ahupua‘a; North Kona District; Hawai‘i Island; Multiple TMKs.
>
> The County of Hawai‘i – DEM is proposing improvements to the Kealakehe WWTP that will provide additional treatment to produce R-1 standard water suitable for reuse in accordance with the State of Hawai‘i, Department of Health Reuse Guidelines. In addition, treated wastewater in excess of demand for reuse will be further treated through a proposed onsite subsurface flow wetlands and then conveyed to a proposed offsite soil aquifer treatment (SAT) facility for even further treatment and disposal.
>
> The recycled water will be used to irrigate a proposed landscaped buffer parcel surrounding the WWTP and the DEM also proposes to construct underground recycled water transmission pipes to properties that plan to utilize the recycled water. These properties include the Old Kona Airport Park and the Queen Lili‘uokalani Trust (QLT) Children's Center. A recycled water transmission line is also proposed from the WWTP to Queen Ka‘ahumanu Highway where it will turn north within the highway right-of-way and connect to a recycled water transmission pipe that is being constructed in the highway by the State Department of Transportation for the DEM as part of its Queen Ka‘ahumanu Highway Widening Project. That pipe will extend from the connection at the Kealakehe Parkway intersection to the driveway entrance of the Kohanaiki Golf and Ocean Club, which plans to use the recycled water for irrigation. At the intersection of Hina Lani Drive, a new transmission pipe will branch off *mauka* (towards the mountain) along Hina Lani Drive to an abandoned Department of Water Supply reservoir, which will be converted to store recycled water.

Cultural Surveys Hawai'i, Inc.
Archaeological and Cultural Impact Studies
Hallett H. Hammatt, Ph.D., President

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Job code: KEALAKEHE 5 nishihara@culturalsurveys.com cspencer@culturalsurveys.com www.culturalsurveys.com

June 2017

Aloha,

At the request of Wilson Okamoto Corporation (WOC), on behalf of the County of Hawai'i – Department of Environmental Management (DEM), Cultural Surveys Hawai'i, Inc. (CSH) is conducting a cultural impact assessment (CIA) for the proposed Kealakehe Wastewater Treatment Plant (WWTP) Master Plan EIS; Kohanaiki, Kaloko, Honokōhau, Kealakehe, Keahuolū Ahupua'a; North Kona District; Hawai'i Island; Multiple TMKs.

The County of Hawai'i – DEM is proposing improvements to the Kealakehe WWTP that will provide additional treatment to produce R-1 standard water suitable for reuse in accordance with the State of Hawai'i, Department of Health Reuse Guidelines. In addition, treated wastewater in excess of demand for reuse will be further treated through a proposed onsite subsurface flow wetlands and then conveyed to a proposed offsite soil aquifer treatment (SAT) facility for even further treatment and disposal.

The recycled water will be used to irrigate a proposed landscaped buffer parcel surrounding the WWTP and the DEM also proposes to construct underground recycled water transmission pipes to properties that plan to utilize the recycled water. These properties include the Old Kona Airport Park and the Queen Lili'uokalani Trust (QLT) Children's Center. A recycled water transmission line is also proposed from the WWTP to Queen Ka'ahumanu Highway where it will turn north within the highway right-of-way and connect to a recycled water transmission pipe that is being constructed in the highway by the State Department of Transportation for the DEM as part of its Queen Ka'ahumanu Highway Widening Project. That pipe will extend from the connection at the Kealakehe Parkway intersection to the driveway entrance of the Kohanaiki Golf and Ocean Club, which plans to use the recycled water for irrigation. At the intersection of Hina Lani Drive, a new transmission pipe will branch off *mauka* (towards the mountain) along Hina Lani Drive to an abandoned Department of Water Supply reservoir, which will be converted to store recycled water.

In future phases, underground transmission pipes and another new storage tank will be constructed in road rights-of-ways and easements for distribution of recycled water to other users.

The purpose of the CIA is to gather information about the project area and its surroundings through research and interviews with individuals that are knowledgeable about this area. The research and interviews assist us when assessing potential impacts to the cultural resources, cultural practices, and beliefs identified as a result of the planned project. We are seeking your *kōkua* (assistance) and guidance regarding the following aspects of our study:

- **General history and present and past land use of the project area.**

Figure 14. Page one of the community consultation letter

KEALAKEHE 5 – CIA for the Kealakehe WWTP

Page 2

- **Knowledge of cultural sites –for example, historic sites, archaeological sites, and burials.**
- **Knowledge of traditional gathering practices in the project area, both past and ongoing.**
- **Cultural associations of the project area, such as legends and traditional uses.**
- **Referrals of *kūpuna* or elders and *kama'āina* (Native-born) who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua'a* (traditional land division extending from the mountains to the sea) lands.**
- **Any other cultural concerns the community might have related to cultural practices within or in the vicinity of the project area.**

Please contact Nicole Ishihara (nishihara@culturalsurveys.com) and/or Chantellee Spencer (cspencer@culturalsurveys.com), at (808) 965-6478.

Me ka ha'aha'a,

Nicole Ann Nāhōkūlaniahiahi Ishihara
Project Director & Cultural Researcher

and

Chantellee Konohia Spencer
Cultural Researcher

Figure 15. Page two of the community consultation letter

In future phases, underground transmission pipes and another new storage tank will be constructed in road rights-of-ways and easements for distribution of recycled water to other users.

The purpose of the CIA is to gather information about the project area and its surroundings through research and interviews with individuals that are knowledgeable about this area. The research and interviews assist us when assessing potential impacts to the cultural resources, cultural practices, and beliefs identified as a result of the planned project. We are seeking your *kōkua* (assistance) and guidance regarding the following aspects of our study:

- **General history and present and past land use of the project area.**
- **Knowledge of cultural sites –for example, historic sites, archaeological sites, and burials.**
- **Knowledge of traditional gathering practices in the project area, both past and ongoing.**
- **Cultural associations of the project area, such as legends and traditional uses.**
- **Referrals of *kūpuna* or elders and *kama‘āina* (Native-born) who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua‘a* (traditional land division extending from the mountains to the sea) lands.**
- **Any other cultural concerns the community might have related to cultural practices within or in the vicinity of the project area.**

In most cases, two or three attempts were made to contact individuals, organizations, and agencies.

5.3 Community Contact Table

Table 11 consists of various agencies and community members that were contacted for this project. CSH contacted a total of 37 parties including OHA, SHPD, the County of Hawai‘i, other agencies, NHOs, and knowledgeable community members. Of the 37 parties consulted, a total of eight people/agencies responded to the consultation letter. Five people participated in formal interviews, however, only four were authorized to be used in this study. CSH initiated its outreach effort in June 2017 through March 2018 through letters and emails. Below is a preliminary list of individuals who shared their *mana‘o* and *‘ike* about the project areas and their corresponding *ahupua‘a*:

Table 11. Community contact table

Name	Affiliation	Notes
Carlson, Carl	Former General Manager of Huehue Ranch	Letter and figures sent via USPS 26 June 2017

Name	Affiliation	Notes
		Replied via email 19 July 2017: *“Thank you for your request for information about the project area. I don‘t believe that I have any information that would be of value to you. FYI, I have a new mailing address.”* (**Address updated in database**)
Cayan, Phyllis	SHPD Intake Specialist	Letter and figures sent via email 31 July 2017 Replied via email 31 July 2017: “*Aloha, your submittal is in the queue for review by the Oahu Burials Specialist.* *Kindly allow 30-45 working days for review completion. A copy of the review letter will be emailed to you by the Reviewer”*
County of Hawai‘i – Planning Department, Cultural Resources Commission		Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017 Replied via email 16 August 2017, *We note and affirm that the proposed project, as described in your letter, is advocated by both the County General Plan and the Community Development Plan (CDP) encompassing the North Kona and South Kona Districts.* *The General Plan, in its Chapter 11, at sub-section 11.6.4.7.2.(b), sets forth the following “Course of Action” to be taken toward implementing the objectives and policies of the Plan: “Upgrade the Kealakehe Wastewater Treatment Plant to produce tertiary (R-1) quality effluent.”* *The region’s Kona CDP sets forth several relevant policies and actions*

Name	Affiliation	Notes
		regarding wastewater treatment and effluent: *1. "Policy PUB-4.4: Sewer Priorities : The highest priority in expanding the sewer system within the Kona Urban Area [between Keauhou and the Kona International Airport] shall be to service any shoreline properties that do not have access to a public sewer system and then to service lots within approximately 1 mile of the shoreline."* *2. "Action PUB–4.4c: Update the sewerage master plan to service the entire Kona Urban Area with priority to the TODs [CDP-specified "transit-oriented development" nodal centers] and the areas within approximately 1 mile of the shoreline."* *3. "Policy PUB–4.5: Wastewater Treatment and Effluent Reuse. The Kealakehe WastewaterTreatment Plant shall be expanded to accommodate the projected sewage volume from the Urban Area extending south of Hina Lani Street to the Keauhou Wastewater Treatment Plant service area."* *4. "Action PUB–4.5a: Master plan the expansion of*

Name	Affiliation	Notes
		the Kealakehe Wastewater Treatment Plant." *We have no additional comments or suggestions with regard to the particular aspects of your study enumerated in your letter.*
Crabbe, Kamana‘opono	Ka Pouhana, OHA	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Fitzgerald, Robert	Director, Dept. of Parks Rec (Old Airport)	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Flores, Kalani	UH Professor of Hawaiian Lifestyles: Hawaii Community College, UH Center at West Hawaii	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Gmirkin, Rick	Archaeologist, Ala Kahakai National Historic Trail	Rick Gmirkin was present at the project site during our interview with Nicole Lui on 10 October 2017. He shared some *mana‘o* about the project which was summarized and sent to him for review. CSH replied via email 8 November 2017: *Aloha e Rick, I hope things are well with you! Please review the attachment that includes your interview summary. If you have any questions, please do not hesitate to reach out to us!* Rick replied 9 November 2017: *Aloha Chantelle and thanks for sharing. There are some edits that I would recommend. Please give me a*

Name	Affiliation	Notes
		call to set up a time to discuss, 808-430-5213. Mahalo CSH reached out 28 November 2017 via phone, left message. Rick Gmirkin replied via email 6 December 2017: *Aloha Chantelle, Sorry we did not connect. I am in DOT meetings tomorrow but wanted to share with you a report that I had mentioned by Tom Wolforth in 1999 that documents the Mamalahoa trail in your project area. It also includes some known mauka-makai trails. I am off on Friday, Let's try and connect next week. Mahalo and Enjoy.* CSH replied 19 March 2018: *Aloha e Rick! I hope things are well with you! E kala mai for the delayed response but mahalo for forwarding that report for reference!* *I included a piece in your summary referencing that report and we used it as a reference when describing the trails within the area.* *Is there anything else you‘d like to add to your summary? Mahalo for all your kōkua!* CSH reached out to Mr. Gmrikin via email on 11 May 2018: *Aloha Rick!* *I hope things are well with you!* *We‘ve already submitted a draft of the CIA report to the client and we‘ve made edits to submit a final copy. The attached document is your contribution to the report. I know our schedules haven‘t synced up but so far we haven‘t received word from you regarding corrections to your*

Name	Affiliation	Notes
		summary. We are looking to submit the final copy by next week and we‘d like to make sure you‘ve read and approved your summary before including it in the final report. If we do not hear back from you and get your approval, unfortunately we won‘t be able to include your summary in the final report. *Please let me know how I can be of any assistance.* Mr. Gmirkin replied via email 14 May 2018: *That looks fine. Mahalo for reaching out*
Gomes, Stanley		Letter and figures sent via USPS 26 June 2017 Letter returned via USPS 9 July 2017
Greenwell, Kelly	Palani Ranch Family/Farmer	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Greenwell, Patricia	Married to L. Radcliffe Greenwell who managed Kahua and Parker Ranch for over 30 years. Referred by Dr. Soehren.	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Halemau, Karin	Paniolo at Huehue Ranch, Lineal descendant, fisherman	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Kahui, Craig V.	Executive Director, La‘i ‘Ōpua 2020	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Kailiwai, John H.	Kama‘āina of Maka‘eo	Letter and figures sent via USPS 26 June 2017

Name	Affiliation	Notes
		Second round of letter and figures sent via USPS 31 July 2017
Keanaaina, Rev. Norman	Mauna Ziona Church	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Kimitete, Richard		Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Kona Hawaiian Civic Club		Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Kossow, Barbara	Ka Ulu Lauhala O Kona	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Kuali‘i, Melvyn Kaleo		Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017 Replied via email 16 October 2017; *E kala mai ia’u for the late response mahalo a nui for the opportunity to participate in the current (CIA) for the (WWTP) Kealakehe 5 project within the ahupua‘a of Kohanaiki, Kaloko, Honokōhau, Kealakehe, and Keahuolū.* *My connection to the afore mentioned ahupua‘a are both familial and professional, I have worked on both the Kohanaiki and Kaiser projects as a descendant and cultural consultant. I have in the past and are currently working with the Kaloko-Honokōhau NHPS in regards to NAGPRA*

Name	Affiliation	Notes
		consultation process concerning nā iwi kūpuna. *I am interested in any previous archaeological surveys conducted as well as current and or ongoing surveys, and if possible I would like to visit the project sites prior to excavation. My concerns are of possible undocumented Burial Non-Burial, Historical, Cultural, Agricultural, habitation sites, and trails. The possibility of finding sites features and trails mentioned are very high, sites such as these have been documented at Kohanaiki, Kaloko, Honokōhau, Kealakehe, Keahuolū and neighboring ahupua‘a such as ‘O‘oma to the north and Lanihau to south.* *I sincerely apologize for not responding promptly I have been working on several new projects and recently returned home.* *Please don’t hesitate to contact me thank you very much.* *‘o wau nō me ka ha‘aha‘a* CSH responded via email 24 October 2017 discussing availability for an interview but received no reply from community contact
Kunewa, Iris		Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Kunitake, Walter		Letter and figures sent via email 26 June 2017 Second round of letter and figures sent via email 31 July 2017
Lamont, Joan	Community Organizer/ Vice President of Beautification, Kona Outdoor Circle	Letter and figures sent via USPS 26 June 2017

Name	Affiliation	Notes
		Second round of letter and figures sent via USPS 31 July 2017
Lee, Reggie	Lineal descendant with DLNR/ Government Agency	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Lui, Joe and Agnes	Kupuna	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Lui, Nicole	Cultural Descendant/CRC Commisioner	Reached out to CSH via email on Thursday 14 September 2017: *I am writing in regards to the Consultation for the CIA for the Kealakehe WWTP. I am writing to you as a descendant and representative of my ohana past and present. I am not writing as a CRC commissioner.* *My question is in regards to consultation. Will there be a time when we will here from CSH in regards to consultation of the area. As for the other Kupuna who I thought could help they no longer want to be a part of the process. My own mother is 80 and it is sometimes hard for her so we will have to be careful as to where we meet and when we meet. I would need at least a weeks advance notice of when you folks would like to meet with us. Here are my contact info and hope to hear from either of you or Sarah. Sarah should have my contact. Just in case here it is. Please do not give to anyone who claims to know me.* *I will be indisposed next week as I will be in Oahu for conference. Nicole Garcia speaks highly of you Nicole*

Name	Affiliation	Notes
		Nishihara and I hold her word in high regard. I look forward to working with you both and CSH. CSH replied via email 15 September 2017 making arrangements for an interview. CSH reached out again via email 28 September 2017 with possible dates for an interview. Nicole Lui replied 28 September via email confirming October 10 for interview. CSH emailed Nicole Lui 8 November 2017: *Aloha e Nicole, I hope things are well with you! Please review the attachment that includes your interview summary. If you have any questions, please do not hesitate to reach out to us!* Nicole replied via email 10 November 2017: *Welina, How much time do I have to review this and make some changes. I have a paper to write for school and because I little bit old I really need to focus on what I am doing and so if I don‘t need to rush on this I will feel better reviewing the interview summary at least by this Sunday and make minor changes.* CSH replied 10 November 2017: *Please do not rush. This Sunday will be perfect. Mahalo for all your kōkua.* Nicole Lui replied 14 November 2017: *Hope you don’t mind but I did add and I did some embellishing to the content. I did not lie about anything I*

Name	Affiliation	Notes
		just added and I did correct some of the content as well other then that it was fine. Please check the grammer and the sentence structure as I am not so good at that. I hope it is okay and that I only meant to reflect my ohana and our history and our love for the aina and its stories and connections to the remaining people of the aina kaha. Hope to meet you someday again. CSH replied 15 November 2017: *Aloha e Keaka! I will work on the edits and send you a new copy to review.* *Mahalo for all your kōkua!* CSH replied 27 November 2017: *Aloha e Keaka, I have revised your interview summary to include the notes you mentioned. Please review and let me know if this is okay to submit for the CIA. Also, I have attached a few pictures from that huaka‘i that I‘d like to include in the report as well... please let me know if the pictures are okay. Mahalo a lehu!* Nicole Lui replied 27 November 2017: *Aloha Chantellee, I read it through and there was a little change that I needed to make it was a little hemahema. The part about Papawai changed to Pawai and then now called Halepa’o. Please if you don’t get it let me know and I will resend. Other then that it is great. Mahalo piha no na kii.* Nicole Lui replied 4 January 2018: *Aloha Chantelle, Did I send the minor changes I made to the revised interview. There were a few changes*

Name	Affiliation	Notes
		that needed to be made again. Please let me know that I sent it to you I thought I did because Papawai was known to us as Halepa’o. I need to make sure I sent my revisions of the second revised interview. M *I hope I making sense.* CSH replied 8 January 2018: *Aloha Keaka & Hau‘oli Makahiki Hou!* *Yes, I received your updated revisions to the interview summary. Attached to this email is the newly revised summary. Please look through at your leisure and let me know if these changes match your revisions.* Nicole Lui replied via email 22 February 2018: *Welina e Chantellee, This is in regards to persons knowledgeable about the area of Kanoenoe and other wahi. Kupuna Johnny Kailiwai is no longer with us he hala as of last year. Just to let you folks know. I apologize if I gave his name I did not find out until a month ago. He was very private.* CSH replied 22 February 2018: *Ke aloha nō i ka ‘ohana Ka‘iliwai. E ‘auamo kākou i ke kaumaha.* CSH replied 28 February 2018: *Aloha e Keaka, I hope all is well with you and your ‘ohana! The attached image is a copy of the project figure that note the features you mentioned during your interview. Please review and verify if these markers are correct. Mahalo for all your kōkua! Mālama pono!*

Name	Affiliation	Notes
		Nicole Lui replied 28 February 2018: *Aloha Chantellee, I am so sorry that I did not have enough time to really show you folks where several of the places once were and where specifically some of the places are at. How can I help you make corrections. The map is not entirely correct and I want to help correct it. I am not computer literate when it comes to these type of map things. Please let me know how I can show you where and where.* CSH replied 1 March 2018: *Yes of course! The most convenient for you I think is if I print out a map and mail it over to you, have you actually draw on the map and make corrections then have you mail it back to us. Once we receive it, we can send it back to our GIS Department and have them add in those corrections. Does that sound good to you? I would just need your physical address.* Nicole Lui replied 9 March 2018: *E Kala mai Chantellee. I have not yet made the corrections to the map. I apologize. I will try and do it today. It is always busy for me and I sometimes forget until to late. Mahalo for your time and understanding. What is the time frame for you to get everything in?* CSH replied 9 March 2018: *Aloha e Keaka, Mahalo for your kōkua. If I needed to give a time frame, I‘d say by end of next week. This will give our mapping department some time to add your corrections to the*

Name	Affiliation	Notes
		map. I completely understand about being so busy, hehe. I lā maika‘i! CSH replied 9 March 2018: *E kala mai e Keaka, I think what was gonna happen is, I would mail you a hard copy of the map to make corrections and you‘d mail it back to me. I was just waiting on a physical address from you. I have the map ready to be sent out. Let me know, mahalo.* Nicole Lui replied 9 March 2018: *Sugars I am so sorry I forgot. I apologize. Here is my address:* *76-6217 Lehua Rd* *Kailua-Kona, HI 96740* CSH sent out hard copy of map on 12 March 2018. Waiting on reply Received corrections to map via USPS on 20 March 2018
Marks, Jerome	‘Aha Moku Rep, Kohala to South Kona	Letter and figures sent via email 26 June 2017 Second round of letter and figures sent via email 31 July 2017
Marquez, David	Kealakehe Ahupua‘a 2020	Letter and figures sent via USPS 26 June 2017 Letter returned via USPS 9 July 2017
Medeiros Jr., Clarence	Lineal Descendant	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Nakahashi, Ikaika	Cultural Historian, Hawai’i Island	Letter and figures sent via USPS 26 June 2017 Replied via email 25 July 2017: *“Mahalo for contacting me regarding the CIA for the proposed Kealakehe*

Name	Affiliation	Notes
		Wastewater Treatment Plant. I recommend CSH utilize the media (e.x. Hawai‘i Tribune-Herald, West Hawai‘i Today, etc.) to solicit additional information for this CIA. I recommend CSH to contact and meet with native tenants and people that currently live or previously lived in Kohanaiki, Kaloko, Honokōhau, Kealakehe, Keahuolū, Island of Hawai‘i for information about the cultural customs and practices for this CIA."
Nazara, Cynthia	Cultural Research Consultant	Cynthia Nazara was present at the project site during our interview with Nicole Lui on 10 October 2017. She shared some *mana‘o* about the project which was summarized and sent to her for review. CSH replied via email 8 November 2017: *Aloha e Cynthia, I hope things are well with you! Please review the attachment that includes your interview summary. If you have any questions, please do not hesitate to reach out to us!* Cynthia called CSH on 8 December 2017 to speak with the archaeologists working on the project and also stated she did not receive word from CSH since our meeting at the project site. CSH sent email on 8 December 2017: *Aloha e Cynthia, I hope things are well with you! Please review the attachment that includes your interview summary. If you have any questions, please do not hesitate to reach out to us!* CSH sent email 19 March 2018:

Name	Affiliation	Notes
		Aloha e Cynthia, I hope things are well with you! We haven‘t received a reply yet regarding your interview summary and are hoping we can get that finalized. If you have any questions, please do not hesitate to contact us. Cynthia replied 19 March 2018: *Aloha I really don't have anything more to say except what I sent previously. Mahalo* CSH replied 19 March 2018: *Mahalo for your reply! I don‘t think I received a previous reply from you regarding your interview summary but if you got a chance to review the document and everything looks okay, we‘ll include it in the draft CIA.* Cynthia replied 19 March 2018: *Mahalo*
Pai, Mahealani	Cultural Specialist/Kamehameha Investment Corp	Letter and figures sent 5 September 2017 Interview confirmed 18 October 2017 in Kahalu‘u. Interview summary hand delievered 8 November 2017 CSH followed up 29 December 2017: *I‘m just following up with you on the status of your interview and wondering if you got a change to look thru it yet. We are still waiting on a few others to review their summary but hoping to wrap up this portion of the report by the end of January."* Uncle Mahealani replied 29 December 2017 via email: *"Kala mai for my delayed response. I need to make some corrections and if*

Name	Affiliation	Notes
		you send me in word doc, then I could go and edit those and get it back to you." CSH immediately replied: *Mahalo for the quick reply! Document is attached.* CSH reached out 28 February 2018: *I hope all is well with you and your 'ohana! The attached image is a copy of the project figure that note the features you mentioned during your interview. Please review and verify if these markers are correct. Mahalo for all your kōkua!* CSH emailed 28 February 2018: *Aloha e Uncle Mahealani, E kala mai, just another thing... have you had the chance to review your interview summary yet?* *I understand we all have kuleana and I don't wanna rush because we want your summary to be as accurate as possible. Just doing a status check! :) I hope school is going smooth too! Mahalo for your kōkua!* CSH reached out on 19 March 2018: *Aloha e Uncle Mahealani! I hope this email finds you in good spirits. We are nearing the date to submit the draft CIA and was wondering if you had a chance to look thru or edit your interview summary yet. Please let me know if you have any questions. Mahalo for all your kōkua!*
Reveira, Teresa	Makani Hou o Kaloko-Honokohau	Letter and figures sent via USPS 26 June 2017 Letter returned via USPS 9 July 2017

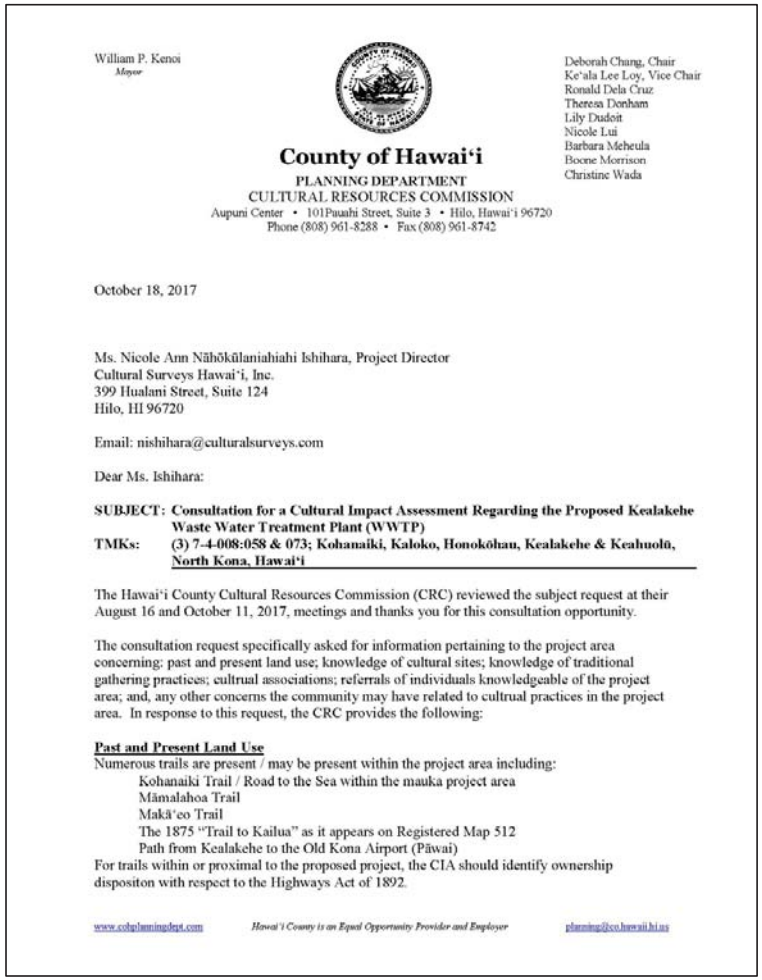
Name	Affiliation	Notes
Reeves, Hannah	Kupuna/Community Organizer	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Tam Sing, Tracy	DLNR, Division of State Parks	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Van Gieson, George	Cultural & Historic Sites	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017 Replied via email 2 September 2017, *Sorry for the delayed response...computer issues..both of them...my only area of concern wold be the remote possibility of leakage at the Hina Lani street project area getting to the Honokohau fish pond, that being an issue depending on any chemicals introduced. Otherwise I have objections; re-using water in Kona is a necessity at this point in time. Thanks for contact me... Sorry I meant the Kaloko fish pond.* CSH replied 5 September 2017: *Aloha and thank you so much for the reply. Outside of your concern with Kaloko fishpond, is there any other mana'o you'd like to share?* *If you'd like, we could arrange a very casual talk-story session if you have any other information to share.* *If not, I thank you very much for your time and we'll include your reply in the report.* *Please let me know.* Replied 5 September 2017:

Name	Affiliation	Notes
		my area of interest was the Holua....and the chief's dwelling near the ponds....and the burials.....would love to talk to you....any ohana to Fred or John..?? CSH replied 5 September 2017: *What's a good day/time for you? I could come out to meet you and we can talk story, I'd probaby be accompanied by my Project Director, Nicole.* *We could also do it over the phone if that's more convenient for you. Just let me know what works. Unfortunately I'm not too familiar with the Spencer side of my 'ohana. My father grew up in O'ahu, Waimanalo to be exact and he was actually adopted by a Spencer.* *Minamina...I wish I knew more about my Spencer side. Please let me know what works for you.* George replied 5 September 2017: *i'm good from about 10 am on till 4 ish.....retired fire captain and am always here on the ranch...call in case something comes up..895 2940* CSH replied 12 September 2017: *Aloha George, I hope you're doing well! Would you be avaiable to talk-story with us on Thursday, October 28? Myself along with my Project Director are available that day and we can meet you at around 10am if that works.* *Please let me know.* George replied 2 October 2017:

Name	Affiliation	Notes
		Catching up...so we are going to meet on the 17th up here..?? CSH replied 2 October 2017: *Good Morning! Yes!, I will meet you on Tuesday the 17th at 10am. Does that time work for you?* Interview confirmed on 17 October 2017 at his home in Volcano. George replied 19 October 2017: *Thank you for taking the time to speak with me. I so enjoyed your company, and your interest in our culture. If I may be of help at any time, feel free to contact me..* *Ahui ho...* CSH replied 24 October 2017: *Aloha George, I enjoyed your company as well! I will definitely keep you on my radar for any future projects. Stay dry! Malama Pono.* CSH reached out to Mr. Van Gieson but email has been discontinued, called and left message but no response
Tyler, Curtis	Resident/Council Member	Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Yent, Martha		Letter and figures sent via USPS 26 June 2017 Second round of letter and figures sent via USPS 31 July 2017
Young, Charles	‘Aha Moku Rep, Ho‘okena	Letter and figures sent via email 26 June 2017 Second round of letter and figures sent via email 31 July 2017

5.4 Consultation with the County of Hawai‘i—Planning Department, Cultural Resources Commission

CSH contacted County of Hawai‘i – Planning Department, Cultural Resources Commission (CRC) on 26 June 2017 via letter and figures. Mr. Luke Mead of the CRC contacted CSH via phone on 18 July 2017 acknowledging receipt of the letter and figures. Mr. Mead requested CSH attend the August 2017 CRC meeting to present the proposed project to the Board and the public. CSH attended the August 2017 CRC meeting where Ms. Nicole Lui and Ms. Theresa Donham requested a map of previous archaeological studies that were conducted and any archaeological sites within and in the vicinity of the project area. CSH attended an October 2017 CRC meeting where we presented those maps to the Board and the public. On 22 February 2018, the CRC sent a letter via email with information regarding past and present land use, cultural associations, and knowledgeable individuals and organizations. See Figure 16 and Figure 17 for a copy of the letter submitted by the CRC to CSH.



William P. Kenoi
Mayor

Deborah Chang, Chair
Ke‘ala Lee Loy, Vice Chair
Ronald Dela Cruz
Theresa Donham
Lily Dudoit
Nicole Lui
Barbara Meheula
Boone Morrison
Christine Wada

County of Hawai‘i
PLANNING DEPARTMENT
CULTURAL RESOURCES COMMISSION
Aupuni Center • 101Pauahi Street, Suite 3 • Hilo, Hawai‘i 96720
Phone (808) 961-8288 • Fax (808) 961-8742

October 18, 2017

Ms. Nicole Ann Nāhōkūlaniahiahi Ishihara, Project Director
Cultural Surveys Hawai‘i, Inc.
399 Hualani Street, Suite 124
Hilo, HI 96720

Email: nishihara@culturalsurveys.com

Dear Ms. Ishihara:

SUBJECT: Consultation for a Cultural Impact Assessment Regarding the Proposed Kealakehe Waste Water Treatment Plant (WWTP)
TMKs: (3) 7-4-008:058 & 073; Kohanaiki, Kaloko, Honokōhau, Kealakehe & Keahuolū, North Kona, Hawai‘i

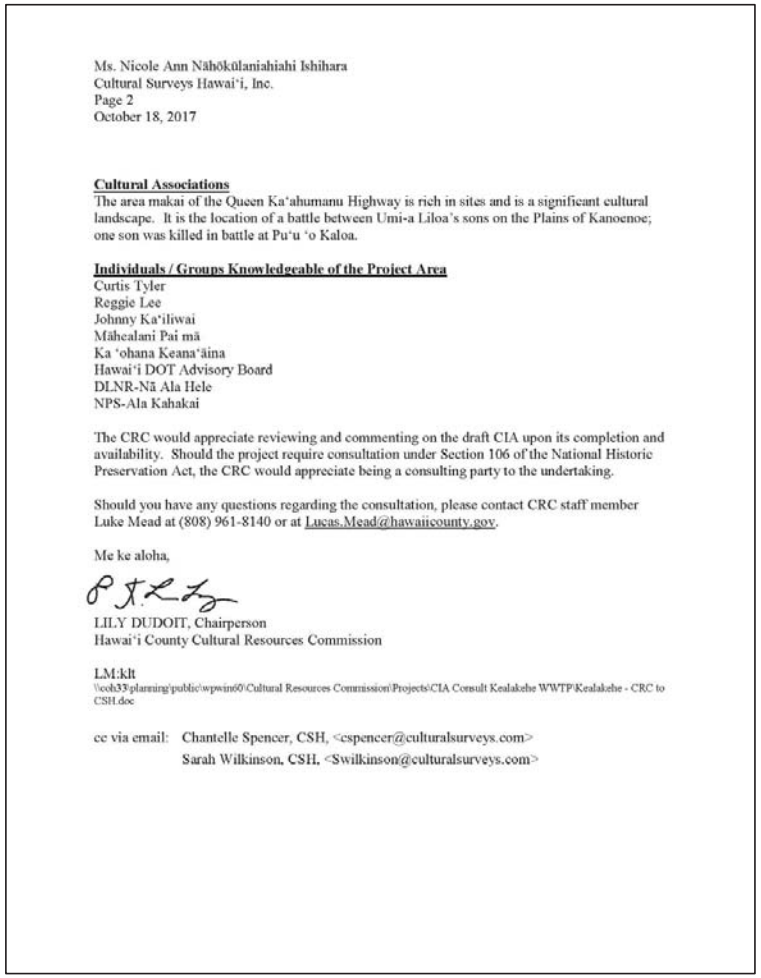
The Hawai‘i County Cultural Resources Commission (CRC) reviewed the subject request at their August 16 and October 11, 2017, meetings and thanks you for this consultation opportunity.

The consultation request specifically asked for information pertaining to the project area concerning: past and present land use; knowledge of cultural sites; knowledge of traditional gathering practices; cultrual associations; referrals of individuals knowledgeable of the project area; and, any other concerns the community may have related to cultrual practices in the project area. In response to this request, the CRC provides the following:

Past and Present Land Use
Numerous trails are present / may be present within the project area including:
Kohanaiki Trail / Road to the Sea within the mauka project area
Māmalahoa Trail
Makā‘eo Trail
The 1875 “Trail to Kailua” as it appears on Registered Map 512
Path from Kealakehe to the Old Kona Airport (Pāwai)
For trails within or proximal to the proposed project, the CIA should identify ownership dispositon with respect to the Highways Act of 1892.

www.cohplanningdept.com *Hawai‘i County is an Equal Opportunity Provider and Employer* planning@co.hawaii.hi.us

Figure 16. Page 1, Letter from the County of Hawai‘i - Planning Department, Cultural Resources Commission



Ms. Nicole Ann Nāhōkūlaniahiahi Ishihara
Cultural Surveys Hawai‘i, Inc.
Page 2
October 18, 2017

Cultural Associations
The area makai of the Queen Ka‘ahumanu Highway is rich in sites and is a significant cultural landscape. It is the location of a battle between Umi-a Liloa’s sons on the Plains of Kanoenoe; one son was killed in battle at Pu‘u ‘o Kaloa.

Individuals / Groups Knowledgeable of the Project Area
Curtis Tyler
Reggie Lee
Johnny Ka‘iliwai
Māhealani Pai mā
Ka ‘ohana Keana‘āina
Hawai‘i DOT Advisory Board
DLNR-Nā Ala Hele
NPS-Ala Kahakai

The CRC would appreciate reviewing and commenting on the draft CIA upon its completion and availability. Should the project require consultation under Section 106 of the National Historic Preservation Act, the CRC would appreciate being a consulting party to the undertaking.

Should you have any questions regarding the consultation, please contact CRC staff member Luke Mead at (808) 961-8140 or at Lucas.Mead@hawaiicounty.gov.

Me ke aloha,

LILY DUDOIT, Chairperson
Hawai‘i County Cultural Resources Commission

LM:klt
\\coh33\planning\public\wpwin60\Cultural Resources Commission\Projects\CIA Consult Kealakehe WWTP\Kealakehe - CRC to CSH.doc

cc via email: Chantelle Spencer, CSH, <cspencer@culturalsurveys.com>
Sarah Wilkinson, CSH, <Swilkinson@culturalsurveys.com>

Figure 17. Page 2, Letter from the County of Hawai‘i - Planning Department, Cultural Resources Commission

5.5 *Kama‘āina* Interviews

The authors and researchers of this report extend our deep appreciation to everyone who took time to speak and share their *mana‘o* and *‘ike* with CSH whether in interviews or brief consultations. We request that if these interviews are used in future documents, the words of contributors are reproduced accurately and in no way altered, and that if large excerpts from interviews are used, report preparers obtain the express written consent of the interviewee/s.

5.5.1 Nicole Keaka Lui

On Tuesday, 10 October 2017, members from CSH met with Nicole Lui, a lineal descendant of the Keahuolū, also pronounced Ke‘ohu‘olu Ahupua‘a. This particular *ahupua‘a* makes up a section of the Kekaha or ‘Āina Kaha lands. Ms. Lui was accompanied by her parents, Agnes Kaelemakule Lui and Raymond “Joe” Lui; and Kawehi Nguyen, a *kama‘āina* of Honokōhau. We met Ms. Lui and Ms. Nguyen at the entrance to the QLT, a center dedicated to serving orphaned and destitute Hawaiian children. We followed them through the property to a clearing overlooking the Plains of Kanoenoe (Figure 18). It is here that Pu‘u o Kaloa is located (Figure 19), a storied hill famous in the battle between brothers Keli‘iokaloa and Keawe-nui-a-Umi.

A loose translation of *kanoenoe* emphasizes mist or fogginess. According to multiple accounts given by *kūpuna* and told directly to Ms. Lui, a mist would settle on these plains from the *mauka* region and signal the start of planting. Due to the aridness of this area, *‘uala* (sweet potato; *Ipomoea batatas*) took well to the land and was cultivated by both men and women as the main staple. Ms. Lui was told stories by her *tūtū wahine* (grandmother), Margaret Pelekane, that she herself took to farming and acquired an iron *‘ō‘ō* (digging stick). This *‘ō‘ō* , with a history all its own, was passed down to Ms. Lui‘s mother and finally to her, a true family treasure.

Noni (*Morinda citrifolia)* was also gathered in this same area and used medicinally by Ms. Lui‘s mother and her grandfather, Solomon Kaelemakule. Agnes, Ms. Lui‘s mother, still gathers *noni* here and makes her own *noni* juice (Figure 20). She also taught Ms. Lui how to make a treat from the *noni.* After gathering the fruit, you cut it into strips and lay them in a drying box set out in the sun. You peel it after it was dried and eat it “right then and there.” In Agnes’ younger days, instead of using a drying box, they’d lay the strips of *noni* out in the sun on the *pāhoehoe* (smooth lava). Things were much cleaner then and there were hardly any flies, making it easier to prepare and store food.

Figure 18. At the QLT property looking *mauka* toward the Plains of Kanoenoe (CSH 2017)

Figure 19. Keaka Lui pointing to the general direction of Pu‘u o Kaloa (CSH 2017)

Figure 20. Ms. Lui’s mother, Agnes, with *noni* and *‘uhaloa* (CSH 2017)

Figure 21. Cynthia Nazara pointing out *‘uhaloa* (CSH 2017)

‘Uhaloa (*Waltheria indica)* also grows in this area and is still gathered by Ms. Lui’s mother as a *lā‘au lapa‘au* (medicinal plant) (Figure 21). The leaves and root of the *‘uhaloa* would be prepared as a tea and used for common colds. According to Ms. Lui’s mother, they did their gathering on Thursdays as that was their day of healing from the time of their *kūpuna* (elders). This old practice was not questioned as they did what was told by their elders. Life was hard in those days and many families left Kekaha and relocated elewhere seeking employment and financial comfort. Ms. Lui’s grandparents, great-grandparents, and their families remained in Kekaha and made their lives there and, in many ways, became the caretakers of this land and deeply accustomed to the way of life for the people here. Ms. Lui’s recollection of the history of Kanoenoe and Pu‘u o Kaloa goes back to Keawenuiaumi and his brother Keli‘iokaloa. At the passing of their father, ‘Umi-a-liloa, Keawenuiaumi was given control over Hilo and Keli‘iokaloa was given Kona. In time, Keli‘iokaloa became a cruel chief and when Keawenuiaumi got word of his harsh acts he took pity on the people of Kona and prepared for battle at the Plains of Kanoenoe. The flat where Keli‘iokaloa was slain bears his name, Pu‘u o Kaloa. Although she cannot confirm the exact location, there are many petroglyphs that surround one particular *pu‘u* which suggests this to be the location of Pu‘u o Kaloa. The details of this battle can be found in *Ruling Chiefs of Hawai‘i* by Samuel Kamakau.

The beach and sanctuary of the QLT property was once referred to as Papawai or Pawai, however, the true Pawai lies south of the QLT property and is situated at the end of the old Kona Airport tarmac. Ms. Lui, her mother, and other surviving *kūpuna* brought to light the traditional name of this area as Hale Pāo‘o (House of the Pāo‘o), *pāo‘o* being the general term for the *‘o‘opu* (Hawaiian goby; *Elotridae*). QLT took into consideration using the true name of this area and recently changed the name of the area to Hale Pāo‘o. In many cases with Hawaiian place names, the pronunciation of the name does not necessarily match the spelling of it. This would be at the discretion of the people living in that area. For example, although spelled Pāo‘o, descendants of the area say “Pa‘o,” which Ms. Lui and her family use today. There was a *ko‘a* outside Hale Pa‘o where Ms. Lui‘s grandfather, Solomon Kaelemakule, would fish. In the back of Hale Pa‘o was her grandfather's *hale wa‘a* (canoe house) situated on a flat of *pāhoehoe.* There is also a *pā ilina* (graveyard) on the beach. Kawehi Nguyen, a descendant of the Kanakamaika‘i ‘Ohana, remembers gathering *‘ōpae ‘ula* (Hawaiian red shrimp; *Halocaridina rubra*) from an anchialine pool toward the back of Pawai Beach. Ms. Lui pointed out the general location of numerous petroglyphs that bring life to this area and adds to its storied past, some on the lava nearing the main access road. As we stood in the clearing taking in the vastness of Kanoenoe, she continued to explain her love for this place and her *kuleana* (responsibility) as a descendant to *mālama* (take care of) this land rich in stories. Before leaving, her closing thoughts focused on the absence of development and how the spirit of the land can remain intact so that connections can be made for generations to come, making the intangible tangible, and bringing life to stories of long ago.

Ms. Lui then wished to visit a portion of the project area that highlights the Māmalahoa Trail and to introduce CSH cultural researchers to Cynthia Nazara, cultural monitor and lineal descendant of the Kekaha region. We met Ms. Nazara at Kealakehe Parkway where she was accompanied by Rick Gmirkin, Community Archaeologist for the Ala Kahakai National Historic Trail. In this area, just off Queen Ka‘ahumanu Highway, we had a clear view of the largest and most intact portion of the old Māmalahoa Trail which is *mauka* of and runs parallel to the highway.

The trail itself is overgrown with fountain grass (*Pennisetum setaceum)* making it easily detectable in an open field of lava (Figure 22 and Figure 23).

Ms. Lui‘s connection with the Māmalahoa Trail goes back to when her great-grandfather, John Kaelemakule, Sr., was elected as Road Supervisor in the late 1880s. He drafted letters to the Minister of the Interior requesting additional funding for maintainenance and upkeep of the Māmalahoa Trail. In addition, he was instrumental in widening the road and later appointed his son, Mano Kaelemakule, as caretaker of a crossroad that connected to the Māmalahoa Highway. High Chief Kinimaka, the grandfather of John Kaelemakule, Sr., was a supervisor of roads and built and managed the Judd Trail. These trails not only hold historical significance to the people of the area but represent an even closer connection to Ms. Lui as her *kūpuna* worked so intimately with them. Ms. Lui follows in her *kūpuna‘s* footsteps today and is resourceful in her role as a cultural monitor for major road projects. These projects span from Ane Keohokalole Highway to the Māmalahoa Bypass road and numerous projects in between. She has been involved in this line of work for the past nine years and continues in the same capacity today on the Queen Ka‘ahumanu Highway project.

In regard to the proposed Kealakehe WWTP project, Ms. Lui’s highest concern is possible destruction of the Māmalahoa Trail and further development on significant historic and cultural sites. Many of these sites can be found in the areas from QLT lands to the Department of Transportation land area where the Māmalahoa Trail is located. She supports the ongoing preservation and protection of these areas and should it come to a point where construction efforts would impose on any historic or cultural site, she strongly suggests the project be rerouted to cause no further damage and supports continuous archaeological and cultural monitoring.

Figure 22. View of the Māmalahoa Trail overgrown with fountain grass (CSH 2017)

Figure 23. The Māmalahoa Trail (CSH 2017)

5.5.2 Rick Gmirkin

On 17 August, Rick Gmirkin, a Community Archaeologist, spoke at the Cultural Resources Commission meeting on behalf of the Ala Kahakai National Historic Trail, National Park Service. Below is a summary of the minutes taken from that meeting:

> He feels this is a great project, but after reviewing the project area, he wished to bring to attention that there are several known trails within the project area. On the north, in the project area above Kaloko is an old abandoned water tank. Directly next to the tank, and possibly where the fence is, is a section of the Road to the Sea, or Kohanaiki Trail. It starts from the homesteads of Kohanaiki to Kaloko. This section of the trail is very well-worn; there is depth through the pāhoehoe indicating travel by horse. Aunty Maluhia used the trail, along with her son Reggie Lee.
>
> There is another trail in the area, within Kealakehe, which is on the mauka side of the Queen Ka‘ahumanu Highway and runs parallel to the highway. This is the Māmalahoa Trail. While it is shown on the map, Mr. Gmirkin wished to bring further awareness to the applicants as long linear projects potentially require digging and installation of lines underground, which may impact the trails. Currently, there is discussion of mitigation for the Māmalahoa Trail because of the highway expansion of Queen Ka‘ahumanu Highway and the inadvertent, further damage to the trail within the project corridor. The mitigation requested for the section of trail in discussion is for it to be documented and potentially restored. This trail connects Kaloko Honokāhau to Mahai‘ula towards the north, and to the south it connects to the intersection of Makalapua and the shopping center on the mauka side. There remains potential future purpose, and the trail is still revered by some individuals of Kekaha.

Mr. Gmirkin also added that in the discussion of the Queen Ka‘ahumanu Highway project, Uncle Curtis Tyler mentioned that the Makā‘eo Mauka-Makai Trail is located in the area. The boundary wall that separates Kealakehe and Keahuolū is a potential location of this trail.

On 10 October, CSH met with Mr. Gmirkin near the largest, intact portion of the Mamalahoa Trail. He mentioned that this portion of the old trail runs from Kealakehe Parkway to beyond the Makalapua Shopping Center, being cutoff, however, by side roads. His extensive knowledge of trails in this region not only cover the Māmalahoa Trail but also the old ranch trails going up *mauka*.

Mr. Gmirkin strongly urged CSH to review a previously published monitoring report to gain further insight to the Māmalahoa Trail within the project area and known *mauka-makai* trails in the corresponding *ahupua‘a*. This suggested report, by Thomas Wolforth printed in 1999, covered the same districts mentioned in the current Kealakehe WWTP project. Mr. Gmirkin’s recomendation of this report is noted in Section 3.3.5 in our description of trails and also in the Previous Archaeology Research section, Section 4.5.

As an advocate for trail preservation, Mr. Gmirkin supports the protection of the Māmalahoa Trail which may be impacted by ground disturbance from the Kealakehe Waste Water Treatment Plant (WWTP) project.

5.5.3 Cynthia Nazara

Cynthia Nazara works as a freelance cultural resource consultant and is a *kama‘āina* of Kaloko. As an active member of the Kona Hawaiian Civic Club, she expressed strong concerns about preserving the remaining portions of the Māmalahoa Trail. A few sections of the trail have already been disturbed during previous construction and she fears further development will cause even greater harm to the historic trail.

Ms. Nazara strongly advises that the water lines must *absolutely* be moved to protect existing historic sites. She has seen the landscape of Honokōhau and Kealakehe change throughout her lifetime and is accustomed to the style of clients who‘d “rather pay fines than follow the written laws and procedures.” She is hopeful that the completion of this CIA will prompt alternative locations for this project.

5.5.4 Māhealani Pai

On Wednesday, 18 October, members from CSH met with Māhealani Pai, a cultural practitioner and a lineal descendant of the Honokōhau-Kaloko-Kohanaiki Ahupua‘a. We met on the grounds of the former Kona Lagoon Hotel in Kahalu‘u Ahupua‘a where Mr. Pai works as a cultural resource specialist. This site is owned by Kamehameha Schools and is currently under renovation to become a cultural and educational complex. Mr. Pai led the restoration efforts of *nā heiau* of Mākole‘ā, Hale o Papa, Ke‘ekū, and Hāpaiali‘i Heiau located near the shoreline of this property.

Mr. Pai was born in 1958 to William Kahakū‘ilani Pai, Jr. and Mabel Ku‘ulei Kalā Augustin. His father was born at ‘Āi‘ōpio Honokōhauiki and hailed from the Kūpono, Nāhe‘eholua, Mahi and Pai family. His mother’s side hails from the Kahele and Kalā ‘Ohana of Waimanu Valley and was later taken as *hānai* (adopt, raise) by the Kuakahela-Simeona family. She then came to Honokōhau and lived with her Uncle Kanakamaika‘i and Aunty Makapini. Māhealani recalls the story of his mother carrying the slop cans from the present Firestone Auto Shop on Palani Road and carrying it in a “China Man” style back to Honokōhau to feed the livestock near ‘Āi‘ōpio fishtrap. Being one of the first families to reside in the area of Kaloko and Honokōhau, Mr. Pai’s ancestors were part of a fishing *hui* (club, association) that took care of *nā loko i‘a* (fishpond) Kaloko, ‘Āimakapā, and the ‘Āi‘ōpio fishtrap.

In his younger years, his immediate family relocated to O‘ahu in search of employment and lived in Nānākuli on the Wai‘anae Coast. He attended many different schools as a child which included Nānāikapono Elemantary, Pu‘uhale Elementary, St. Anthony School, Kalākaua Middle School, Damien Memorial School, and Farrington High School. Though he spent the majority of his time in O‘ahu, he would return to Kona every summer to visit his grandparents.

Mr. Pai‘s *‘ohana* introduced him to a sustainable lifestyle at a very young age. His family specialized in *‘ōpelu* (mackerel scad; *Decapterus pinnulatus*) fishing and ate it at nearly every meal. They even sold some off the side of the road as a means of living. They would make floaters from the wood of the *hau* (beach hibiscus; *Hibiscus tiliaceus*) tree which grew abundantly near ‘Āimakapā and use this when fishing. In those days, *mauka* and *makai* families worked together and took care of one another. During the holiday season, those up *mauka* who wanted fish would pack and send a donkey down the *makai* trail. Once received by the families on the coast, they would send it back with fish.

On the coast they also gathered *‘ōpae ‘ula*, *‘opihi* (limpet; *Cellana sandwicensis*), *he‘e* (general name for octopus), and *limu* (general name for seaweed). In order for any *limu*, especially *limu ‘ele‘ele* (*Enteromorpha prolifera*), to flourish, the water needed to be at the right conditions and was used as bait for the *nenue* fish (chun; *Kyphosus* spp.). The *‘auku‘u* or Black-crowned Night Heron (*Nycticorax hoactli*) was viewed as a sign of fresh water. *‘Uala* (sweet potato; *Ipomoea batatas*) was also cultivated near the shore as the land was too arid for nearly any other crop to thrive. His grandmother planted watermelon, squash, pumpkin, and pineapple for the family. In keeping true to their sustainable lifestyle, old leaves from the squash and pumpkin were used as mulch for the next crop promising healthy soil for the next gathering.

In 1990, Mr. Pai was involved in the Public Access Shoreline Hawaii‘i (PASH) case that centered on his family’s traditional and customary practice of harvesting *‘ōpae‘ula* as bait for *‘ōpelu* fishing along the coastal shoreline of Kohanaiki Ahupua‘a. His efforts gave momentum to the drive to allow Native Hawaiians to exercise their native gathering rights in shoreline areas that may or may not be affected by commerical development.

During the interview, Mr. Pai shared a *mo‘olelo* of a *kupua* (demigod) named Kalualapauila. This demigod could change from a human form into a *manō* (shark) and he was the high priest, Ka‘iwi, near the current location of Kealakehe Parkway is an area named Ka‘iwi. A *heiau* was erected at the northern boundary of Kealakehe and surrounded by *kauila* (*Alphitonia ponderosa*), which no longer grows in the area.

Mr. Pai is very knowledgeable of historic trails in the Honokōhau and Kealakehe area and applauds the local efforts to preserve the Mamālahoa Trail in its current state as it was completely overgrown before. He mentioned one particular trail in the area of Lā‘iopua, where the current West Hawai‘i Department of Hawaiian Home Lands (DHHL) lots are. There is also a trail that leads from the Kaloko Fishpond up toward Kohanaiki *mauka* where their family ancestors lived along the trail. He mentioned that in older times markers separated each *ahupua‘a*, either an *ahu* (rock shrine) or *ko‘a*. Specific markers on land also served to locate *‘ōpelu ko‘a* (*‘ōpelu* fishing grounds). He mentioned the area between the current location of the WWTP and the ocean is known as a *leina*, a place where spirits would leap to enter the next realm. Mr. Pai dissected the terminology of Ke-ala-kehe as “the winding path.” Another trail, a particularly winding path, would lead to the *pali* (cliff) of this *leina*, where the *noio* bird (Hawaiian noddy tern; *Anous tenuirostris melanogenys*) would rest.

Mr. Pai’s concern with this project is the possibility of unearthing burials during the widening of the road (as part of a separate project) and possibly disturbing burials situated within the crevices of lava. He pointed out a few caves *makai* of Queen Ka‘ahumanu Highway which may also be a location for burials. When Queen Ka‘ahumanu Highway was first widened, *iwi* (human remains) were found south of Kaloko National Park. In 1982 after Hurricane Iwa and again in 1991 after Hurricane Iniki, *iwi* were uncovered in the sand at Maka‘eō also known as Old A‘s. In the case where workers come into contact with *iwi*¸ it is of utmost importance, especially to Mr. Pai, that they be handled with great respect and reverence in seeking the continuation of their *moe loa* (eternal rest). In this unfortunate scenario, the appropriate parties should be contacted most efficiently so the correct procedures may take place to ensure proper handling and treatment.

Section 6 Traditional Cultural Practices

6.1 Habitation

The *mo‘olelo* of Kamiki and his brother Maka‘iole relates that they were supernatural siblings who were raised and empowered by their ancestor Ka-uluhe-nui-hihi-kolo-i-kua. The *mo‘olelo* discusses the various priests of the area and gives a description of the landscape. Kamiki describes the fishing grounds of Kekaha including the area known as Ka‘ele-huluhulu (“splintered outer hull”), which was named after the rough waters of Hale‘ōhi‘u and how the canoes were dragged over the canoe landing. Kamiki also went deep sea fishing near a *ko‘a* located at Pāo‘o. After catching 400 *aku*, Kamiki traveled to Nā-Hono-‘elua, now known as Honokohau, and divided his catch between the sacred chiefess Paehala and the people of that area.

The *wahi pana* compiled in Table 1, Table 2, and Table 3 indicate the *ahupua‘a* of Kaloko, Kealakehe, and Keahuolū were rich in resources (as described in land commission testimonies) and well utilized (boundaries, villages, watering holes, and *‘ili ‘āina*).

In addition to *mo‘olelo* and testimonies, previous archaeology has yielded signs of habitation including house sites, lava shelters, planting pits, and recreational activites (such as *papamū, kōnane*, *hōlua,* and petroglyphs).

Descendant of the area, Ms. Nicole Lui, shared that many families once lived in the Kekeha region but relocated to seek employment and financial stability. Her great-grandparents, grandparents, and a few other families remained in the Kekeha region. Cultural practitioner and lineal descendant of Honokōhau, Kaloko, and Kohanaiki Ahupua‘a, Māhealani Pai, shared that his *‘ohana* was one of the first families to reside in the Kaloko and Honokōhau area.

6.2 Gathering of Plant Resources

The *wahi pana* of Pu‘u-o-Kaloa was used as a sign of coming rains for the people of Keahuolū and Kealakehe. When the *līhau* or light, dewy mists sat at the top of this particular *pu‘u*, the people of this area knew rain was on its way. It was an important omen for the farmers of this area who cultivated sweet potatoes and other crops. In 1869, David Kalākaua described the lands of Keahuolū, which included half of the Hualalai mountains. The mountains were abundant in *koa*, *kukui*, and *‘ōhi‘a*. The upper portions used for cultivation were suitable for coffee, oranges, taro, ptoatoes, and bananas. Breadfruit and *kolī* grew wild. The lower portions of Keahuolū were used for grazing cattle, sheep, and goats. The *makai* region was rich in aquacultural resources and coconut trees.

Ms. Lui pointed out that *‘uala* was grown in the plains of Kanoenoe due to its aridness. Her *tūtū wahine*, Margaret Pelekane, was a farmer and acquired an iron *‘ō‘ō* and passed it down to Ms. Lui’s mother and finally to her. It is considered a family treasure. *Noni* was gathered in this area and used medicinally by Ms. Lui’s mother and her grandfather, Solomon Kaelemakule. Ms. Lui’s mother still gathers *noni* here and makes her own juice. Ms. Lui also shared a recipe with *noni*. After gathering the fruit, you cut it into strips, lay them in a drying box, and place in the sun. Ms. Lui shared that growing up, they would place the *noni* strips on the *pāhoehoe*. She pointed out that it was much cleaner at that time and there were hardly any flies making it easier to prepare and store food. *‘Uhaloa* was also found within the project area and is still gathered by Ms. Lui’s

mother and used for *lā‘au lapa‘au*. The leaves and root of the *‘uhaloa* are prepared as a tea and used for the treatment of common colds. According to Ms. Lui’s mother, gathering occurred on Thursdays, as it was considered a day of healing from the time of their *kūpuna*. She added that the particular date for gathering was never questioned, as they did what their elders said.

Mr. Pai gathered *hau* with his family and made floaters with the wood. Mr. Pai shared that *‘uala* was planted near the shore because the land was too arid for any other crop to thrive. He recalls his grandmother cultivating watermelon, squash, pumpkin, and pineapple for their *‘ohana*. In addition, to truly keep to a sustainable lifestyle, the old leaves from the squash and pumpkin were used as mulch for the next crop.

6.3 Aquaculture

In the *mo‘olelo* of Kamiki, he describes the coastline of Kona including the fishing grounds of Kekaha; the rocky terrain of the canoe landing called Hale‘ōhi‘u; and the supernatural currents of the area (Ke-au-kā, the current that strikes; Ke-au-kāna‘i, the current of smooth waters; and Ke-au-miki, the current that pulls to the deep sea) that are identified as Pele’s brothers. The *mo‘olelo* of Punia share how he would catch lobsters for his mother in caves guarded by Kai‘ale‘ale and his sharks. In addition to *mo‘olelo* discussing in length the variety of coastal resources of Kona, *kū‘ula* and *ko‘a* were noted in historical documents such as land claims, archaeological surveys, and through consultations.

Ms. Lui’s friend, Kawehi Nguyen, a descendant of Kanakamaika‘i ‘Ohana, recalls gathering *‘ōpae‘ula* from an anchialine pool toward the back of Pawai Beach. Mr. Pai’s family was part of a fishing *hui* that took care of Kaloko and ‘Āimakapā Loko I‘a and the ‘Āiōpio fishtrap.

Mr. Pai’s *‘ohana* introduced him to a sustainable lifestyle at a young age. His family specialized in *‘ōpelu* fishing and ate it at every meal. They also sold *‘ōpelu* on the side of the road as a means of living. He recalls people gathering *‘ōpae ‘ula*, *‘opihi*, *he‘e*, and *limu*. Mr. Pai pointed out for *limu ‘ele‘ele* to flourish, the water needs to be at the correct conditions. *Limu ‘ele‘ele* was also used as bait for the *nenue*. He shared his *‘ike* of the *‘auku‘u* or Black-crowned Night Heron as an indicator of fresh water nearby. He pointed out that where the West Hawai‘i DHHL lots are located there is a *mauka-makai* tral that leads from the Kaloko Fishpond to Kohanaiki Mauka where family ancestors once resided. He added that in earlier times *ahu* and *ko‘a* were used as *ahupua‘a* boundary markers. Specific markers such as *‘ōpelu ko‘a* could be found on land and indicated *‘ōpelu* fishing grounds.

6.4 Nā Ala Hele

Several trails ran through these *ahupua‘a*. The most noteable was the *alaloa* that crossed *makai* lands, which linked royal centers, coastal communities, and resources. Another trail was Kealaehu (“The path of Ehu”), which is located in the *mauka* region above Māmalahoa Highway. Kealaehu spans from Ka‘ū before traveling through South Kona and North Kona, continuing on to Ka‘ūpūlehu where it cuts *makai* to Kīholo and meets with the *alaloa* alignment. The trails continue traveling north to Kawaihae and beyond (Maly and Maly 1993:73). A number of previous archaeological studies also documented pre-Contact and historic trails (Borthwick and Hammatt 1992b; Borthwick et al. 1993; Ching and Rosendahl 1968; Colin et al. 1996; Donham 1990c; Fager and Graves 1993; Hammatt and Shideler 2008; Hammatt et al. 1999, 2008; Haun and Henry 1991, 2006; Head and Rosendahl 1995; Henry and Graves 1993; O’Hare and Rosendahl 1993; Rechtman

and Escott 2002; Renger 1971; Rosendahl 1989; Wilkinson et al. 2011; Wilkinson et al. 2017; Yucha et al. 2016).

Mauka to *makai* trails were also evident in Kohanaiki, Kaloko, Kalaoa, and Honokōhau Ahupua‘a. These trails were utilized by upland families who traveled to the coast to fish and gather water during droughts. Mr. Pai echoed the descriptions of the *mauka* to *makai* trails and added that the *mauka* and *makai* families often helped each other out. During the holidays, *mauka* families who wanted fish would pack and send a donkey *makai*. Once the *makai* family received the donkey, they would send it back with fish for the *mauka* family. Mr. Rick Gmirkin, Community Archaeologist at the Ala Kahakai National Historic Trail, described that the current project area “above Kaloko is an old abandoned water tank” and next to the tank is possibly a section of the Road to the Sea Trail or the Kohanaiki Trail. He shared that Aunty Elizabeth Maluhia Lee, a long-time *kama‘āina* of the area and *lauhala* (pandanus; *Pandanus odoratissuimus*) master weaver who has since passed away, utilized the trail with her son Reggie Lee. Mr. Gmirkin noted that the trail starts from the homesteads of Kohanaiki and travels to Kaloko and the portion near the project area is very well worn. The depth through the *pāhoehoe* indicates travel by horse.

Ms. Lui escorted CSH to the Māmalahoa Trail, which is located within the project area near Kealakehe Parkway. Cultural Monitor for the Queen Ka‘ahumanu Highway project, Cynthia Nazara, and Rick Gmirkin, Community Archaeologist for the Ala Kahakai National Historic Trail, were near the trail when CSH arrived. Ms. Lui introduced us to Ms. Nazara and Mr. Gmirkin where they pointed out the trail, which runs parallel (*mauka*) to Queen Ka‘ahumanu Highway. The trail itself is overgrown with fountain grass. Ms. Nazara pointed out that portions of the trail have been disturbed due to previous construction work and urged that the remaining portions of the trail be preserved. Mr. Gmirkin urges for the proper preservation and protection of the Māmalahoa Trail and other noted trails in the project area. Ms. Lui’s connection to the Māmalahoa Trail is with her great-grandfather, John Kaelemakule, Sr., who was a road supervisor in the late 1880s. Her great-grandfather drafted letters to the Minister of the Interior requesting additional funding to maintain the Māmalahoa Trail.

6.5 Burials

Mo‘olelo suggest the remains of Kamehameha I may have been buried nearby. Kamakau states that the *iwi* of Kamehameha I were taken to Kekaha and placed in a secret cave (Kamakau 1961:215). Previous archaeological studies have documented many burials (Carpenter 1995; Ching and Rosendahl 1968; Emory and Soehren 1971; Estioko-Griffin and Lovelace 1980; Ladd 1968; Monahan et al. 2012; Neighbor Island Consultants 1973; Renger 1971; Rosendahl 1993; Soehren 1980b, 1981).

Palihiolo Heiau is a *luakini heiau* said to have been reconstructed by Kalākaua. A coconut grove is said to have surrounded the *heiau* where Kalākaua’s grandfather was hung for murder. Ms. Lui shared her knowledge of a graveyard on the beach near Hale Pa‘o (also known as Hale Pāo‘o). Mr. Pai shared his knowledge of burials during the widening of Queen Ka‘ahumanu Highway, which were found within the crevices of lava. He also pointed out that *iwi* were found *makai* of Queen Ka‘ahumanu Highway and south of Kaloko National Park. In 1982 after Hurricane Iwa and again in 1991 after Hurricane Iniki, *iwi* were uncovered at Maka‘eō, also known as Old A’s.

Section 7 Summary and Recommendations

CSH undertook this CIA at the request of Wilson Okamoto Corporation and on behalf of the County of Hawai‘i – Department of Environmental Management (DEM). The research broadly covered the *ahupua‘a* of Kaloko, Kealakehe, and Keahuolū, including the current project area.

7.1 Results of Background Research

Background for this project yielded the following results (presented in approximately chronological order):

1. *Mo‘olelo* suggest the remains of Kamehameha I may have been buried in Kaloko Ahupua‘a. Kamakau states that the *iwi* of Kamehameha were taken to Kekaha in Kaloko at a secret cave (Kamakau 1961:215).
2. Pukui shares a *mo‘olelo* of ‘Ōhiki, a legendary hero, who prayed to Pele to save the priest, Ka-lua-lapa-uila. As a result, a storm arose. The priest turned into a *manō* as it tried to enter a *heiau* to save the priest’s human form. One of Pele’s sisters, Hi‘iaka-noho-lae (“Hi‘iaka living at [the] point”) came to live in this sacred area that was forbidden from Pele (Pukui et al. 1974:70).
3. A distinguishing feature of the Kona landscape are the many trails that cross and zig-zag through each *ahupua‘a*. The *alaloa* is a trail that crossed the *makai* lands that linked royal centers, coastal communities, and resources (Maly and Maly 1993:73). A *mauka* trail called Kealaehu (“The Path of Ehu”) passed the area a little *mauka* of the old Māmalahoa Highway. Kealaehu spanned from Ka‘ū to Kawaihae.
4. Another distinct feature of the Kona landscape are the *hōlua* slides. *Hōlua* is an ancient sport that can be traced back to the time of Pele and was pursued by those of *ali‘i* ranking. The sleds were narrow but long (approximately 12 to 18 ft) and used to race downhill. The track itself ran *mauka* to *makai* and was covered with *pili* grass. The track was slicked with *kukui* (candlenut; *Aleurites moluccana*) oil (Mitchell 1975:38).
5. In the early nineteenth century, the residents of Kaloko Ahupua‘a were feeling the pressures and consequences of Western Contact. Native Hawaiians were enlisting as seamen on foreign ships while harbor facilities were being constructed in Kailua and Kealakekua.
6. The *ahupua‘a* of Kaloko was awarded and kept by Lot Kamehameha (Kamehameha V) during the Māhele. A total of 21 additional land claims were made in Kaloko of which 12 were awarded in the uplands. Kealakehe Ahupua‘a was awarded to Kekuapanio, a young noble who was a favorite amongst *ali‘i* such as Kauikeaouli (Kamehameha III), who later returned the land to the government. The entire *ahupua‘a* of Keahuolū was awarded to Ane Keohokālole who held two walled house lots “from very ancient times” along the shoreline.
7. Oral histories indicate that during the mid-1800s, private residences were scattered along the coastline, *mauka* regions (specifically above 900 ft), and in the vicinity of Māmalahoa Highway. *Mauka* and *makai* trails were utilized by upland families who traveled to access coastal resources and gather water during upland droughts. Goats and cattle contributed to droughts by stripping the vegetation of the area. In 1870, a resident known as J. Kihe stated that the families who resided in the Kekaha region moved with the exception of one family who remained.

8. Previous archaeology yielded habitation sites, temporary habitation sites, lava tubes, lava shelters, trails (pre-Contact and historic), historic campsites, and recreational activities (such as *papamū*, *kōnane*, petroglyphs, *hōlua*).

7.2 Results of Community Consultation

CSH attempted to contact 37 NHOs, agencies, and community members. Seven people/agencies responded to the consultation letter. Five people participated in formal interviews, however, only four were authorized to be used in this study. CSH initiated its outreach effort in June 2017 through March 2018. Below is a list of individuals who shared their *mana‘o* and *‘ike* about the project area:

1. Nicole Keaka Lui, descendant of Keauolū and Kekaha
2. Rick Gmirkin, archaeologist, Ala Kahakai National Historic Trail
3. Cynthia Nazara, cultural consultant and descendant of Kekaha
4. George Van Gieson, retired fire captain and *kama‘āina*
5. County of Hawai‘i—Planning Department, Cultural Resources Commission
6. Ikaika Nakahashi, Cultural Historian (Maui County and Hawai‘i County)—State of Hawai‘i, SHPD
7. Kaleo Kuali‘i, cultural consultant and descendant of Kohanaiki

7.3 Cultural Community Concerns and Recommendations

Based on information gathered from the community consultation, participants voiced and framed their concerns in a cultural context.

1. Ms. Nicole Lui is concerned about the possible destruction of the Māmalahoa Trail. She is also concerned about future development and how it impacts significant and cultural sites. She focused on sites found in the vicinity of the QLT lands to Department of Transportation lands near the Māmalahoa Trail. She supports ongoing preservation and protection of these areas and strongly suggested the project be rerouted to cause no further damage and continuous archaeological and cultural monitoring.
2. Mr. Rick Gmirkin expressed deep concern with preserving the Kohanaiki Trail (also called Road to the Sea), Māmalahoa Trail and other *mauka* and *makai* trails within the expanse of the project area. As the Māmalahoa Trail is threatened by possible ground disturbance associated with the Kealakehe WWTP project, he further urges the preservation and protection of this trail.
3. Cynthia Nazara expressed strong concerns about preserving the remaining portions of the Māmalahoa Trail. Although portions of the trail have been disturbed by previous construction, she fears further development will cause greater harm to the trail. Ms. Nazara strongly advised that the water lines be moved to protect existing historic sites.
4. Mr. Māhealani Pai is concerned the project may unearth burials and possibly disturb burials situated within the crevices of lava. Mr. Pai knows of several caves *makai* of Queen Ka‘ahumanu Highway that may also be a location for burials. He pointed out that when Queen Ka‘ahumanu Highway was first widened, *iwi* were found south of Kaloko National Park. It is of utmost importance for Mr. Pai that if workers come into contact with *iwi*, they be handled with great respect and reverence in seeking the continuation of their *moe loa*.

He requested that appropriate parites be contacted efficiently so the correct procedures may take place to ensure proper handling and treatment.

7.4 Impacts and Recommendations

Based on information gathered from the cultural and historical background, and the community consultation, CSH identified potential impacts and makes the following recommendations based on approved community consultations.

1. Community participants voiced concerns regarding the Māmalahoa Trail and suggest the project be rerouted to avoid further disturbance and destruction. One of the community participants suggested archaeological and cultural monitoring for the Māmalahoa Trail. One participant strongly urged that CSH review a previously published monitoring report to gain further insight of the Māmalahoa Trail and known *mauka-makai* trails.
2. Previous archaeological studies have yielded a number of burials (Carpenter 1995; Ching and Rosendahl 1968; Emory and Soehren 1971; Estioko-Griffin and Lovelace 1980; Ladd 1968; Monahan et al. 2012; Neighbor Island Consultants 1973; Renger 1971; Rosendahl 1993; Soehren 1980b, 1981). In addition to previous archaeological studies, a community participant has shared their knowledge of burials found north and *makai* of the project area.
3. In the event that any potential historic properties are identified during construction activities, all activities will cease and the SHPD will be notified pursuant to HAR §13-280-3. In the event that *iwi kūpuna* are identified, all earth moving activities in the area will stop, the area will be cordoned off, and the SHPD and Police Department will be notified pursuant to HAR §13-300-40. In addition, in the event of an inadvertent discovery of human remains, the completion of a burial treatment plan, in compliance with HAR §13-300 and HRS §6E-43, is recommended.
4. In the event that *iwi kūpuna* and/or cultural finds are encountered during construction, project proponents should consult with cultural and lineal descendants of the area to develop a reinterment plan and cultural preservation plan for proper cultural protocol, curation, and long-term maintenance.

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