# NATURAL ENERGY LABORATORY OF HAWAII AUTHORITY

*An Authority of the State of Hawaii attached to the Department of Business, Economic Development & Tourism*

Source of 100% Hawaii Deep Seawater

April 27, 2022

Ms. Mary Alice Evans, Director
Office of Planning and Sustainable Development
235 South Beretania Street, 6th Floor
Honolulu, Hawaii 96813

Subject: Draft Environmental Assessment
NELHA's Innovation Center and Hale Wawaloli Visitor Center
TMKs (3) 7-3-043:051, 7-3-043:100, and 7-3-043:088 (portion)
North Kona District, Hawaii Island, State of Hawaii

Dear Director Evans:

With this letter, the Natural Energy Laboratory of Hawaii Authority (NELHA) hereby transmits the Draft Environmental Assessment and anticipated Finding of No Significant Impact (DEA-AFNSI) for the Innovation Center and Hale Wawaloli Visitor Center situated at TMKs (3) 7-3-043:051, 7-3-043:100, and 7-3-043:088 (portion), in the North Kona District on the island of Hawaii for publication in the next available edition of the Environmental Notice.

In addition to this letter, NELHA has submitted the electronic version of the Environmental Review Program submittal form, an electronic version of the DEA in PDF format, and a KML file for the project location on the State of Hawaii, Office of Planning and Sustainable Development – Environmental Review Program's website.

If there are any questions, please contact NELHA at (808) 327-9585 x225 or our consultant Michele Lefebvre by phone (808) 494-2039 or by email at michele.lefebvre@stantec.com.

Very truly yours,

Gregory P. Barbour
Executive Director

CC: Michele Lefebvre, Stantec Consulting Inc.

73-4460 Queen Kaahumanu Hwy., #101, Kailua-Kona, Hawaii USA 96740-2637
Phone: (808) 327-9585 Fax: (808) 327-9586 Email: nelha@nelha.org Website: http://www.nelha.org

**From:** webmaster@hawaii.gov
**To:** DBEDT OPSD Environmental Review Program
**Subject:** New online submission for The Environmental Notice
**Date:** Thursday, April 28, 2022 6:11:39 PM

---

**Action Name**

NELHA's Innovation Center and Hale Wawaloli Visitor Center

**Type of Document/Determination**

Draft environmental assessment and anticipated finding of no significant impact (DEA-AFNSI)

**HRS §343-5(a) Trigger(s)**

- (1) Propose the use of state or county lands or the use of state or county funds

**Judicial district**

North Kona, Hawai‘i

**Tax Map Key(s) (TMK(s))**

(3) 7-3-043:051; (3) 7-3-043:100; (3) 7-3-043:088 (portion)

**Action type**

Agency

**Other required permits and approvals**

County of Hawai‘i, Department of Public Works, Building Division Approval and Building Permit; County of Hawai‘i, Department of Public Works, Engineering Division, Grading Permit; County of Hawai‘i, Department of Public Works, Engineering Division, Drainage Plan; State Department of Health, NPDES Permit; State Historic Preservation Division, Chapter 6E Historic Sites Clearance

**Proposing/determining agency**

Natural Energy Laboratory of Hawaii Authority

**Agency contact name**

Gregory Barbour

**Agency contact email (for info about the action)**

nelha@nelha.org

**Email address or URL for receiving comments**

nelha@nelha.org

**Agency contact phone**

(808) 327-9585

**Agency address**

73-4460 Queen Ka‘ahumanu Highway
#101
Kailua-Kona, Hawaii 96740-2637
United States
Map It

**Was this submittal prepared by a consultant?**

Yes

**Consultant**

Stantec Consulting Services Inc.

**Consultant contact name**

Michele Lefebvre

**Consultant contact email**

michele.lefebvre@stantec.com

**Consultant contact phone**

(808) 494-2039

**Consultant address**

P.O. Box 191
Hilo, Hawaii 96721
United States
Map It

**Action summary**

The proposed project is located just southwest of the Kona International Airport and consists of the construction and operation of a new Innovation Center for the Natural Energy Laboratory of Hawaii Authority (NELHA) as well as a separate Hale Wawaloli Visitor Center for the Hawaii Ocean Science and Technology Park (HOST Park). The Innovation Center would be an expansion of the existing Research Village. The current research facility is essentially at full capacity and the expansion would provide for program growth for the foreseeable future. The Innovation Center would include offices, conference spaces, laboratories, indoor and outdoor research spaces, and meeting areas. The Hale Wawaloli Visitor Center would be an addition to the existing Wawaloli Beach Park facilities, and would serve as NELHA's shoreline visitor education center. The proposed project has been designed to complement the visual character of the area and minimize impacts to coastal resources.

**Reasons supporting determination**

Part 5: Findings and Reasons of the Draft EA outlines those factors considered to support the determination.

**Attached documents (signed agency letter & EA/EIS)**

- Draft_EA_NELHA_Innovation_Center_Hale_Wawaloli.May_2022.pdf

**Action location map**

- Submittal-to-OPSD-ERP.zip

**Authorized individual**

Michele Lefebvre

**Authorization**

- The above named authorized individual hereby certifies that he/she has the authority to make this submission.

**DRAFT ENVIRONMENTAL ASSESSMENT**

# NELHA's Innovation Center and Hale Wawaloli Visitor Center

TMKs (3) 7-3-043:051, 7-3-043:100, and 7-3-043:088 (portion)
North Kona District, Hawai'i Island
State of Hawai'i

May 2022

Natural Energy Laboratory of Hawaii Authority
73-4460 Queen Ka'ahumanu Highway, #101
Kailua-Kona, HI 96740-2637

This page intentionally left blank

## DRAFT ENVIRONMENTAL ASSESSMENT

# NELHA's Innovation Center and Hale Wawaloli Visitor Center

TMKs (3) 7-3-043:051, 7-3-043:100, and 7-3-043:088 (portion)
North Kona District, Hawai'i Island, State of Hawai'i

AGENCY:

Natural Energy Laboratory of Hawaii Authority
73-4460 Queen Ka'ahumanu Highway, #101
Kailua-Kona, HI 96740-2637

CONSULTANT:

Stantec Consulting Services Inc.
P.O. Box 191
Hilo, HI 96721

Geometrician Associates
P.O. Box 396
Hilo, HI 96721

CLASS OF ACTION:

Use of State Lands and State Funds

This document is prepared pursuant to:

The Hawai'i Environmental Policy Act,
Chapter 343, Hawai'i Revised Statutes, and
Title 11, Chapter 200.1, Hawai'i Department of Health Administrative Rules

**[this page intentionally let blank]**

## TABLE OF CONTENTS

**PART 1: PROJECT DESCRIPTION, LOCATION, AND ENVIRONMENTAL ASSESSMENT PROCESS** ..... 1
1.1 Project Location and Property Ownership ..... 1
1.2 Project Description ..... 1
1.2.1 Innovation Center ..... 1
1.2.2 Hale Wawaloli Visitor Center ..... 7
1.2.3 Landscaping ..... 8
1.3 Purpose and Need ..... 9
1.4 Environmental Assessment Process ..... 17
1.5 Public Involvement and Agency Coordination ..... 19

**PART 2: ALTERNATIVES** ..... 20
2.1 Proposed Project ..... 20
2.2 No Action ..... 20
2.3 Alternatives Considered but Eliminated from Detailed Analysis ..... 20

**PART 3: ENVIRONMENTAL SETTING, ENVIRONMENTAL CONSEQUENCES, CUMULATIVE IMPACTS, AND MITIGATION MEASURES** ..... 21
3.1 General Setting ..... 21
3.2 Environmental Consequences ..... 21
3.3 Physical Environment ..... 22
3.3.1 Geology, Soils, Geologic Hazards, and Climate Change ..... 22
3.3.2 Coastal Processes, Drainage, and Flood Zones ..... 27
3.3.3 Water Quality and Water Quantity ..... 29
3.3.4 Flora, Fauna, and Ecosystems ..... 36
3.3.5 Noise ..... 45
3.3.6 Air Quality and Scenic Resources ..... 47
3.3.7 Hazardous Materials and Wastes ..... 48
3.4 Socioeconomics ..... 49
3.5 Cultural Practices and Sites ..... 50
3.6 Historic and Archaeological Resources ..... 54
3.7 Infrastructure ..... 55
3.7.1 Utilities and Public Services including Wastewater Treatment and Solid Waste Management ..... 55
3.7.2 Traffic ..... 56
3.7.3 Airport Operations ..... 58
3.8 Review of Potentially Applicable Federal Authorities ..... 59
3.8.1 Archeological and Historic Preservation Act (16 U.S.C. § 469a-1) and National Historic Preservation Act (16 U.S.C. § 470) (NHPA) ..... 59
3.8.2 Clean Air Act as Amended (42 U.S.C. 7401, et seq.) ..... 59
3.8.3 Coastal Barriers Resource Act (16 U.S.C. 3501) ..... 60
3.8.4 Endangered Species Act (16 U.S.C. 1536(a)(2) and (4)), Essential Fish Habitat Consultation Process Under the Magnuson-Stevens Fishery Conservation and Management

Act (16 U.S.C. 1801), and Fish and Wildlife Coordination Act (16 U.S.C. 661) ..... 60
3.8.5 Environmental Justice (Executive Order 12898) ..... 62
3.8.6 Farmland Policy Protection Act (7 U.S.C. 4202(8)) ..... 63
3.8.7 Floodplain Management Act (42 U.S.C., 4321, and Executive Order 11988) Floodplain Management (24 May 1977) ..... 63
3.8.8 Protection of Wetlands (Executive Order No. 11990 & Executive Order No. 12608), and Clean Water Act, as Amended (33 U.S.C. 1251 et seq.) ..... 63
3.8.9 Safe Drinking Water Act (42 U.S.C., 300H-3(E)) ..... 64
3.8.10 Wild and Scenic Rivers Act (15 U.S.C. 1271-1287) ..... 64
3.9 Irreversible and Irretrievable Commitments of Resources ..... 64
3.10 Unavoidable Adverse Impacts ..... 65
3.11 Unresolved Issues ..... 65
3.12 Required Permits and Approvals ..... 66
3.13 Consistency with Government Plans and Policies ..... 66
3.13.1 Hawai‘i State Plan and Hawai‘i State Land Use Law ..... 66
3.13.2 Coastal Zone Management Program (Chapter 205A, HRS) ..... 66
3.13.3 Coastal Zone Management Act (16 U.S.C.1456(c)(1)) ..... 67
3.13.4 Hawai‘i County Zoning, Special Management Area, and General Plan ..... 68
3.13.5 Kona Community Development Plan ..... 71
3.13.6 Consistency with HRS Chapter 227-D ..... 72

**PART 4: DETERMINATION ..... 74**

**PART 5: FINDINGS AND REASONS ..... 75**

**PART 6: REFERENCES ..... 77**

**LIST OF TABLES**

Table 1 Plant Species Observed in the Project Site ..... 37
Table 2 Bird Species Detected at the Project Site ..... 39

## LIST OF FIGURES

Figure 1 Project Location Map .....10
Figure 2 Innovation Center Project Site.....11
Figure 3 Hale Wawaloli Visitor Center Project Site.....12
Figure 4 Conceptual Master Plan: Innovation Center Phases 2 and 2A.....13
Figure 5 Conceptual Floorplan – Innovation Center .....14
Figure 6 Conceptual Building Sections – Innovation Center.....15
Figure 7 Conceptual Floorplan – Hale Wawaloli Visitor Center .....16
Figure 8 Sea Level Rise Exposure Map: Innovation Center.....25
Figure 9 Sea Level Rise Exposure Map: Hale Wawaloli Visitor Center .....26
Figure 10 Flood Hazard Zone Map .....28

## APPENDICES

Appendix 1 Early Consultation Letters
Appendix 2 Cited Figures from NELHA Master Plan
Appendix 3 Biological Survey Results
Appendix 4 Archaeological Inventory Survey Report
Appendix 5 Traffic Impact Analysis Report (TIAR)

# SUMMARY OF THE PROPOSED ACTION, ENVIRONMENTAL IMPACTS, ANDMITIGATION MEASURES

The proposed project is located on the Kona coast just southwest of the Kona International Airport and consists of the construction and operation of a new Innovation Center for the Natural Energy Laboratory of Hawaii Authority (NELHA) as well as a separate Hale Wawaloli Visitor Center for the Hawaii Ocean Science and Technology Park (HOST Park). The Innovation Center would be an expansion of the existing Research Village (Phase 1 in the 2011 NELHA Master Plan). The current research facility is essentially at full capacity and the expansion would provide for program growth for the foreseeable future. The Hale Wawaloli Visitor Center would be an addition to the existing Wawaloli Beach Park facilities.

The Innovation Center would be developed in two phases, the first of which ("Phase 2") would begin construction in fall 2023, and "Phase 2A" would be built approximately 10 years later. Phase 2 would include offices, conference spaces, laboratories and wet-room research space, meeting nooks, and outside covered workspaces as well as support areas for maintenance and storage. Phase 2 would also include outdoor space for research, vehicular and pedestrian accessible routes, parking areas (50 stalls), security, and landscaping. Phase 2A would build office and incubator space, outdoor space for tenant research activities, and 88 additional parking stalls. Road and drainage improvements along with a wastewater treatment system would be constructed in Phase 2.

The Hale Wawaloli Visitor Center would be accessed from the existing parking area at Wawaloli Beach Park and would serve as NELHA's shoreline visitor education center. It would include an outdoor covered pavilion, an open amphitheater space for community gatherings and public events, and three enclosed spaces (for office and storage uses).

The Proposed Project has been designed to complement the visual character of the area and minimize impacts to coastal resources. No impacts to biological resources, historic or archaeological resources, or cultural sites or practices are expected from the Project.

**[this page intentionally left blank]**

# PART 1: PROJECT DESCRIPTION, LOCATION, AND ENVIRONMENTAL ASSESSMENT PROCESS

## 1.1 Project Location and Property Ownership

Natural Energy Laboratory of Hawaii Authority (NELHA) – an entity of the State of Hawaii attached to the State Department of Business, Economic Development & Tourism – proposes a new Innovation Center and Hale Wawaloli Visitor Center ("Proposed Project") in the Hawaii Ocean Science and Technology Park (HOST Park). The Innovation Center is located within Tax Map Keys (TMKs) (3) 7-3-043:051 and 7-3-043:100 and the Hale Wawaloli Visitor Center (Visitor Center) is located within a portion of TMK 7-3-043:088 (the Project Site) at Keahole Point in North Kona, as shown on Figures 1 through 3. The three parcels are owned by the State of Hawai'i, and are leased and managed by NELHA. The parcels for the Innovation Center cover approximately 12.5 acres, and although parcel 7-3-043:088 is much larger (approximately 21.5 acres), the footprint for the Visitor Center on this parcel would be less than 0.2 acre. The Innovation Center and Visitor Center are separated by a distance of approximately 0.6 miles. The Project Site is located *makai* of the Ellison Onizuka Kona International Airport. Photo Series 1 and 2 include photographs taken at the sites for the proposed Innovation and Visitor Centers.

## 1.2 Project Description

### 1.2.1 Innovation Center

The Innovation Center would be an expansion of the existing Research Village, which was Phase 1 in the 2011 NELHA Master Plan (NELHA 2011) and would be developed in two phases (Phase 2 and then Phase 2A). The conceptual Master Plan for the Innovation Center showing both phases is shown on Figure 4. Additional detail for the two phases is included below; the square footages and location of areas/features shown on figures and described in the text are conceptual in nature and their exact sizes and layout within the building would be determined during final design.

One of the key objectives of this center would be to compliment many of the building blocks for a thriving ocean economy that are already in place which include: world-class government infrastructure assets; education and research and development foundations; an increasing number of entrepreneurial ecosystem and talent development programs; and non-profit-led community improvement projects. The ocean economy cluster provides economic opportunity for local communities throughout the State. On a broader scale, growing this cluster would also improve the competitive position and balance of trade for the United States (U.S.) and help the U.S. build global dominance in ocean innovation and conservation technologies.

The Innovation Center would strengthen the ocean economy cluster as outlined above, building on the following regional assets at HOST Park. There has already been much success in developing an accelerator in the area of food security at HOST Park, and this model and existing world class asset would assist to replicate these efforts in the area of ocean technology and ocean conservation. New accelerators would specifically focus food security and expand into innovation in the areas of deep-sea exploration, ship automation, surface and underwater drones

and navigation, ocean energy, and remote sensing, as well as finding solutions to ocean-related environmental challenges in the areas of ocean health monitoring, natural hazards and early warning systems, ocean observation and instrumentation, ocean data visualization, coral reefs, and marine archaeology.

**Phase 2**

*Overview*

Initial development of the Innovation Center ("Phase 2") would begin construction in fall 2023, following issuance of construction permits. Construction for Phase 2 is expected to last approximately 12 months. Phase 2 would include approximately 21,000 square feet (sq. ft.) of facilities under roof including offices, conference spaces, laboratories and wet-room research space with flowing seawater, a "maker-space" workshop, meeting nooks, and outside covered workspaces as well as support areas for maintenance and storage. Phase 2 would also include approximately 48,200 sq. ft. of graded outdoor space for research tankage with access to sea water, fresh water, and electricity, vehicular and pedestrian accessible routes, parking areas (50 stalls), security, and environmentally appropriate landscaping. While the building load would be designed for a maximum of 269 occupants, it is estimated that the daily average of visitors and staff would be 30 per day. The building would have the capacity for special events with up to 200 attendees, but these would occur infrequently, approximately three times a year.

The Phase 2 structure includes a single-story building with east and west wings connected by a breezeway. The shape of the building and location of features in the building are shown on Figure 5. Figure 6 shows the building sections and elevations. The western portion of the building includes the lobby, common area, conference room, indoor laboratory, wet room laboratory, makerspace, outdoor laboratory, kitchen, two offices, utility rooms, and outdoor restrooms for staff and visitors. The eastern portion of the building includes the following: offices; meeting nooks; a commons nook; utility rooms; and indoor restrooms for visitors and staff. These spaces are described in greater detail below.

*Innovation Center Phase 2: Details for the East Wing*

Visitors and staff would enter the building at the lobby, which would be located at the connection between the two wings (Figure 5). The 350 sq. ft. lobby would provide a waiting area for up to 20 persons, a reception desk, and security checkpoint. Next to the lobby would be the 500 sq. ft. common area for use by visitors and staff. It would include an open, flexible space with a sofa, lounge chairs, and tables. Next to the common area would be an 800 sq. ft. conference room with audio visual equipment available for presentations or meetings. Adjacent to the lobby would be a 200 sq. ft. mail room.

South of the conference room would be the 1,000 sq. ft. makerspace that would include a large flexible workspace with various equipment for staff with shared interests to collaborate. Across from the makerspace would be a 2,000 sq. ft. indoor laboratory for ocean research. The details of this space would be identified by the future tenant but would include plumbing for surface sea water (SSW), deep sea water (DSW), and sea water disposal. Adjacent to the indoor laboratory would be a wet room laboratory for blue technology research that would encompass 3,000 sq. ft. with plumbing for SSW, DWS, and potable water. Blue technology refers to a broad spectrum of industries and innovative technologies focused on promoting sustainable ocean activities.

Adjacent to the wet room would be a 1,000 sq. ft. outdoor laboratory that would include plumbing for SSW, DWS, and potable water. There would be two open offices available for rent, each encompassing 600 sq. ft. (total 1,200 sq. ft.) adjacent to the common and conference room.

Across from the makerspace, there would be a 20,000 sq. ft. outdoor "tankage" area to accommodate above-ground water tanks, raceways, and flumes for aquaculture research. Plumbing for potable water, SSW, DSW, and for water disposal would be installed at several locations within the outdoor tankage area. There would also be an outdoor covered work area encompassing 2,000 sq. ft., and 160 sq. ft. outdoor restrooms for men and women. Restrooms would feature water efficient fixtures and LED lighting. Adjacent to the restrooms would be a 300sq. ft. outdoor shower area with storage for surfboards and bicycles.

*Innovation Center Phase 2: Details for the West Wing*

Located throughout the west wing would be four meeting nooks, each encompassing 200 sq. ft. (total 800 sq. ft.) and available for informal meetings.

There would also be the following available for rent: two large offices, each 800 sq. ft. (total 1,600 sq. ft.); eight medium offices, each 300 sq. ft. (total 2,400 sq. ft.); and four small offices, each 150 sq. ft. (total 600 sq. ft.).

Two indoor 200 sq. ft. restrooms would be located adjacent to the common area. Restrooms would include water efficient fixtures and LED lighting. Next to the restroom would be a 50 sq. ft. janitorial room for storage of cleaning supplies and equipment.

The Innovation Center would also include the following: a 120 sq.ft. electrical room; a 100sq. ft. telecommunications room near the electrical room to house phone and data cable distribution equipment; a 100 sq. ft. mechanical room to house seawater air conditioning (SWAC) units; a 120 sq. ft. inverter room to house inverters for a roof-mounted PV panel system; and a 500 sq. ft. outdoor receiving/loading area.

*Innovation Center: Parking and Access*

The Innovation Center would primarily be accessed by an asphalt paved driveway connecting to Makako Bay Drive on the west side, and a secondary gravel paved driveway on the east side connecting to Makako Bay Drive. The site would include approximately 50 stalls parking, including American with Disabilities Act (ADA) compliant stalls and four electric vehicle (EV) charging stations, accessed from Makako Bay Drive. Parking would be located in two lots, one constructed as part of Phase 2 and the other in Phase 2A. It would also include parking at the laboratory for two boats up to 25 feet long. There would also be a pedestrian/bike walkway between Phase 1 and Phase 2 (Figure 4).

*Innovation Center: Wastewater*

A wastewater treatment system comprised of septic tanks and a leach field would be constructed to support development of the Innovation Center. Wastewater would be treated using three septic systems, which would be located *makai* of the east wing of the Innovation Center. The systems would not need to be traffic-rated and would likely be composed of plastic and the absorption beds would use perforated PVC pipe for distribution. Since the percolation rate in the area is extremely fast, a three-foot layer of imported soil would need to be placed at the bottom of the absorption beds.

## Photo Series 1: Existing Conditions at Innovation Center Site

Looking southeast towards adjacent tenant

Looking southwest across disturbed gravel area

Looking northwest

Looking towards the coastal trail from the site

## Photo Series 2: Existing Conditions at Hale Wawaloli Visitor Center Site

Looking southeast towards existing parking lot

Looking north from the site

Looking west, coastal trail *makai* of the site

Buildings constructed under Phase 2A would require additional systems and may require their sewage to be pumped to a higher elevation due to the proximity to the ocean.

*Innovation Center: Utilities*

Both phases of the development would be compliant with ADA Standards for accessible design, and all buildings would include LED lighting. The Project would comply with the County of Hawai'i Outdoor Lighting Ordinance (Hawai'i County Code Chapter 9, Article 14) and Hawai'i Revised Statutes (HRS) §201-8.5 (Night sky protection strategy). All exterior lighting would consist of blue-deficient lighting such as filtered LED lights or amber LED lights, with a Correlated Color Temperature (CCT) of 3200 Kelvin.

Electrical and sewer service would be extended from nearby public grid termini. In a letter submitted during early consultation, the Department of Water Supply (DWS) acknowledged the water needs for the Project and stated that additional public water-system improvements would likely be required (Appendix 1). NELHA are actively engaged in a Capital Improvements project to develop a new public potable water source along with associated storage and distribution system improvements. In addition, they will continue conservation efforts and their active support for commercializing new desalination technologies at the HOST Park. A domestic water service lateral is proposed to connect to the existing 12-inch main line within Makako Bay Drive and run along the site's western access driveway. Additionally, branch laterals would be extended from this line to the buildings and other areas onsite requiring potable water.

A fire protection water service lateral is proposed to connect to the existing 12-inch main line within Makako Bay Drive and run along the site's eastern access driveway. A single onsite fire hydrant is proposed to serve the buildings constructed under Phase 2, and additional onsite fire hydrants would be required to serve Phase 2A.

<u>Phase 2A</u>

Phase 2A would be built approximately 10 years after Phase 1 and would include approximately 30,000 sq. ft. of facilities under roof, 88 additional parking stalls, and approximately 66,400 sq. ft. of graded outdoor space for tenant research activities and tankage. Additional road and drainage improvements would be constructed in Phase 2A, as well as a wastewater treatment system built in compliance with State Department of Health regulations.

### 1.2.2 Hale Wawaloli Visitor Center

The Hale Wawaloli Visitor Center would become the public viewport on the science, engineering, and business activities at HOST Park, serving as a visitor education center as well as a multipurpose space for the community to hold presentations, meetings, and gatherings. Its development would occupy approximately 2,500 sq. ft. and include an outdoor covered pavilion with 2,000 sq. ft. under roof, and a 500 sq. ft. outdoor amphitheater (Figure 7). It would be accessed from the existing parking area at the Wawaloli Beach Park and feature environmentally appropriate landscaping.

The covered pavilion would include a 1,200 sq. ft. roofed space, open on three sides, for holding presentations, gatherings, and public information sessions. The pavilion would also include a 140 sq. ft office for use by the personnel who monitor and maintain security at HOST Park, a 50 sq. ft.

electrical and telecommunications room to house power and data distribution equipment, and two 110 sq. ft. storage rooms.

Adjacent to the pavilion would be an amphitheater, which would open to the sky, that would accommodate gatherings and presentations for the public and visitors. The 200 sq. ft. amphitheater stage would be made of concrete and would be surrounded by a grassed seating area for the audience.

*Hale Wawaloli Visitor Center: Parking and Access*

Since sufficient restroom and parking facilities are already present directly adjacent to the proposed Visitor Center at Wawaloli Beach Park, no additional restrooms or parking are proposed. However, as part of the Project, two parking stalls in the existing parking lot would be converted to an ADA compliant parking stall and access aisle. Additionally, a new concrete walkway would be connected to the existing parking lot to provide pedestrian access to the site.

*Hale Wawaloli Visitor Center: Utilities*

No wastewater would be generated from the proposed improvements at the Visitor Center. A domestic water service lateral is proposed to connect to the existing 12-inch main line within Makako Bay Drive to serve this site. Additionally, a new fire hydrant, connecting to the existing 12-inch main within Makako Bay Drive, would be constructed just north of the existing parking lot, adjacent to the existing driveway.

### 1.2.3 Landscaping

Landscaping around the Innovation Center and Hale Wawaloli Visitor Center would feature native species, adapted to the coastal environment, as well as "canoe" species that were introduced by the first Polynesian navigators to Hawai'i. NELHA would ensure that all non-native plants used for the Project are not listed as invasive by the Hawaiian Ecosystems at Risk (HEAR) and Pacific Island Ecosystem at Risk (PIER) risk assessment rating system. No invasive materials would be used for the Project. Native plants used in landscaping would be integrated into educational opportunities, with interpretive signage.

Featured plants at both the Innovation Center and Visitor Center would include (but not be limited to) native and Polynesian introduced plants such as loulu (*Pritchardia* spp./native only), milo (*Thespesia populnea*), coconut (*Cocos nucifera*), hala (*Pandanus tectorius*), naupaka (*Scaevola taccada*), pohinahina (*Vitex rotundifolia*), 'akulikuli (*Sesuvium portulacastrum*) and 'aki'aki (*Sporobolus virginicus*).

Landscaping plantings would help stabilize the graded areas near and at the existing slopes, and swale would help the area around the buildings become more effective bioswales/stormwater infiltration areas. Site design would collect the surface runoff to be directed for the landscape, or for infiltration, into the subsurface. Within the bio-swale/infiltration areas, the Project would include plantings of 'aki'aki, kupukupu (*Nephrolepis cordifolia*), 'uki (*Cladium jamaicense*) and makaloa (*Cyperus laevigatus*). These plants can tolerate occasional inundation, but otherwise are very drought tolerant once established.

Irrigation would initially support the new landscape areas to help establish plantings. However, once established, many of the native plants would be weaned off regular irrigation and would

rely on available rainfall and occasional supplemental irrigation. Areas with roof cover may require permanent irrigation, but the drought tolerant native plants used would limit this water application. All irrigation would be distributed through the most efficient drip irrigation systems, controlled with a smart irrigation controller with an integrated weather station or moisture monitoring device.

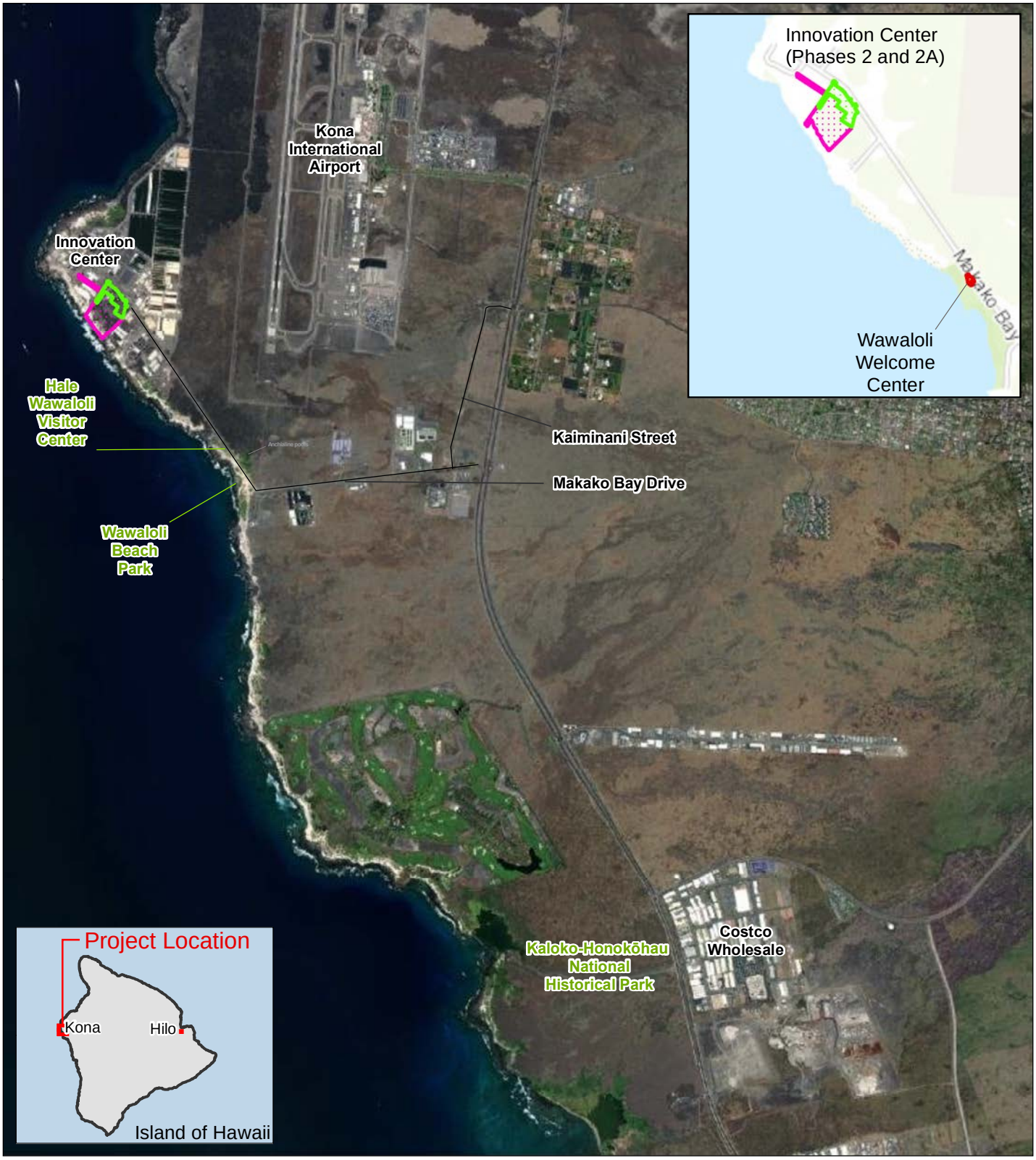
The landscape is designed to enhance the scenic stretch of coastline while integrating sustainable principles and using native and culturally important plants. The irrigation system would incorporate data from a weather station and environmental data to inform an automatic controller when the system needs to deliver supplemental water. The irrigation system would also incorporate a sub-meter to monitor water use and to highlight leaks.

## 1.3 Purpose and Need

NELHA's mission is to develop and diversify the Hawai'i economy by providing resources and facilities for energy and ocean-related research, education, and commercial activities in an environmentally sound and culturally sensitive manner. NELHA's HOST Park serves as a unique outdoor demonstration site for renewable energy, aquaculture, and other ocean-based technologies.

HOST Park has become a premier ocean science innovation hub and operates at the nexus of water, energy, and food. Two active sets of underwater intake pipelines and land-based pump stations deliver cold DSW from a depth of up to 3,000 feet as well as warm SSW for various uses on land. Current equipment and pipeline infrastructure is capable of pumping up to 100,000 gallons per minute of seawater through the 900-acre technology park.

Consistent with NELHA's mission, the purpose and need of the Proposed Project is to (1) complete Phases 2 and 2A of the NELHA Master Plan and provide for research program growth, since the current facility is essentially at current capacity, and (2) provide a publicly accessible visitor education center, cultural gathering place, and scenic meeting place for use by visitors and residents.




Legend

Phase 2

Phase 2A

N

Stantec

0 3,000 6,000 Feet

Scale (8.5 x 11): 1:25,000

Queen Ka'ahumanu Highway - Kailua-Kona, Hawaii
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

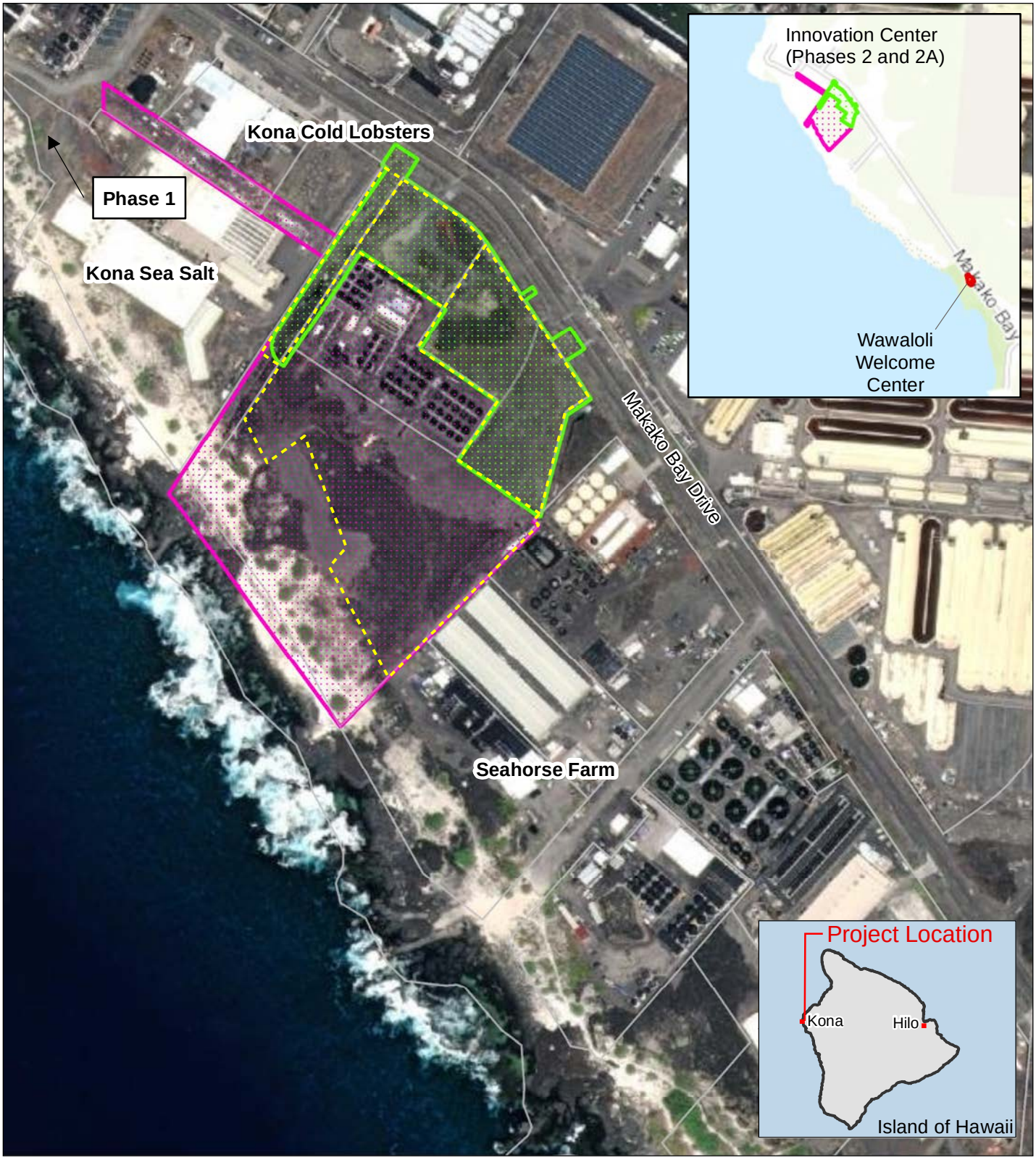
| DRAWN BY: JT | 1ST REVIEW: CJ | 2ND REVIEW: ML |
|---|---|---|
| DATE: 1/12/2022 | PROJECT NO: 185805157 | |

Figure 1:
Project Location Map

V:\2037\Active\185805157\03_data\gis_cad\gis\mxds\Project_Location_8x11P_20220112.mxd Revised: 2022-01-12 By: jtrook

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data.
The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.




Legend

- Phase 2
- Phase 2A
- Parcels
- Proposed Perimeter Fence

N

Stantec

0 300 600 Feet

Scale (8.5 x 11): 1:25,000

Queen Ka'ahumanu Highway - Kailua-Kona, Hawaii
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

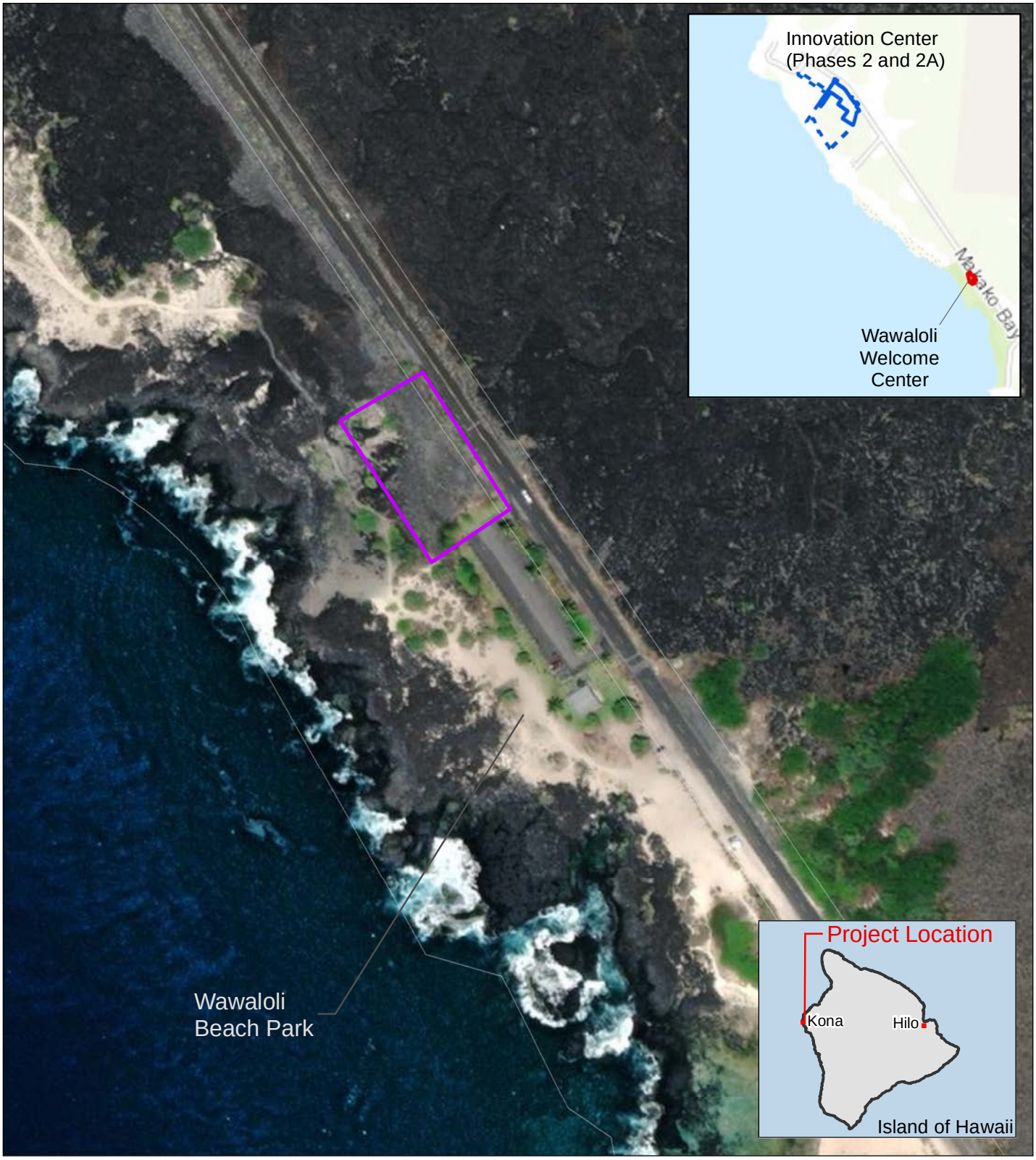
| DRAWN BY: JT | 1ST REVIEW: CJ | 2ND REVIEW: ML |
|---|---|---|
| DATE: 1/7/2022 | PROJECT NO: 2037201715 | |

Figure **2**:
Innovation Center
(Phases 2 and 2A)

V:\2037\Active\185805157\03_data\gis_cad\gis\mxds\Project_Location_North_8x11P_20220107.mxd Revised: 2022-01-07 By: jtrook

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data.
The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.




Legend

Proposed Wawaloli Welcome Center

Parcels

N

Stantec

0 200 400 Feet

Scale (8.5 x 11): 1:25,000

Queen Ka'ahumanu Highway - Kailua-Kona, Hawaii
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

| DRAWN BY: JT | 1ST REVIEW: CJ | 2ND REVIEW: ML |
|---|---|---|
| DATE: 8/17/2021 | PROJECT NO: 2037201715 | |

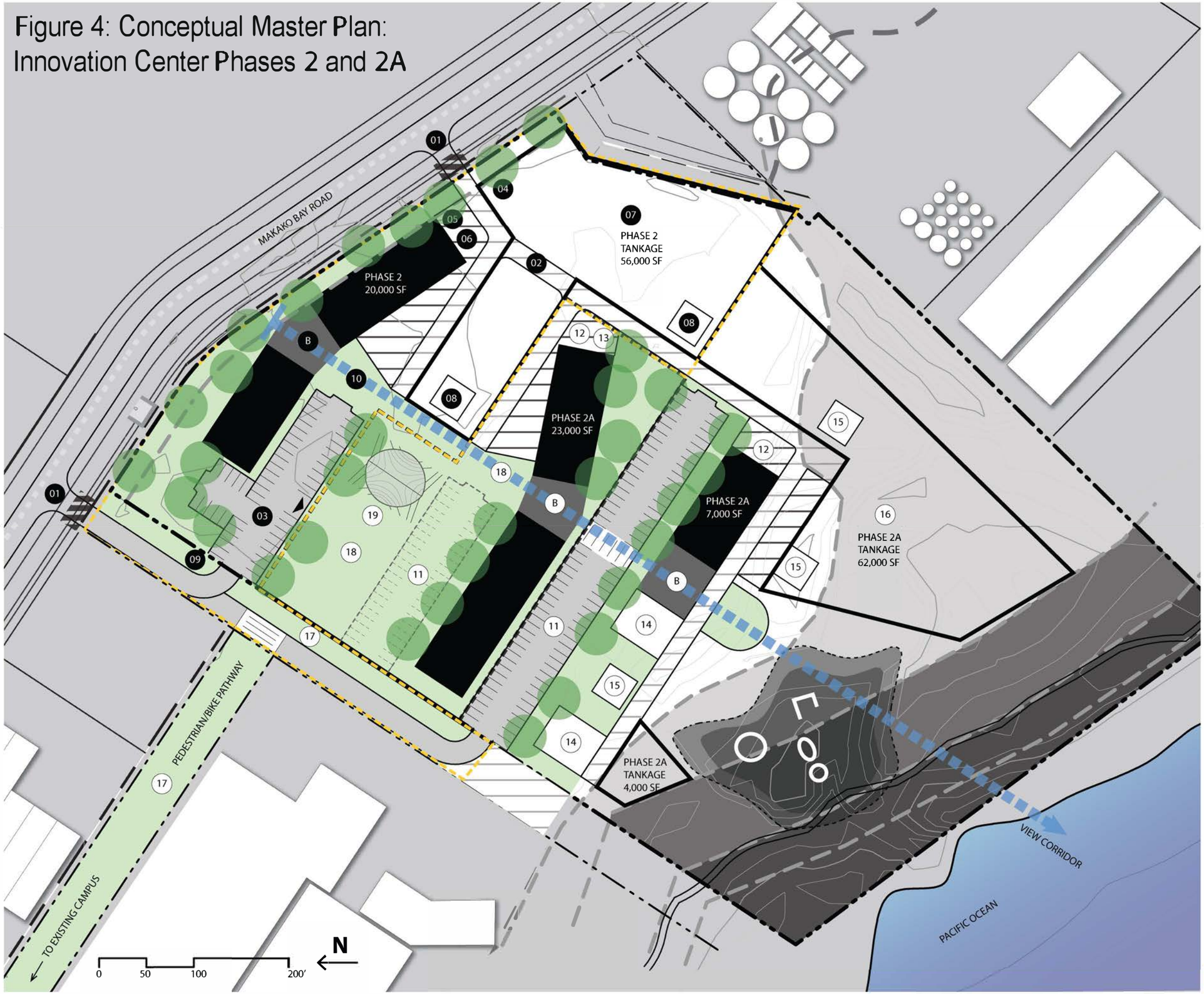
Figure **3**:
Wawaloli Welcome Center

V:\2037\Active\185805157\03_data\gis_cad\gis\mxds\Project_Location_South_8x11P_20210817.mxd Revised: 2021-08-17 By: chrjohnson

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data.
The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

# Figure 4: Conceptual Master Plan: Innovation Center Phases 2 and 2A




## PREFERRED MASTER PLAN

- New site entry and road along sea water easement.
- New secondary site access road (graded gravel) to service laboratory and tankage activites.
- Existing tenant, Royal Hawaiian Sea Farm (RHSF), new access via proposed Phase 2 parking lot.
- Connect existing campus and proposed campus with pedestrian/bike pathway and courtyards.
- Vista axis from Makako Bay Road to Ocean, interlinking buildings' breezeways, courtyards, and archaelogical site. Screened along Makako Bay Road.
- Phase 2 development near Makako Bay Road to minimize utilities lengths and grading extents.
- Phase 2A development at vacated tenant site and makai area.
- Single story, bar-form buildings, sited to capture natural ventilation and daylighting.

## LEGEND

**PHASE 2**

- 01 SITE ENTRY/ROAD
- 02 SERVICE ROAD
- 03 PARKING
- 03 BOAT PARKING
- 05 SURFBOARD RACK/STORAGE
- 08 LOADING
- 03 AQUACULTURE TANKAGE
- 08 PAVILION WORK AREA
- 08 PEDESTRIAN PATH
- 10 COURTYARD
- B OPEN AIR BREEZEWAY

PHASE 2 LIMITS

PERIMETER FENCE & GATE

**PHASE 2A**

- 11 PARKING
- 12 LOADING
- 13 COVERED STORAGE
- 14 WET LAB (TEA HOUSE)
- 15 PAVILION WORK AREA
- 16 AQUACULTURE TANKAGE
- 17 PEDESTRIAN PATH
- 18 COURTYARD
- 19 SHADE STRUCTURE
- B OPEN AIR BREEZEWAY

TANKAGE
PHASE 2: 56,000 SF
PHASE 2A: 66,000 SF
TOTAL: 122,00 SF
PARKING
PHASE 2: 50 STALLS
PHASE 2A: 88 STALLS + 46 (ALT)
TOTAL: 138 STALLS + 46 (ALT)

# Figure 5: Conceptual Floorplan - Innovation Center

## LEGEND

- COMMONS
- OFFICE
- LABORATORY
- UTILITIES

## NELHA - INNOVATION CENTER

DIAGRAM - PROGRAM DISTRIBUTION

# Figure 6: Conceptual Building Sections - Innovation Center

| REV NO. | SYM. | DESCRIPTION | SHT ___ OF ___ | DATE | |
|---|---|---|---|---|---|
| | | | | | APPROVED: |

ADAM G. WOLFING
LICENSED PROFESSIONAL ARCHITECT
No. 18327
HAWAII, U.S.A.

EXPIRATION DATE 04/30/2022

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE

STATE OF HAWAII

NATURAL ENERGY LABORATORY OF HAWAII AUTHORITY

KONA BIG ISLAND HAWAII

BUILDING SECTIONS

| DESIGNED BY: | CHECKED BY: | JOB NO. | DRAWING NO. |
|---|---|---|---|
| AW | KL | | A-330 |
| DRAWN BY: | APPROVED BY: | DATE | SHEET |
| MN | RN | 07/30/2021 | OF_____SHTS |

SCALE: 1/8" = 1'-0"

FILE _____ DRAWER_____ FOLDER_____

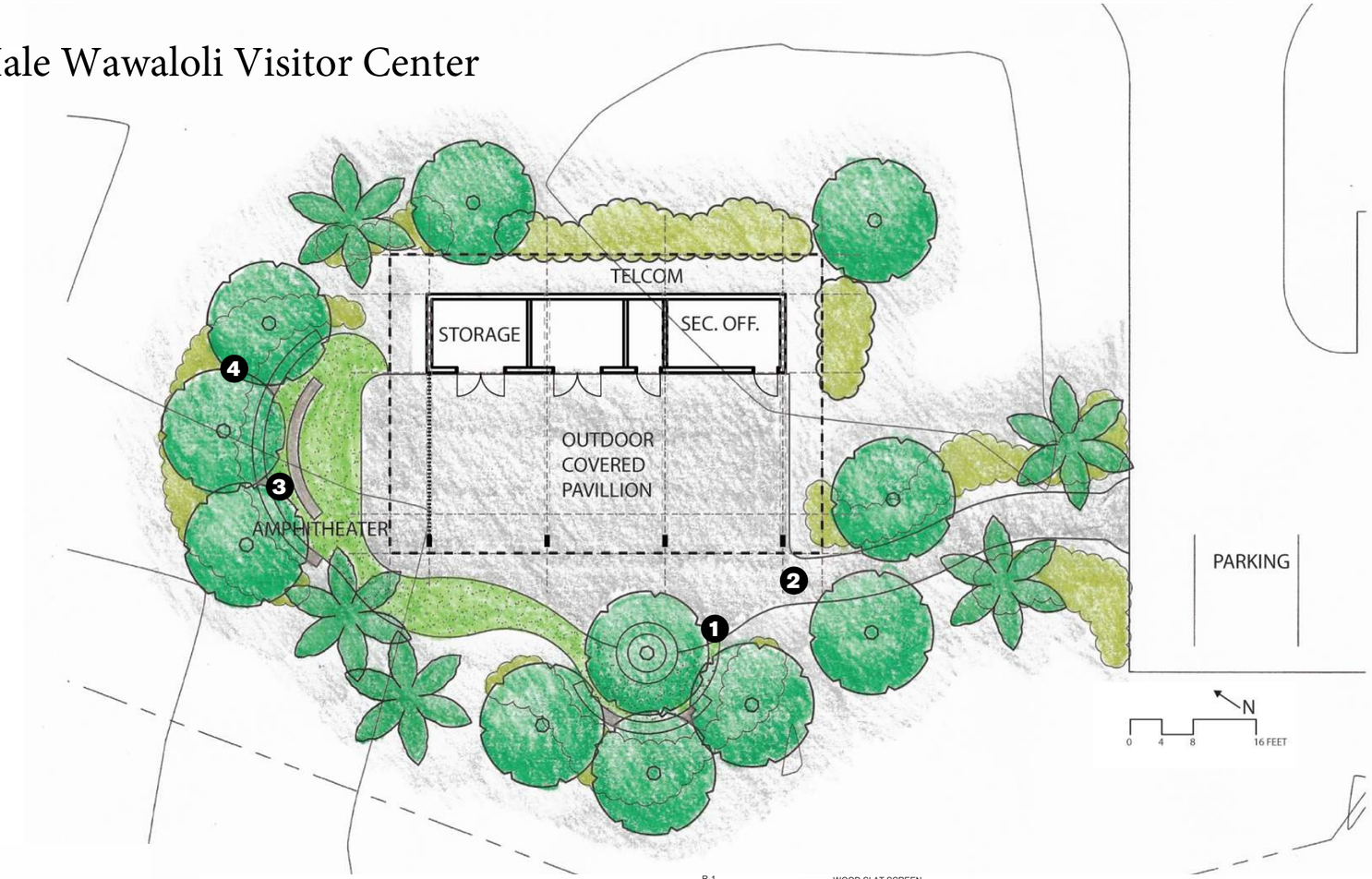
SCHEAMTIC DESIGN

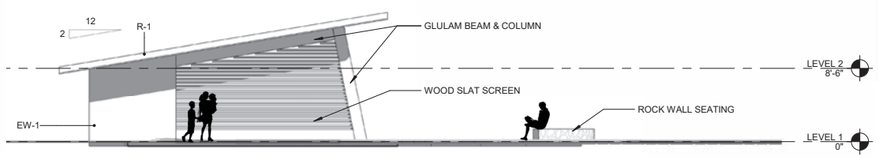
7/30/2021 5:24:38 PM

BIM 360://2006.00 NELHA Innovation Center/NELHA-R-rvt

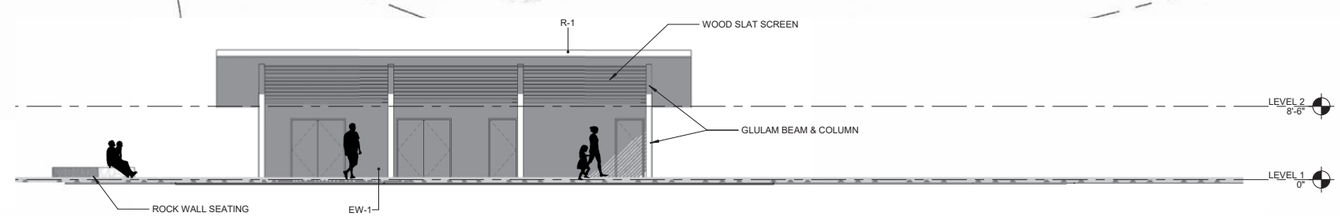
# Figure 7: Conceptual Floorplan - Hale Wawaloli Visitor Center

1. ARRIVAL AREA WITH SEATWALL AROUND TREE AND CURVED SEATWALL AT EDGE OF GRASS
2. CONCRETE WALKWAY AND LANAI-HEAVY WATER WASH FINISH TO LIGHTLY EXPOSE AGGREGATE
3. SEATING AREA WITH 18" TALL CURVED SEATWALL - SECOND ROW SLIGHTLY TERRACED
4. CANOPY SHADE TREES




1 NORTH ELEVATION
1/8" = 1'-0"




3 WEST ELEVATION
1/8" = 1'-0"

ROOFING ASSEMBLY
R-1 STANDING SEAM METAL ROOFING SYSTEM (TO RECEIVE PV PANELS) O/
WEATHER BARRIER O/
EXTERIOR SHEATHING O/
WOOD NAILERS W/ INSULATION (R-20) O/
PLYWOOD O/
WOOD DECKING

WALL ASSEMBLY
EW-1 SEALED CMU, STACK BOND

WINDOWS
ANNODIZED ALUMUNIUM WINDOW FRAMING W/
LOW E GLAZING

DOORS
HOLLOW METAL DOOR FRAME/
FIBERGLASS DOOR

| REVISION NO. | SYM. | DESCRIPTION | SHT NO. | DATE | |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | APPROVED: |

STATE OF HAWAII

NELHA - VISITOR CENTER

KAILUA-KONA BIG ISLAND HAWAII

BUILDING ELEVATIONS

| DESIGNED BY: | CHECKED BY: | JOB NO. | DRAWING NO. |
|---|---|---|---|
| DRAWN BY: | APPROVED BY: | DATE | SHEET |
| SCALE: 1/8" = 1'-0" | | 06/2021 | OF SHTS |

A-301

SCHEMATIC DESIGN

7/31/2021 10:10:30 PM

BIM 360://2004.01 NELHA Innovation Center NELHA-AR-VC.rvt

## 1.4 Environmental Assessment Process

*NELHA Background*

By Act 236 of the HRS, 1974, the State of Hawai‘i established the Natural Energy Laboratory of Hawai‘i (NELH) on 322 acres at Keahole Point on the Island of Hawai‘i. The physical characteristics of the site were considered uniquely suited for several significant State and federal energy programs. NELH was mandated to provide a support facility for research on the ocean thermal energy conversion (OTEC) process and its related technologies. The success of these programs was envisioned as highly significant for the intensive, long-term development of energy source alternatives to fossil fuels.

In 1979, a barge dubbed “Mini-OTEC,” anchored offshore of Keahole Point, demonstrated the world’s first production of net electrical power via closed-cycle OTEC. A year later, the NELH facilities that draw deep seawater from 2,000 feet and surface seawater from the 45-foot depth were constructed at Keahole Point. By 1984 it had become apparent that the seawater being pumped for OTEC research could also be used or reused for aquaculture and other purposes such as cooling. New legislation in 1984 legalized commercialization on State property, allowing NELH to host new tenant business ventures that could make use of the resources at Keahole Point. In 1985, the State Legislature created the HOST Park on an adjacent 548 acres at Keahole in anticipation of expansion needs of NELH’s growing businesses. In 1990, HOST Park and NELH were melded into one research and technology park under the administration of a new agency, NELHA, attached to the Hawai‘i State Department of Business, Economic Development & Tourism. In 1998-99, the Legislature expanded the activities allowed at the HOST Park to include other business activities that could enhance economic development and generate additional revenues to support the growing park. Today, NELHA is “landlord” to nearly 50 enterprises that generate over $100 million annually in economic impact, $5 million per year in tax revenues and are responsible for over 600 jobs statewide (UHERO 2012, 2015, 2019). Currently, two pipeline systems constantly pump deep and surface seawater to shore, including the world’s largest and deepest ocean water pipeline with an intake at 3,000 feet depth.

The cumulative impacts of long-term operation and expansion of NELHA operations were evaluated in four previously accepted environmental impact statements (EIS):

- Research Corporation of the University of Hawai‘i (RCUH). 1976. Environmental Impact Statement for the Natural Energy Laboratory of Hawaii at Keahole Point, Hawaii (Phase I). Prep. by R.M. Towill Corp. for RCUH.

- Hawai‘i State High Technology Development Corporation (HTCD). 1985. Final Environmental Impact Statement, Development Plan for the Hawaii Ocean Science and Technology Park and Expansion of the Natural Energy Laboratory of Hawaii, Keahole, North Kona, Hawaii.

- Natural Energy Laboratory of Hawai‘i. 1987. Final Environmental Impact Statement, Alternative Methods of Seawater Return Flow Disposal, Keahole, North Kona, Hawaii.

- Natural Energy Laboratory of Hawai‘i. 1992. Final Environmental Impact Statement, Development of Land Exchange Parcel, Natural Energy Laboratory of Hawaii. Prep. By GK & Associates for NELHA.

In addition, the following EIS addressed the impacts of land development and proposed aquaculture uses on an adjacent 83-acre parcel obtained by NELHA in a 1986 land exchange:

- Hawai‘i County Planning Department. 1986. Final Environmental Impact Statement, ‘O’oma II, North Kona, Hawaii. Prepared for Hawai‘i County Planning Department and Kahala Capital Corporation by Helber, Hastert, Van Horn & Kimura.

As discussed in Section 3.6.4, the Proposed Project is clearly of a type authorized by HRS Chapter 227D, which stated: “The purpose of the natural energy laboratory of Hawaii authority shall be to facilitate research, development, and commercialization of natural energy resources and ocean-related research, technology, and industry in Hawaii.” This Environmental Assessment (EA) is being prepared to analyze the impacts from construction and occupancy of an Innovation Center and Visitor Center.

*Environmental Assessment Process*

This EA process is being conducted in accordance with Chapter 343 of the HRS. This law, along with its implementing regulations, Title 11, Chapter 200.1, of the Hawai‘i Administrative Rules (HAR), is the basis for the environmental impact process in the State of Hawai‘i. Section 343-5, HRS established nine types of actions that “trigger” compliance. The use of State lands is one of these “triggers.” Since the Proposed Project crosses parcels that are controlled and managed by the NELHA, compliance with HRS and HAR is required. Additionally, NELHA seeks to partially fund the Proposed Project with State insurance proceeds resulting from damage caused by the 2018 eruption of Kilauea volcano, which demolished two lab buildings and a visitor center in the Puna district that were owned by NELHA. Use of such State funds is another “trigger” for which compliance with HRS and HAR is required.

According to Chapter 343, an EA is prepared to determine impacts associated with an action, to develop mitigation measures for adverse impacts, and to determine whether any of the impacts are significant according to 13 specific criteria.

Part 4 of this document states the anticipated Finding of No Significant Impact (FONSI); Part 5 provides a review and analysis of the “Significance Criteria” defined in Section 12 of the Chapter 11-200.1, HAR. In the EA process, if the approving agency, after considering comments to the Draft EA, determines that no significant impacts would likely occur, then the agency issues a FONSI, and the action is permitted to proceed to obtaining any other discretionary permits and approvals. If the agency concludes that significant impacts are expected to occur as a result of the proposed action, then an EIS is prepared to analyze the impacts and identify mitigation.

## 1.5 Public Involvement and Agency Coordination

The following agencies and organizations were consulted in development of the EA:

Federal:

- National Park Service, Kaloko-Honokōhau National Historical Park
- United States Fish and Wildlife Service (USFWS)

State:

- Department of Land and Natural Resources (DLNR)
- Department of Transportation (DOT)
- State Historic Preservation Division (SHPD)
- Department of Agriculture (DOA)
- Ellison Onizuka Kona International Airport
- Department of Health (DOH)

County:

- Civil Defense Agency
- County Council
- Department of Public Works
- Department of Water Supply
- Fire Department
- Planning Department
- Police Department

Private:

- Royal Hawaiian Sea Farms
- Ocean Rider
- Kona Coast Shellfish
- Kona Sea Salt
- Shrimp Improvement Systems Hawaii
- Cyanotech Corporation
- Hawaiian Islands Trading Company

Copies of communications received during early consultation are contained in Appendix 1 and relevant aspects of reply letters are discussed in the text of the EA.

# PART 2: ALTERNATIVES

## 2.1 Proposed Project

The action under consideration is described in Sections 1.1 to 1.3, above.

## 2.2 No Action

Under the No Action Alternative, the Proposed Project would not be developed on the site and no ground disturbance associated with the Proposed Project would occur. Under this alternative, there would not be additional research facilities or a visitor education center or public gathering area at this site in the HOST Park. The no action alternative would fail to encourage development of the NELHA as a marine research and commercial facility as prescribed in the County of Hawai'i General Plan. Also, under the no action alternative, Policy 3.3(a) encouraging development of alternate energy resources, 3.3(c) encouraging expansion of energy research industry, and 3.3(d) educating the public on new energy technologies and fostering attitudes and activities conducive to energy conservation, would not occur at this time at the Project Site. However, the Project Site is on land managed by NELHA and under this alternative NELHA could in the future propose and develop different research and visitor facilities and/or at a different location with the HOST Park.

## 2.3 Alternatives Considered but Eliminated from Detailed Analysis

NELHA considered alternative building locations and configurations, alternative building styles, and alternative access and parking.

NELHA looked at taller building structures, layouts that included more separate buildings, and siting the buildings closer to the coast. However, it was decided that the taller structures did not match nearby development, were less aesthetically pleasing, and would have more environmental impacts If they were sited closer to the coast than the style for the Proposed Project. The other layouts also did not minimize distance to utilities and would have been more costly to construct and maintain.

In the end, none of the other alternatives were found to be optimal for the property or the perceived demand for research facilities, and none resulted in fewer environmental impacts than the Proposed Project, and all were eliminated from detailed analysis.

# PART 3: ENVIRONMENTAL SETTING, ENVIRONMENTAL CONSEQUENCES, CUMULATIVE IMPACTS, AND MITIGATION MEASURES

## 3.1 General Setting

The portion of three parcels shown on Figures 1 and 2 that comprise the Proposed Project location are referred to throughout this EA as the Project Site. The term Project Area is used to describe the general area of North Kona. The Innovation Center site is located within TMKs 7-3-043:051 and 7-3-043:100, and the Hale Wawaloli Visitor Center site is located on TMK 7-3-043:088.

Parcel 051 is currently developed and sub-leased by Royal Hawaiian Sea Farms and is accessed along a graded road. The area, sub-leased by Royal Hawaiian Sea Farms, includes water tanks and other temporary structures. To the southwest of the proposed site for the proposed Innovation Center is an undeveloped coastal parcel. Northwest is a developed parcel with Hawaiian Islands Trading Company dba Sea Salts of Hawaii as the tenant, northeast is Makako Bay Drive, and next to the area on the southeast are three developed parcels with Ocean Rider Inc., Shrimp Improvement Systems and Blue Ocean Mariculture as the tenants. The eastern two-thirds of the Innovation Center portion of the Project Site area has been subject to prior grading and is partially developed; only the southwestern portion of Parcel 100 has not been subject to prior land disturbance. The portion of the Project Site that would be developed in Phase 2A for a walkway between Phase 1 and Phase 2 is sub-leased by Kona Cold Lobsters which operates an aquaculture business.

The Hale Wawaloli Visitor Center is located approximately 0.6 miles south of the Innovation Center properties and includes a roughly 0.2-acre portion of TMK: (3) 7-3-043:088. There are undeveloped lands to the northwest and southwest of this area, and Makako Bay Drive is located northeast. The parking lot for the existing Wawaloli Beach Park facility is located to the southeast. Most of the area for the Hale Wawaloli Visitor Center, except for a small area in the northwestern corner, has been subject to prior land disturbance.

Both areas are approximately 3,000 feet east of the nearest runway of the Ellison Onizuka Kona International Airport.

## 3.2 Environmental Consequences

This section of the EA includes a description of the environmental setting of the Project Site as well as the potential impacts to the resources from the Proposed Project and alternatives. An analysis of environmental consequences, both primary and secondary, and the cumulative are also considered in this section. Cumulative impacts are impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. Cumulative impacts include the direct and indirect impacts of a project together with the reasonably foreseeable future actions of others.

Past projects in the vicinity of the Project Site include developments by the tenants in HOST Park as well as airport improvements and resort and recreational development at Kohanaiki. The nearest reasonably foreseeable future projects would be additional development in HOST Park. As identified in the 2018-2019 Biennial Report, NELHA is expecting to complete a Master Plan update in the next several years (NELHA 2019). Additional plans and key studies include an updated EIS in the next three to five years and sub-division approvals, as necessary following the EIS (from County of Hawai‘i). NELHA's stretch goal for carbon neutrality includes establishing an energy storage testbed, developing a microgrid, and adding solar photovoltaic panels, among other concepts. The report emphasized an increased focus on aquaculture in 2019 and also identified: (1) upgrades to the road system and construction of new roads to access additional parcels; and (2) the Mats4 LLC project on 1.3 acres on Kaiminani Drive which is currently building a fuel station and convenience store on a commercial lease property (NELHA 2019).

## 3.3 Physical Environment

### 3.3.1 Geology, Soils, Geologic Hazards, and Climate Change

*Environmental Setting*

The Project Site has an elevation that varies from 10 feet above mean sea level (amsl) to 18 feet amsl and receives an average annual rainfall of 13 inches (Giambelluca et al. 2013). The geologic substrate on most of the Project Site is pahoehoe lava flows from Hualālai dated between 1,500 and 3,000 years in age (Wolfe and Morris 1996). Soil in the Project Site is classified by the U.S. Natural Resources Conservation Service as Lava flows, pahoehoe, 2-20 percent slope, and Beaches, 2-6 percent slope, without true soil development (U.S. Soil Conservation Service 1973).

The Island of Hawai‘i is subject to geologic hazards, such as lava flows and earthquakes. Slopes on the Project Site appears to be stable with no evidence of subsidence or landslides. Volcanic hazard as assessed by the U.S. Geological Survey in this area of North Kona is Zone 4, on a scale of ascending risk from 9 to 1 (Heliker 1990). The hazard risk is based on the fact that Hualālai has steep slopes and is the third most historically active volcano on the island.

Volcanic hazard Zone 4 areas have had about five percent of their land area covered by lava or ash flows since the year 1800 and less than 15 percent of their land area covered by lava in the past 750 years. They are at lower risk than Zone 3 areas because the frequency of Hualālai eruptions is lower than those of Kilauea and Mauna Loa.

The Island of Hawai‘i experiences high seismic activity caused by eruptive process within active volcanoes or by deep structural adjustments due to the weight of the islands on Earth's underlying crust (USGS 2019a). Although the earthquakes are seldom large enough to cause widespread damage, they can produce locally extensive ground fractures and subsidence (USGS 2019b). For example, the 6.6 magnitude earthquake that occurred in 2006 centered just off the northwest shore of Hawai‘i Island resulted in widespread damage to buildings and roads in Kona. The large earthquakes that affected the island of Hawai'i on Sunday, October 15, 2006, did not appear to result in any material damage at NELHA. Some surface seawater production was interrupted for approximately two hours until staff could arrive and re-prime and restart pumping units (NELHA 2006).

*Impacts and Mitigation Measures*

Geologic Hazards

In general, geologic conditions do not impose undue constraints on the Project Site that would result in the Project being challenging to implement, as demonstrated by the existing ocean technology-related infrastructure at the HOST Park. Design for the Innovation Center and Hale Wawaloli Visitor Center will be reviewed by a structural engineer and the buildings would meet all appropriate seismic standards.

Climate Change

According to the U.S. Environmental Protection Agency (EPA), global climate change may result in a rise in sea level that could worsen Hawai'i's existing coastal hazards, including waves, hurricanes, and tsunamis, and extreme tides (EPA 2016). Of the man-made greenhouse gases, the greatest contribution currently comes from carbon dioxide emissions. Through complex interactions on a regional and global scale, these greenhouse gas emissions and net losses of biological carbon sinks (i.e., vegetation) cause a net warming effect of the atmosphere, primarily by decreasing the amount of heat energy radiated by the earth back into space. Although greenhouse gas levels have varied for millennia, recent industrialization and burning of fossil carbon sources have caused greenhouse gas concentrations to increase dramatically and are a possible contributor to overall global climatic changes (IPCC 2007).

Potential changes to Hawai'i resulting from the effects of climate change include higher than normal temperatures, contraction or expansion of existing vegetation species distribution, the expansion of the range of existing invasive species populations and the introduction of new pathogens and invasive species, decrease in prevailing northeasterly trade winds, decline in rainfall and increased variability in rainfall patterns, increased ocean acidity, sea level rise, and threats to human health (University of Hawai'i at Mānoa Sea Grant College Program 2014).

The State of Hawai'i in HRS §226-109 identifies priorities to prepare the State to address the impacts of climate change. Also, Title 11-200.1-13 includes significance criteria to consider in environmental impact analysis that includes the hazardousness of sea level rise including: 1) the potential effects of a proposed action on climate change as indicated by assessing greenhouse gas emissions in a qualitative, or if reasonable, quantitative way; and 2) the effects of climate change on a proposed action and its environmental impacts. It recommends that agencies consider the short- and long-term effects and benefits in the alternatives and mitigation analysis in terms of climate change effects and resiliency to the effects of a changing climate.

Figures 8 and 9 illustrate that the locations of the Innovation Center and Hale Wawaloli Visitor Center, respectively, are not within the area predicted to be impacted from a sea level rise of 3.2 feet, which could occur as early as the 2060s (PacIOOS 2017). The Project's design including surface runoff drainage plans address the potential impact from flooding that could occur if increased variability in rainfall patterns occur. A more detailed description of flood and drainage plans are described in Section 3.3.2.

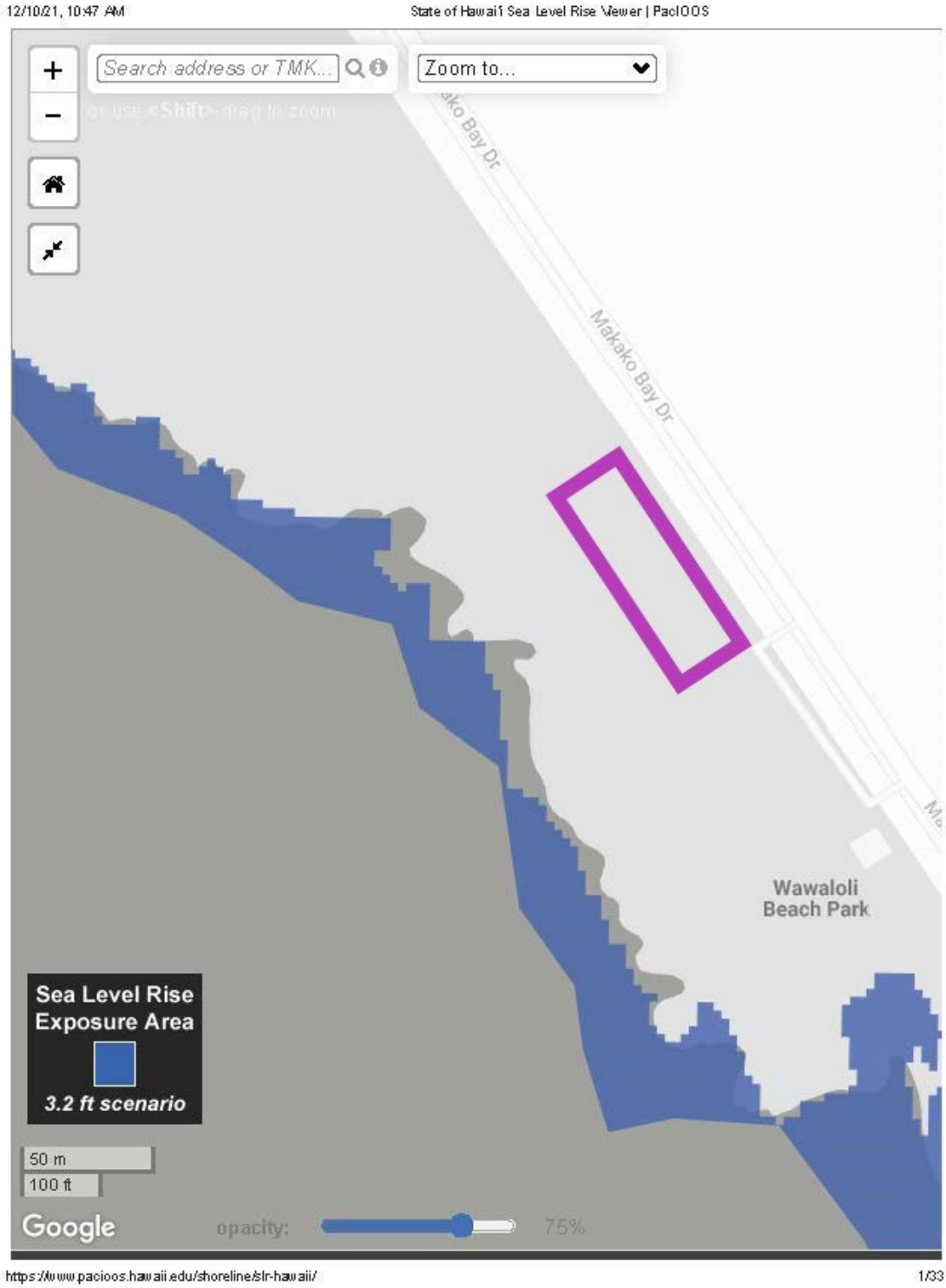
Potential impacts to climate change from the Project include direct impacts from emissions of greenhouse gases during construction and occupation of the proposed development related to the consumption of fuels (combustion), as well as indirect impacts from greenhouse gas emissions

associated with electrical power consumption. Since the Project would primarily rely on solar photo-voltaic generated electricity as well as implement energy conservation measures, including the use of cold seawater for heat transfer in the air conditioning, its operation would not result in a substantial increase in emissions when occupied. Additionally, the Project would promote the research and development of alternative energies, which would assist not only NELHA but the world in reducing greenhouse gas emissions. Therefore, Project impacts would contribute a negligible increase to global greenhouse gas emissions.

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions. There would be no change in impacts to climate, or from geologic conditions or seismic activity. Under this alternative, the research for alternative energy would not occur at the Project Site but could occur elsewhere.

**Figure 8 Sea Level Rise Exposure Map: Innovation Center**

Figure 9 Sea Level Rise Exposure Map: Hale Wawaloli Visitor Center



*Cumulative Impacts*

Since there are negligible impacts associated with climate change from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to these resources.

### 3.3.2 Coastal Processes, Drainage, and Flood Zones

*Existing Environment*

As illustrated on Figures 1 and 2, disturbance associated with the Innovation Center is located approximately 260 feet from the ocean and disturbance associated with the Hale Wawaloli Visitor Center is located approximately 220 feet from the ocean. The shoreline in this area consists of low pahoehoe cliffs, backed by shallow and intermittent storm sand beaches that are moderately vegetated, behind which are higher and almost bare pahoehoe flats. Shoreline erosion is not occurring on or near the Project Site, which is at elevations ranging from 10 to 18 feet amsl on the pahoehoe flats. Terrain is irregular and undulating due to the past volcanic flows.

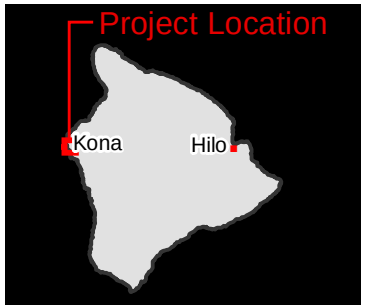
The Federal Emergency Management Agency's Flood Insurance Rate Maps (FIRM) 1551660706F (9/29/2017) and 1551660708F (9/29/2017) show that the property for the Innovation Center Phase 2 is located in Flood Zone X, Phase 2A of the Innovation Center is partially in Zone X and Zone AO, and the Hale Wawaloli Visitor Center is located in Zone X (see Appendix 2, Figure 2.8 in the NELHA Master Plan). Zone X is outside the 0.2 percent annual chance floodplain, whereas Zone AO is subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet (Figure 10).

According to the Pacific Tsunami Warning Center and the Hawai'i County Civil Defense Agency, the Innovation Center and Hale Wawaloli Visitor Center are located within the area that should be evacuated during a tsunami warning (see Appendix 2, which is Figure 2.8 in the NELHA Master Plan).

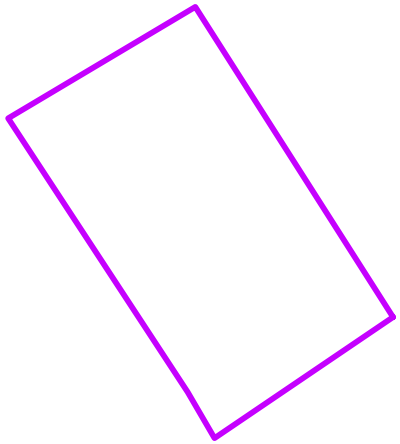
The drainage at NELHA has been extensively studied and reported in the NELHA Master Plan (NELHA 2011). Off-site drainage enters the Project Area from *mauka* to the Honua'ula Forest Reserve. Culvert crossings under Queen Ka'ahumanu Highway direct the runoff to the HOST Park. Analysis in the Master Plan concluded that development of the parcels in the HOST Park is not expected to impact overall drainage. Individual lots are required to construct on-site retention systems to maintain flows at predevelopment conditions. Drainageways along roads at NELHA have been regraded to more efficiently direct runoff through the culverts and on-site retention areas, where possible (NELHA 2011).

## Innovation Center






## Hale Wawaloli Visitor Center



Legend

- Phase 2
- Phase 2A
- Proposed Wawaloli Welcome Center
- Proposed Perimeter Fence
- 1% Annual Chance Flood Hazard
- Parcels

N

Stantec

Feet
0 200 400 1 in = 400 feet

Queen Ka'ahumanu Highway - Kailua-Kona, Hawaii
NAD 1983 StatePlane Hawaii 1 FIPS 5101 Feet

| DRAWN BY: JT | 1ST REVIEW: CJ | 2ND REVIEW: ML |
|---|---|---|
| DATE: 1/25/2022 | PROJECT NO: 185805157 | |

**Figure 10:**
**Flood Hazard Zone Map**

V:\2037\Active\185805157\03_data\gis_cad\gis\mxds\Fig10_Project_Flood_Hazard_Zones_8x11L_20220124.mxd Revised: 2022-01-25 By: jtrook

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data.
The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

*Impacts and Mitigation Measures*

The only part of the Project (Phase 2A) that would occur in the AO flood zone is the perimeter fence, as shown in Figure 10. The chain link fence would allow flood waters to pass through without affecting flood elevations and would be constructed to be consistent with other fences at HOST Park. Any other proposed activities or temporary structures in the AO flood zone would conform with DPW requirements for such a siting. The Project would be required to follow County regulations and policies related to flood control and drainage, among them Chapter 27 of the Hawai'i County Code. Chapter 27 requires the difference between pre-development and post-development runoff to be contained onsite, limiting impacts. A Master Drainage Plan was conducted as part of the NELHA Master Plan, and the Project would be consistent with that plan. A specific Drainage Plan for the Project would be submitted for review and approval by the County of Hawai'i DPW as part of the grading permit process. As part of this Drainage Plan, the amount of expected runoff including the effects of the Proposed Project would be calculated according to DPW standards. As required by Chapter 27, storm water should be disposed into drywells, infiltration basins, or other approved infiltration methods (Section 27-20(e)). Implementation of the approved Drainage Plan would ensure that runoff from the Project Site would not be directed toward adjacent properties and the development would not alter the general drainage pattern above or below the development (Section 27-20(e)). Surface disturbance within the AO flood zone would be limited to installation of the perimeter fence, which is essential for site security, and no other surface disturbance associated with grading, parking, and landscaping would occur within the AO flood zone.

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions. There would be no impacts to flood zones under this alternative.

*Cumulative Impacts*

Since there are no impacts associated with flood zone exposure from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to flood zones.

### 3.3.3 Water Quality and Water Quantity

*Existing Environment*

Water Quality

No natural overland drainageways are present in the Project Site; however, an open rock-lined seepage trench that receives water from the Cyanotech facility across the road cuts across the corner of the site of the Innovation Center near Makako Bay Drive. According to maps from the USFWS confirmed by field inspection, no wetlands are present at the Project Site (http://www.fws.gov/wetlands/Data/Mapper.html, accessed December 2021). The nearest mapped wetlands are approximately 2.5 miles south at Kaloko-Honokōhau National Historical Park.

The high quality of the offshore waters was a major factor in selection of the site for NELH and HOST Park. This is due to strong oceanic circulation patterns and lack of major sources of pollutants. The

State Department of Health classifies coastal waters off Keahole Point as class AA. HAR 11-54-03(c)(1) states that class AA waters are:

> "High quality waters are those in which water quality is expected to exceed that necessary to support oceanographic research, propagation of aquatic communities and wildlife, compatible recreation and aesthetic enjoyment. It is the objective of class AA waters 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. To the extent practicable, the wilderness character of these areas shall be protected."

*As required by various State and County permits issued between 1978 and 1994 in the course of development of NELH and HOST Park, for 40 years NELHA has been sampling and monitoring the waters along the coastline of Keahole Point as part of a Comprehensive Environmental Monitoring Program designed "to protect the unique environmental resources of the Keahole Point area and their diverse uses" (NELHA 2020).*

*Groundwater recharge in the Keahole Point area is primarily from rainfall. An unconfined basal lens underlies the coastal region of western Hawai'i from Keahole northward to beyond Kawaihae and southward to beyond Keauhou. In the vicinity of Keahole, the lens is brackish, likely less than 125 feet thick and discharges in a narrow band a few feet wide in the intertidal zone. At Keahole Point, brackish water discharges are diffuse and not usually visible along the shoreline. The coastal part of the lens experiences appreciable ocean tidal influence (NELHA 2011).*

*Anchialine ponds are land-locked bodies of water lacking surface connection to the ocean, but with measurable salinities and dampened tidal fluctuations. The West Hawai'i coast harbors most of the anchialine ponds in the state. Two clusters of ponds have been identified on NELHA property: (1) a northern complex of approximately five pools is situated north of the NELHA Research Campus inland of the cobble beach at Ho'ona Bay; and (2) a southern complex of ten pools north of the HOST Park access road and approximately 650 feet mauka of shoreline of Wawaloli Beach Park (NELHA 2020). These ponds are not located within the proposed Hale Wawaloli Visitor Center portion of the Project Site.*

<u>Water Quantity</u>

*The State Commission on Water Resource Management (CWRM) classification of aquifers locates this part of Kona as being in the Keauhou Aquifer System of the Hualālai Aquifer Sector. The sustainable yield of the aquifer has been estimated at 38 million gallons per day (mgd). The project site is not located above any of the nine Principal or Sole-Source aquifers identified in the U.S. EPA's Region 9 (https://archive.epa.gov/region9/water/archive/web/html/ssa.html, accessed March 2022).*

*The recharge area for the Keauhou Aquifer System is assumed to consist of essentially the surface area contained within the boundaries of the aquifer system. The Keauhou Aquifer System where the project is located has rainfall of less than 20 inches along the shoreline to about 125 inches in the Kahalu'u Forest Reserve. As computed by the CWRM, groundwater recharge is limited to the contribution of rainfall within the unit. It does not include potential inflow from adjacent units, nor*

the contribution of fog drip in the upper forests, which studies have determined to be a considerable amount.

*Impacts and Mitigation Measures*

Water Quality

As part of the Proposed Project, the existing on-site open seepage trench would be covered and no longer be open. No other impacts to surface water quality would be expected from the Proposed Project.

Potential impacts from the Project could occur to water quality during grading and construction activities from erosion and sedimentation. These impacts would be minimal, since grading of the Project Site during construction would be conducted in accordance with the grading permit which would be issued by Hawai‘i County. Prior to the initiation of construction for the Proposed Project, NELHA would ensure that a National Pollutant Discharge Elimination System (NPDES) general permit is in place. The permit would require best management practices (BMPs) to minimize erosion and for stormwater pollution prevention. Oversight of the BMPs would be conducted weekly for the duration of construction, with updates and corrective actions documented and transmitted to the State Department of Health, Clean Water Branch. Additionally, all earthwork and grading would conform with Chapter 10 – Erosion and Sedimentation Control – of the Hawai‘i County Code. Implementation of these BMPs would prevent potential impacts to water quality.

The intent is for the Proposed Project to collect and convey stormwater runoff into multiple onsite seepage pits with sizing based on a 10-year, one-hour rainfall event. Water runoff from parking lots, driveways, and other surfaces would be treated to minimize potential impacts to inland and coastal waters using standard stormwater pollution prevention technology which has proven to be effective at HOST Park. Data collected as part of NELHA Comprehensive Environmental Monitoring Program (CEMP) has demonstrated that the marine water chemistry has remained unchanged since the nearshore water quality monitoring started in 1982 (NELHA 2020). The specific technology, or combination of technologies, that would be implemented for the Project would be identified during the final design. On-going monitoring as part of the CEMP would ensure that the Proposed Project does not impact the nearshore marine water quality.

Consistent with the NELHA Master Plan, the Project would construct three individual wastewater systems (IWSs) to service the Innovation Center, each consisting of a septic tank and an associated leach field. NELHA is considering an option to design and install one of the IWSs to include a Nitrogen Removal Biosystem (NRB) (FDOH 2021). The objective would be to provide the first in-state full-scale test-bed for demonstrating the effectiveness of this methodology in reducing the nitrogen content of IWS effluent. This approach has already been validated in Florida and parts of the mainland Northeast; for example, in Suffolk County on Long Island New York application of this approach is mandated for all new home construction (East End Beacon 2020).

Modifications to the IWS leachfield required for the NRB consist mainly of lining the absorption bed with a partially permeable barrier, using a finer grade of granular fill material (sand or cinder soil) than is normally used in Hawai‘i, and an added layer of organic cellulosic material such as sawdust

or wood chips, along with the addition of ports from which to draw samples of leachate from various parts of the leachfield. The degree of denitrification achieved in the test-bed would be determined by comparison to the other two on-site IWSs and the influent of the NRB. All will be outfitted with similar sampling ports.

The expected daily average occupancy of a combined 30 visitors and staff per day, each of them generating up to 30 gallons per day of wastewater, yields a predicted flow of wastewater from the Innovation Center of approximately 900 gallons per day (gpd) - equivalent to approximately three residential households. Wastewater disposal for the Project would comply with the State DOH Administrative Rules, Chapter 11-62.

NELHA's Seawater Return System was the focus of a 2001 study that reviewed the hydraulics of seawater disposal at the facility (TNWRE 2001). Among the conclusions of that independent third-party review is that distributed dispersal of "used" seawater by means of covered shallow pits and trenches is effective. The Proposed Project would dispose of seawater used for aquaculture and other activities in the indoor wet laboratories and outdoor tankage areas by percolation into the ground by "French drains." These would consist of a network of perforated plastic pipe embedded in shallow excavated pits and/or trenches backfilled with lava-rock cobbles and small boulders and capped with a layer of gravel. These percolation areas would be located immediately beneath the outdoor tankage areas themselves.

Stormwater run-off from the impermeable surfaces and parking areas of the Innovation Center would be treated in a similar fashion, with percolation pits located near where the flows are generated.

The combined wastewater-generating activities proposed for the Innovation Center are similar to those in effect at NELH and HOST Park for the past 40 years, with disposal methods also largely as described above. Since long-term monitoring has shown the ground water chemistry at HOST Park to be relatively constant, with only intermittent anthropogenic nutrient enrichments and associated recoveries (NELHA 2020), no persistent or cumulative impacts to groundwater are expected from generation of wastewater or stormwater.

Water Quantity

*Freshwater*

An important goal of the Project is to use water as efficiently as possible. The Proposed Project would include water efficient fixtures and implement water efficient research practices throughout the development. With these strategies, the Innovation Center is expected to utilize 4,000 gpd of potable water for Phase 2 and an additional 2,000 gpd for Phase 2A, or approximately 1.5% of NELHA's allotment from DWS at full build-out. This use is the equivalent of 10 average single-family residences in North Kona (Hawai'i County DWS 2010:809-29), in an aquifer being utilized by more than 10,000 homes and 1,000 commercial water accounts. Since Project construction would be phased, the potable water use associated with Phase 2A would occur approximately 10 years after Phase 2A is constructed.

As briefly described in Section 1.2.1, NELHA is currently developing water sources, storage solutions, conservation, and distribution as well as continuing efforts to commercialize new desalination

technologies at the HOST Park. Potable water for the Project would be supplied through NELHA's existing internal water system, which is supplied by a master meter from the Department of Water Supply and the water is likely to be derived from the Keauhou Aquifer System.

The National Park Service (NPS) has expressed concerns in response to EISs and EAs in the region about whether the sum of development in the area surrounding Kaloko-Honokōhau National Historical Park (NHP) could impact the ponds and coastal waters that form the groundwater dependent ecosystems (GDEs) under NHP's protection. Notable resources include anchialine ponds with endangered invertebrate species, as well as the following: Kaloko fishpond, which is being restored for traditional and productive aquaculture use for human consumption; 'Ai'opio fishtrap, which is intensely utilized for fishing and traditional and customary cultural practices; 'Aimakapa fishpond and wetland, which is an important foraging and nesting habitat for the endangered Hawaiian Stilt and the endangered Hawaiian Coot, and overall important habitat for migratory waterfowl; and the general coastal waters, which are used by juvenile threatened green sea turtles and the endangered hawksbill sea turtle. NPS is particularly concerned about impacts to groundwater quantity and quality, polluted runoff, inadequately treated wastewater, and groundwater withdrawal. In their early consultation letter dated November 30, 2021, the NPS identified potential concerns from the Project related to potable and non-potable water usage, wastewater treatment, and pollution from surface water drainage.

It is important to note that the HOST Park has been developed to grow sustainable-oriented research and businesses that assist in minimizing the effects of global climate change by developing knowledge and disruptive technologies to: (1) increase food security and supply; (2) understand the role the ocean plays in global climate change; (3) monitor and manage marine pollution; (4) support programs in developing ocean energy technology; and (5) develop better conservation technologies for our ocean resources. These mission objectives are complementary to those of the NPS, and progress towards them are expected to also benefit the NPS and resources they are bound to protect. The Proposed Project is integral to NELHA's ability to foster such progress.

At this point, it is not possible to determine what proportion of the Project's freshwater would be derived from wells that tap a portion of the aquifer that flows under and through the NHP. When viewed in context of the current daily withdrawals from the entire aquifer for all uses, which totaled 14.86 mgd in 2015 (Hawai'i County DWS 2015), even under a "worst case" scenario in which all 6,000 gpd of the water for the Project were to be derived from a well or wells that draw water from a portion of the aquifer that flows through the groundwater dependent ecosystems at the NHP, this quantity represents less than 0.04% of total use. The direct effects of such withdrawal are negligible, and there is almost no chance that well water withdrawal could directly affect the salinity or availability of water resources at the NHP. In any case, any wells that would be developed by NELHA in the future to provide water for its developments would be sited in locations already identified by the NHP as being of no concern to them with regards to groundwater impacts, and they would also comply with the State Water Code, Chapter 174C, HRS, and HAR Chapters 13-167 to 13-171 and would consider impacts to the aquifer. Since the Project improvements are located 3 miles north of the NHP, at nearly the same elevation, there is no known hydrological mechanism by which any of the filtered return flow from irrigation, the

septic system, or used seawater disposal would recharge or affect in other ways groundwater feeding the NHP's GDEs.

The use can also be considered from a cumulative perspective, the fast-growing North Kona District is the center of the visitor industry and real-estate development that powers the economy of the island. In this dynamic region, there are many public and private projects being planned. Each development has some potential to affect use of water in the Keauhou Aquifer System. The guide to the effects of future developments on water use is the Hawai'i County Water Use and Development Plan (WUDP), which projects future uses and the strategy of the County to satisfy them within the sustainable yield of the aquifer. As a result of discussions with the NPS, possible effects to the NHP have also become an important consideration. The County of Hawai'i adopted by ordinance the WUPD Update dated August 2010 (2010 WUDP), and the CWRM granted approval in December 2011. The 2010 WUDP update implemented a broad, uniform approach island-wide to conservatively evaluate the County's land use policies set forth in the County General Plan and Zoning Code. The intent of the 2010 WUDP was to guide the County in prioritization and focus of future assessment efforts.

The 2010 WUDP identified two aquifers to be considered in an update for further evaluation and detailed assessment, including the Keauhou Aquifer Sector. The update consisted of two phases. The first phase involved the refinement of the water demand scenarios and projection. This was completed in 2015 (DWS 2015). The second phase (DWS 2016) focused on the development of source development strategies and scenarios, and also explored methods to identify traditional and customary native Hawaiian rights, cultural uses or other public trust purposes related to, affected or impacted by ground water development, and also dealt with how those impacts should be mitigated.

The 2010 WUPD forecast future demand to rise from 14.86 mgd to 27.87 mgd by 2025, at which point it would be 73.34% of the currently estimated sustainable yield of the aquifer. At some point, particularly without monitoring and mitigation, the cumulative impact of water development could be manifested in markedly reduced flows of groundwater and salinity changes of a magnitude that might affect natural resources and cultural practices. Some form of monitoring and mitigation is thus clearly necessary. The great majority of development associated with the anticipated demand scenario is expected to be supplied by the DWS system; hence, source development will principally involve DWS and its partnerships with private entities and State agencies. DWS will also be responsible for continually coordinating with the NHP as well as practitioners of traditional and customary uses during source development to ensure that water development and use do not impact natural and cultural resources. Throughout the WUDP planning process, DWS has envisioned a number of source development strategies to focus on meeting the anticipated demand scenario. The implementation strategies provided guidance for further integration and planning coordination of water resource management with the development of land use policies to ensure sustainable management of water resources. Strategies include requiring extensive water conservation measures of all new projects, monitoring wells for signs of increasing salinity, and utilizing water from wells located in areas of the aquifer, or adjacent aquifers, that do not have the potential to reduce groundwater flow to the NHP. Involvement of Native Hawaiian individuals and organizations during major water project planning is also a key component (Hawai'i County DWS 2015).

At some point in the future, new development projects may be foreclosed, or alternative ways of providing water will need to occur, because of impacts to water resources that will be calculated using the latest information as each project goes through the approval process. That point has not yet arrived, and the cumulative impact of the potential withdrawal of all of the center's needed 9,000 gpd (in Phases 2 and 2A) combined with the existing uses and reasonably foreseeable uses does not at this time require mitigation in addition to that already occurring through DWS planning and monitoring. Safeguards in place can prevent and/or mitigate impacts in the foreseeable future.

Seawater

The Innovation Center is expected to utilize up to 2,100 gallons per minute (gpm) of seawater (combined SSW and DSW) for Phase 2 and 2,400 gpm for Phase 2A. This can be compared to the average pumping rate at the HOST Park over the 12 months of 2021 of 13,500 gpm. Therefore, the Phase 2 of the Proposed Project would represent an additional 15.6% above 2021 pumping rates (although these were slightly lower than in the recent past due to reduced economic activity). Approximately 10 years later, Phases 2 and 2A together would represent a 33% increase over 2021 rates.

Historically, at peak usage, NELHA has pumped up to 21,000 gpm at the HOST Park. NELHA's permitted use under CDUP HA-1862 is up to 126,000 gpm, so Phase 2 would represent 1.7% of permitted pumpage, and approximately 10 years later Phase 2 and Phase 2A together would represent 3.57% of permitted pumpage. Combined seawater use for the Proposed Project along with other ongoing uses is well below the permitted pumpage rates. Additionally, the CEMP would continue to monitor both the nearshore environment and groundwater surrounding the Project Site and any deviations from normal background water chemistries due to Project activities would result in corrective actions and mitigation to restore normalcy. Therefore, the Proposed Project is not expected to impact seawater or the nearshore environment.

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions. There would be no impacts to water quality or quantity under this alternative.

*Cumulative Impacts*

The relevant past, present, and reasonably foreseeable future projects for cumulative impacts are described in Section 3.2. Although any given project has potential to deplete groundwater and/or impact water quality by sedimentation or nutrient loading, this discussion analyzes issues that might arise not from the impacts of an individual project, but rather cumulative impacts in the region. NELHA began monitoring marine water quality in 1982 as part of a weekly pipeline monitoring program, and that effort was expanded into the CEMP beginning in 1989. Looking for potential impacts to the nearshore environment from both naturally occurring and anthropogenically enriched groundwater, NELHA's Water Quality Laboratory monitors for levels of enrichment that would be harmful to groundwater, anchialine ponds, and marine waters. As part of that program, NELHA monitors groundwater via 34 wells on land, benthic and pelagic biota, surface seawater, deep seawater as well as discharge locations and sources within the park (NELHA 2020). The information is available online on NELHA's Lab Reports website (https://nelha.hawaii.gov/resources/library/nelha-lab-reports/). Data from NELHA's CEMP

demonstrates that previous and existing operations at NELH and HOST Park have not had a cumulative impact on ecosystem function or water quality:

- Coral cover has gradually increased following significant damage by storms in the early 1990s;
- Fish communities have been stable over the past 28 years;
- Phytoplankton biomass has not exceeded the conservative limit established by DOH;
- Nearshore ocean water chemistry has been historically consistent; and
- Groundwater chemistry has been mostly stable over the past 32 years, with only intermittent nutrient spikes and recoveries (NELHA 2020).

As described above, impacts to water quality and water quantity from the Proposed Project would be negligible. Additionally, on-going water monitoring at HOST Park would ensure the Proposed Project does not contribute impacts to water quality which is a critical resource for research there. Therefore, the cumulative impacts of the Proposed Project to water resources in combination with past, present, and reasonably foreseeable future actions are expected to be minor.

### 3.3.4 Flora, Fauna, and Ecosystems

*Existing Environment*

The climate in this region of Kona is hot and arid, with a mean annual temperature of approximately 80 degrees (UHH Geography 1998). To assess the biological resources, a survey for biological resources was conducted by Geometrician Associates at the Innovation Center and Visitor Center sites (Appendix 3). Additionally, in response to a request for Technical Assistance, the United States Fish and Wildlife Service (USFWS) provided the names of listed threatened and endangered species that could be present at the site or in the area. All species identified in the letter with a potential to be present in the Project Site are considered in this section. The USFWS letter is included with the other early consultation letters received in Appendix 1.

<u>Vegetation</u>

The pre-human vegetation of the Project Area was very likely quite similar to that of today and included Coastal Strand near the shoreline and Coastal Dry Shrubland in areas *mauka*, although with somewhat different species assemblages than today. The Coastal Strand vegetation consisted of the typical Hawaiian Island pan-tropical herbs, grasses, vines, and low shrubs adapted to a sandy/rocky, salty substrate (Appendix 3).

The pre-human fauna of the area would have contained the same shorebirds and seabirds as are present today, with the addition of others that have since become extinct. There is limited habitat due for waterbirds in the Project Area due to the lack of ponds or fresh or brackish water bodies; however, in the past these species might have flown over as they passed between the wetlands of Kaloko-Honokohau and areas further north. The absence of forests likely precluded any major concentrations of forest birds in the Project Area. Other native fauna would have included Hawaiian hoary bats (*Lasiurus cinereus semotus*) and various species of invertebrates (Appendix 3).

Since the arrival of humans most of Hawai'i's lowland vegetation has drastically changed. The landscape of much of urban Kona has been radically altered by centuries of settlements, over a century of grazing, and particularly urban development, which has occurred all around the properties. Western contact brought with it a wide variety of invasive weeds and feral mammals that grazed or fed on seeds. The vegetation of the hot and arid Kekaha region of Kona remained sparse but changed in composition, with highly invasive grasses. Dozens of non-native birds were also introduced. The development of landscaped resorts and golf courses has provided lush habitats for both native and non-native birds (Appendix 3).

The Innovation Center area has two basic vegetation types: (1) Coastal Strand, at the far makai end where no development is proposed, and (2) mostly barren lava in the inland portion. The Coastal Strand has a mixture of alien weeds along with common, pan-tropical native herbs, vines and grasses. The only prevalent large shrub or tree on the site is the alien tree heliotrope (*Tournefortia argentea*). Among natives, naupaka (*Scaevola taccada*), 'uhaloa (*Waltheria indica*), 'aki'aki (*Sporobolus virginicus*), and hinahina (*Heliotropium* spp.) are very common, as are the aliens sourbush (*Pluchea symphytifolia*) and fountain grass (*Cenchrus setaceus*). In the mostly barren inland section, areas that have been disturbed support fountain grass and other weeds. The alien sword fern *Nephrolepis multiflora* is also sparingly present in lava cracks. The only rare plant located on the site is one maiapilo (*Capparis sandwichiana*), which is found just outside the Coastal Strand, adjacent to the fence on the eastern end of the property (Appendix 3).

All plant species found on the property during the survey are listed in Table 1. Of the 38 species detected, most were non-native. Ten species were indigenous (native to the Hawaiian Islands and elsewhere) and one was endemic (found only in the Hawaiian Islands). No threatened or endangered plant species were present in the Project Site. The very rare *Fimbristylis hawaiiensis*, which is often less than an inch in height and may be shriveled in dry conditions and difficult to spot, was not seen. With the exception of the endemic and rare maiapilo, all the native species detected are very common in the area, on the island, and throughout the Hawaiian Islands. Maiapilo is a fragrant-flowered shrub that is found patchily in ever-more restricted dry coastal areas of the Hawaiian Islands. It has been proposed at various times for listing as endangered, but is currently considered only rare, with no legal protections. From a conservation perspective, where feasible, it should be protected and/or incorporated in landscaping, where it often thrives (Appendix 3).

**Table 1 Plant Species Observed in the Project Site**

| Scientific Name | Family | Common Name | Life Form | Status* |
|---|---|---|---|---|
| *Boerhavia coccinea* | Nyctaginaceae | Boerhavia | Herb | A |
| *Boerhavia acutifolia* | Nyctaginaceae | Alena | Herb | I |
| *Capparis sandwichiana* | Capparaceae | Maiapilo | Shrub | E |
| *Cenchrus setaceus* | Poaceae | Fountain grass | Grass | A |
| *Chenopodium murale* | Amaranthaceae | Lamb's quarters | Herb | A |
| *Chloris barbata* | Poaceae | Swollen fingergrass | Grass | A |
| *Chrysobalanus icaco* | Chrysobalanaceae | Cocoplum | Shrub | A |
| *Coccoloba uvifera* | Polygonaceae | Sea grape | Tree | A |
| *Cynodon dactylon* | Poaceae | Bermuda grass | Grass | A |

| Scientific Name | Family | Common Name | Life Form | Status* |
|---|---|---|---|---|
| *Eragrostis amabilis* | Poaceae | Lovegrass | Grass | A |
| *Euphorbia hirta* | Euphorbiaceae | Garden spurge | Herb | A |
| *Fimbristylis cymosa* | Cyperaceae | Mau‘u ‘aki‘aki | Sedge | I |
| *Heliotropium amplexicaule* | Boraginaceae | Heliotrope | Herb | A |
| *Heliotropium curassavicum* | Boraginaceae | Seaside heliotrope | Vine | I |
| *Indigofera suffruticosa* | Fabaceae | Indigo | Shrub | A |
| *Ipomoea pes-caprae* | Convolvulaceae | Pohuehue | Vine | I |
| *Jacquemontia ovalifolia* | Convolvulaceae | Pa‘u o Hi‘iaka | Vine | I |
| *Leucaena leucocephala* | Fabaceae | Haole koa | Tree | A |
| *Macroptilium lathyroides* | Fabaceae | Cow pea | Shrub | A |
| *Melinis repens* | Poaceae | Natal red-top | Grass | A |
| *Morinda citrifolia* | Rubiaceae | Noni | Shrub | A |
| *Nephrolepis multiflora* | Nephrolepidaceae | Sword fern | Herb | A |
| *Phyllanthus debilis* | Euphorbiaceae | Niruri | Herb | A |
| *Pluchea symphytifolia* | Asteraceae | Sourbush | Shrub | A |
| *Portulaca pilosa* | Portulacaceae | Portulaca | Herb | A |
| *Prosopis pallida* | Fabaceae | Kiawe | Tree | A |
| *Scaevola taccada* | Goodeniaceae | Naupaka kahakai | Shrub | I |
| *Schinus terebinthifolius* | Anacardiaceae | Christmas-berry | Shrub | A |
| *Sesuvium portulacastrum* | Aizoaceae | Akulikuli | Herb | I |
| *Sida fallax* | Malvaceae | ‘Ilima | Shrub | I |
| *Spergula arvensis* | Caryophyllaceae | Corn spurrie | Herb | A |
| *Sonchus oleraceus* | Asteraceae | Sow thistle | Herb | A |
| *Sporobolus diandrus* | Poaceae | Indian dropseed | Grass | A |
| *Sporobolus virginicus* | Poaceae | ‘Aki ‘aki grass | Grass | I |
| *Tournefourtia argentea* | Boraginaceae | Tree heliotrope | Tree | A |
| *Tribulus terrestris* | Zygophyllaceae | Goat head | Herb | A |
| *Tridax procumbens* | Asteraceae | Coat buttons | Herb | A |
| *Waltheria indica* | Sterculiaceae | ‘Uhaloa | Herb | I |

*A = alien, E = endemic, I = indigenous, PI = Polynesian, END = Federal and State Listed Endangered (none)

An online mapping tool provided by the USFWS indicates that no designated or proposed critical habitat for endangered plant (or animal) species is located on or near the property (USFWS 2019). The nearest designated critical habitat units are four polygons associated with critical habitat for three plants: ko‘oko‘olau (*Bidens micrantha* ssp. *ctenophylla*), uhiuhi (*Mezoneuron kavaiense*) and wahine noho kula (*Isodendrion pyrfolium*). Due to substrate habitat requirements, none of these plants are currently found at the Project Site or have the potential to be found naturally (Appendix 3).

Birds

The eight species of birds detected during the survey were seen and heard mainly in the strand vegetation, shoreline lava flats, and tidepool areas (Table 2). The pahoehoe lava had extremely few birds. The majority of species detected were non-natives, and the most abundant were common myna (*Acridotheres tristis*), spotted dove (*Streptopelia chinensis*), and Japanese white-eye (*Zosterops japonicus*). Although most individuals detected were non-native, several native birds naturally associated in Hawai‘i with shorelines, ponds or streams, were also detected in the shoreline area. These included ruddy turnstone or ‘akekeke (*Arenaria interpres*), wandering tattler or ‘ulili (*Tringa incana*), black-crowned night heron or auku‘u (*Nycticorax hoactli*), and Pacific golden-plover or kolea (*Pluvialis fulva*). No rare, threatened or endangered birds were seen,

although the native birds found here are all protected under the Migratory Bird Treaty Act (Appendix 3).

**Table 2 Bird Species Detected at the Project Site**

| Scientific Name | Common Name | Status |
|---|---|---|
| Acridotheres tristis | Common Myna | Alien Resident |
| *Arenaria interpres* [2] | Ruddy Turnstone (‘Akekeke) | Indigenous Resident |
| *Carpodacus mexicanus* | House Finch | Alien Resident |
| *Estrilda astrild* | Common Waxbill | Alien Resident |
| *Francolinus pondicerianus* | Gray Francolin | Alien Resident |
| *Tringa incana* [2] | Wandering Tattler (‘Ulili) | Indigenous Resident |
| *Nycticorax hoactli* [2] | Black-Crowned Night Heron (Auku‘u) | Indigenous Resident |
| *Pluvialis fulva* [2] | Pacific Golden-Plover (Kolea) | Migratory Resident |
| *Streptopelia chinensis* | Spotted Dove | Alien Resident |
| *Zosterops japonicus* | Japanese White-eye | Alien Resident |

[1] Protected under Endangered Species Act (none)
[2] Protected under Migratory Bird Treaty Act

No native landbirds were detected during the survey. The only one that might be seen is *Asio flammeus sandwichensis*, the Hawaiian endemic sub-species of the short-eared owl. Also called pueo, this diurnal bird of prey is regularly seen within the grasslands, shrublands and forests of Kona. The properties do not provide habitat for pueo (Appendix 3). The Hawaiian hawk (*Buteo solitarius*), listed as endangered by the State of Hawai‘i but no longer listed by the USFWS, is unlikely to be present at the Project Site. No trees suitable for hawk nesting are located at either location of the Project Site.

Two listed threatened and endangered waterbirds are frequently seen nearby and probably overfly the Project Area, though habitat is not present. These are the endangered Hawaiian stilt or ae‘o (*Himantopus mexicanus knudseni*) and the threatened Hawaiian geese or nēnē (*Branta sandvicensis*). They are often seen in coastal ponds, golf course irrigation pond/water hazards and even wastewater treatment ponds, and sometimes they fly and land in nearby areas. Of these two, only the nēnē has any reasonable potential to land and linger on the Project Site. One other listed Hawaiian waterbird found nearby at Kaloko-Honokohau National Historical Park, the Hawaiian coot or ‘alae ke‘oke‘o (*Fulica alai*), is not expected to be found in the Project Site because of its behavior and the lack of suitable habitat (Appendix 3).

As with all of the island of Hawai‘i, several listed seabirds may overfly the shoreline in Kona and the Project Area: the endangered Hawaiian petrel (*Pterodroma sandwichensis*); the endangered band-rumped storm petrel (*Oceanodroma castro*); and the threatened Newell’s shearwater (*Puffinus auricularis newelli*). Although they may fly over various locations in the Keahole area on their way to and from mountain nesting areas and the open ocean, no suitable nesting habitat for any of these seabird species is present in the Project Area. The primary cause of mortality in these species in Hawai‘i is thought to be predation by alien mammalian species at the nesting colonies. Collision with man-made structures is another significant cause. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. Disoriented seabirds may collide with manmade structures and, if not killed outright, become easy targets of predatory mammals (Appendix 3).

Hawaiian Hoary Bat

The endangered Hawaiian hoary bat is the only native Hawaiian land mammal. This bat is solitary and roosts in trees rather than caves. It is found throughout the island of Hawai'i and has been observed in leafy kiawe (*Prosopis pallida*) scrub vegetation that dominates much of coastal North Kona. Bats may forage for flying insects over the properties on a seasonal basis, but there are no shrubs and trees tall enough to provide suitable roosting habitat. Bats are often visible while they are feeding on flying insects near dusk and dawn at various locations around the island of Hawai'i. The presence of these bats can also be verified by echolocation detectors. If a bat is detected during a night's study, this merely indicates that they were present in the area. Conversely, the absence of bat detections does not indicate an absence of bats, which may have been absent for only a night, a week, or a season, or may have simply gone undetected. Determination of bat populations or usage patterns requires sophisticated, long-term studies. No bats were observed in our survey, which took place in daylight and did not use any detection equipment. For the purposes of this assessment, it is assumed that Hawaiian hoary bats are present at least some of the time, as they have been frequently seen near the coast. Hawaiian hoary bats are vulnerable to disturbance during the summer pupping season (Appendix 3).

Hawaiian Monk Seal

As noted in the USFWS letter, Hawaiian monk seals (*Neomonachus schauinslandi*) have been recorded in the vicinity of the Project Site (Appendix 1). These seals are known to haul out on sandy and rocky beaches throughout the Island of Hawai'i. No aspect of the Proposed Project involves use of or effects to sandy or rocky beaches or adjacent land.

Sea Turtles

The threatened honu or Central North Pacific distinct population segment of green sea turtle (*Chelonia mydas*) and the endangered honu 'ea or hawksbill sea turtle (*Eretmochelys imbricata*) are present in all Hawaiian waters. As noted in the USFWS letter, green sea turtles may nest on any sandy beach in the Pacific Islands, while hawksbills show a wide tolerance for nesting substrate ranging from sandy beach to crushed coral, with nests typically placed under vegetation (Appendix 1). Both species exhibit strong nesting site fidelity. Although very restricted in their nesting sites, with none known in this area, both turtles appear to be expanding the number of nesting sites in the Hawaiian Islands. Nesting occurs on beaches from May through September, peaking in June and July, with hatchlings emerging through November and December. Construction on or near beaches can result in sand and sediment compaction, sea turtle nest destruction, beach erosion, contaminant and nutrient runoff, and an increase in direct and ambient light pollution which may disorient hatchlings or deter nesting females. Off-road vehicle traffic may result in direct impacts to sea turtles or nests, and also contributes to habitat degradation through erosion and compaction. As discussed above, no aspect of the Proposed Project involves use of or effects to sandy, rocky or coral beaches or adjacent land. No outdoor lights are planned that would shine towards the sandy areas.

Introduced Mammals, Reptiles, and Amphibians

During the survey we observed numerous small Indian mongooses (*Herpestes a. auropunctatus*) and sign of wild goats (*Capra h. hircus*). It is likely that feral cats (*Felis catus*), mice (*Mus* spp.), rats (*Rattus* spp.) and domestic dogs, (*Canis f. familiaris*) are occasionally present on the properties. None of these alien mammals have conservation value and all are deleterious to native flora and fauna (Appendix 3).

There are no native terrestrial reptiles or amphibians in Hawai‘i. None were observed during the survey, but various anoles, skinks and geckoes may be present, as they are common on the island (Appendix 3).

Invertebrates

No invertebrate surveys were conducted for this Project, as these require highly trained specialists and long-term observations and were not justified by the habitat. In general, rare, threatened, or endangered invertebrates on the Island of Hawai‘i tend to be associated with either higher-elevation, older substrate rainforests (e.g., various *Drosophila*); coastal dry shrubland (*Hylaeus anthracinus*); the summit of Mauna Kea (*Nysius wekiuicola*); extremely dry, disturbed lava flows below 3,000 feet in elevation (the Blackburn’s sphinx moth [*Manduca blackburnii*]); or freshwater or estuarine aquatic settings (various *Megalagrion*). The only species with potential to occur in the Project Site include Blackburn’s sphinx moth and yellow-faced bee (*Hylaeus anthracinus*) (Appendix 3).

The endangered Blackburn’s sphinx moth has been found at various locations throughout West Hawai‘i, including many areas in North Kona, and is generally associated with drier environments and ‘a’ substrates. The native host plant for the moth is aiea (*Nothocestrum* spp.) and is extremely rare; however, the prolific non-native tree tobacco (*Nicotiana glauca*) is a substitute host that quickly colonizes dry, disturbed lava flows. The adult moth feeds on nectar from native plants including beach morning glory (*Ipomoea pes-caprae*), ilie‘e (*Plumbago zeylanica*), and maiapilo. Moth larvae feed upon non-native tree tobacco, which occupies disturbed areas such as open fields and roadway margins, and the native aiea, which is found in dry to moist forests at elevations ranging from 1,500 to 5,000 feet above mean sea level (amsl). There is no aiea near the properties, but tree tobacco is common throughout disturbed sites in North Kona, and it can rapidly spread into adjacent undisturbed areas. Systematic survey of the properties and nearby areas determined that no tree tobacco was present. However, ground disturbance during construction affords a site for the weed to sprout from seeds and the fast-growing weed can overrun a construction site quickly, creating an attractive nuisance (Appendix 3).

Seven species of the endemic yellow-faced bee (*Hylaeus* spp.) in the Hawaiian Islands have been listed as endangered because of their vital role as pollinators of native plants, their limited or threatened habitat, and their vulnerability to predators. One of these, *Hylaeus anthracinus*, has within modern times been found in various entomological surveys at locations on the Island of Hawai‘i in coastal and lowland dry ecosystems such as Kealakekua and South Point. *Hylaeus anthracinus* is apparently restricted to small patches of habitat on each island. The largest area is probably on Molokai, where an area of sand dunes stretching from Moomomi to Kalaupapa may support a large population. Elsewhere it is found at Kaena Point on Oahu; Pali o Kalapakea on Kahoolawe; Kanaio and Manawainui on Maui; and various locations on the Big Island including

Pohakuloa Training Area, South Point and several sites both north and south of HOST Park, in Kohanaiki, Kaloko-Honokohau National Historical Park, Makalawena and Mahaiula. Additional sites may exist, but it is likely that they too will be small areas (Appendix 3).

A report by the Xerces Society discussed surveys in North Kona and South Kohala that found it in diverse shoreline vegetation in salt-adapted coastal vegetation. The ideal species mix is a mixture of favorable host/habitat species including some combination of naupaka, ‘ilima (*Sida fallax*), ‘akoko (*Chamaesyce* spp.), naio (*Myoporum sandwicense*), tree heliotrope, maiapilo, and various native species in the Boraginaceae, Nyctaginaceae and Convolvulaceae. Coral rubble is also a key factor. All of these elements are present at the properties, particularly the Coastal Strand of the Innovation Center property (Appendix 3).

*Impacts and Mitigation Measures*

Vegetation

As discussed above, no threatened or endangered plant species as listed by the USFWS appear to be present in the Project Site. One rare plant, maiapilo, is present at the proposed Innovation Center location. As mitigation for this impact, the Proposed Project will avoid all direct and indirect impacts to the maiapilo from construction of the Innovation Center.

There are no uniquely valuable vegetation types, although the Coastal Strand vegetation is important if common habitat for a variety of native shoreline birds and *Hylaeus* bees, including a potentially endangered species. The Coastal Strand vegetation would be avoided by the Proposed Project. As discussed above, wide-ranging threatened and endangered animal species may occasionally be present on or fly over the Project Site, as they are throughout most of coastal West Hawai‘i. These include the Hawaiian hoary bat, Blackburn’s sphinx moth, the Hawaiian goose, the Hawaiian stilt, and several species of seabirds that do not land in the Project Area or utilize its resources but may fly over the area at night.

To avoid impacts from the introduction of non-native species, the Proposed Project would implement biosecurity protocols including cleaning and inspection of construction equipment for invasive species including fire ants, frogs, rats, and mice will be applied during construction, as applicable, as well as later during operation.

Additionally, in choosing landscaping species all invasive species will be avoided and the Project would utilize primarily native and Polynesian-introduced species as described in Section 1.2.3.

In all areas of Hawai‘i, disturbance and cutting of woody vegetation may disrupt Hawaiian hoary bat roosting. As bats use multiple roosts within their home territories, this disturbance from the removal of vegetation is usually minimal. However, during the pupping season, from about June 1 to September 15 each year, female bats carrying pups may be less able to rapidly vacate a roost site when the vegetation is cleared. In order to prevent impacts to Hawaiian hoary bats, seasonal woody vegetation clearing restrictions are necessary. However, no tall woody vegetation exists on the properties and there should be no impacts to roosting bats. Bats may also be wounded or killed by snagging on barbed wire. No barbed wire will be installed as part of the Project.

Fauna

No tree tobacco or other hosts of Blackburn's sphinx moth larvae, eggs or pupae are present, and no impact to this species is expected as a result of initial construction. However, if tree tobacco sprouts, and is allowed to grow, clearing of individuals over three feet may result in harm to the species, necessitating vegetation management.

There is very little potential at the properties for use by nēnē for nesting or feeding, because the sparse, open, dry vegetation has little in the way of tender grass shoots or fresh water that attracts these birds. Nevertheless, the occasional presence of nēnē, which range widely and are unafraid of humans, could occur.

Hawaiian stilts would not be attracted to the site because of the lack of water bodies.

The Project would not disturb any Coastal Strand vegetation during construction of the Innovation Center property or the Hale Wawaloli Visitor Center. The proposed fence at the Innovation Center would be routed around some isolated tree heliotrope and naupaka plants. As such, even in the event that *Hylaeus anthracinus* is occasionally present, the effects to habitat would be miniscule and inconsequential.

Outdoor lighting in Hawai'i often attracts threatened or endangered seabirds that may become disoriented by the lighting, resulting in downed birds.

The following mitigation measures are proposed and have been closely adapted from USFWS avoidance and mitigation measures for listed species:

1. To minimize potential impacts to Hawaiian hoary bats:
    - NELHA and its contractors will not disturb, remove or trim woody plants taller than 15 feet during the bat birthing and pup rearing season (June 1 through September 15).
    - NELHA will not use barbed wire for fencing.
2. To avoid and minimize potential Project impacts to seabirds:
    - Consistent with other sites at HOST Park, aquaculture tanks would be covered either by netting, shade-cloth, or other covering to exclude waterfowl.
    - To avoid potential seabird downing through interaction with outdoor lighting, no construction or unshielded equipment lighting will be used after dark between the months of April and October. All permanent lighting will be kept to minimum necessary levels, with shielded lights so as to lower the ambient glare, in conformance with the Hawai'i County Outdoor Lighting Ordinance (Hawai'i County Code Chapter 9, Article 14). Furthermore, as stated in Section 1.2.1 all exterior lighting will consist of blue-deficient lighting such as filtered LED lights or amber LED lights, with a CCT of 3200 Kelvin. This will not only reduce the risk that threatened or endangered seabirds may be attracted to and then disoriented by lighting, but will also assist in protecting dark skies.
    - NELHA will avoid nighttime construction altogether during the seabird fledging period, September 15 through December 15.

3. To avoid and minimize potential Project impacts to Hawaiian geese, Hawaiian stilts, and Hawaiian coots, in the unlikely event that any are observed on the properties:
    - NELHA will ensure that there would be no standing water during construction or operation of the Proposed Project to avoid attracting Hawaiian stilts and Hawaiian coots.
    - NELHA will ensure that construction personnel do not approach, feed, or disturb these birds.
    - If Hawaiian geese are observed loafing or foraging within the Project Area during the breeding season (September through April), or if Hawaiian stilts or Hawaiian coots are observed utilizing the area, NELHA will ensure that contractors halt work and engage a biologist familiar with their nesting behavior surveys for nests in and around the Project Area prior to the resumption of any work.
        - The surveys will be repeated after any subsequent delay of work of three or more days (during which the birds may attempt to nest).
        - The contractor will inform project personnel and other contractors about the presence of Hawaiian geese.
    - NELHA will include a condition in the construction contract that if nests of Hawaiian geese, Hawaiian stilts, or Hawaiian coots are discovered within a radius of 150 feet of proposed work, or a previously undiscovered nest is found within said radius after work begins, all work will cease immediately and the USFWS will be contacted for further guidance.
    - NELHA will include a condition in the construction contract that if there are areas where the Hawaiian goose, the Hawaiian stilt, or the Hawaiian coot is known to be present, the contractor must post and implement reduced speed limits, and inform Project personnel and contractors about the presence of Hawaiian geese onsite.
4. To avoid and minimize potential Project impacts to Blackburn's sphinx moth:
    - A biologist familiar with Blackburn's sphinx moth will survey areas of proposed activities for Blackburn's sphinx moth and its larval host plants prior to construction.
    - Surveys will be conducted during the wettest portion of the year (November-April) if possible, and in any case within four to six weeks prior to construction.
    - Surveys will include searches for eggs, larvae, and signs of larval feeding (chewed stems, frass, or leaf damage).
    - If moths, or the native aiea, or tree tobacco over three feet tall are found during the survey, NELHA will inform the federal agency, which will contact the USFWS for additional guidance to avoid take.
    - If no Blackburn's sphinx moth, aiea, or tree tobacco are found during surveys, measures will be taken to avoid attraction of Blackburn's sphinx moth to the Project location and prohibit tree tobacco from entering the site. NELHA will ensure that the contractor or facility manager has trained personnel who will:
        - Remove any tree tobacco less than three feet tall.
        - Monitor the site every four to six weeks for new tree tobacco growth before, during and after the proposed ground-disturbing activity.
5. To minimize potential impacts to Hawaiian yellow-faced bees:
    - A qualified biologist will survey the area of proposed disturbance for yellow-faced bees.

- Construction will avoid coastal strand habitat. Orange construction fencing will be installed at the makai boundary of both footprints. Construction will remain strictly within footprints that avoid any disturbance of coastal strand habitat.
- In the unlikely event that Project disturbance will occur in or adjacent to known occupied yellow-faced bee habitat, a buffer area around the habitat may be required, and can be developed on a site-specific basis through coordination with the USFWS.
- Outside this area, woody debris and coral rubble will be left in place, and no vehicular activity will be permitted.
- NELHA will post educational signs to inform people of the presence of sensitive coastal strand species, and no fires or wood-collecting will be allowed.

6. To avoid and minimize potential impacts to Hawaiian monk seals as well as sea turtles and their nests:
    - The Project will not involve any modifications of the beach or shoreline environment at any time, including clearing or removal of native shoreline vegetation, and stockpiling of any material or trash along the shoreline.
    - The Project will not involve any work in the aquatic environment.
    - In the extremely unlikely event that a basking sea turtle is found in either of the Project Sites (i.e., has left the shoreline area and crawled onto the lava area 200 feet back from the shoreline to where proposed construction would occur), NELHA will ensure that workers cease all mechanical or construction activities within 100 feet and/or between the basking turtle and the ocean until the animal voluntarily leaves the area.

Under the No Action Alternative, the Project would not be constructed, and the site would remain unchanged from current conditions. There would be no Project construction, and, therefore, no impacts to the native plant species present in the Project Site or removal of potential habitat for protected wildlife species.

*Cumulative Impacts*

Past, present, and reasonably foreseeable future projects in the vicinity have impacted biological resources through alteration of the landscape through introduction of weeds, removal of native vegetation, and loss of habitat for native wildlife species.

Impacts to biological resources from the Proposed Project would be minor, due to the limited number of native species present at the Project Site and the protection measures outlined to avoid impacts to Federally-listed species and prevent spread of non-native weeds.

Therefore, the cumulative impacts of the Proposed Project to biological resources in combination with past, present, and reasonably foreseeable future actions are expected to be minor.

### 3.3.5 Noise

*Environmental Setting*

The main source of noise affecting HOST Park and the Project Area is from air traffic at the nearby Ellison Onizuka Kona International Airport, located approximately 3,000 feet north of the Project

Site. Other minor sources of noise include adjacent aquaculture, wind, and the ocean waves. Traffic from Queen Ka'ahumanu is far enough from the Project Site as to not be a significant source of noise.

The noise descriptor used to assess environmental noise by many federal and State of Hawai'i agencies, including Department of Housing and Urban Development (HUD), the Federal Aviation Administration (FAA) and the Hawai'i Department of Transportation (DOT), is the Day-Night Average Sound Level (DNL). DNL is a representation of the average noise during a typical day of the year. DNL levels of 55 or less are typical of quiet, rural, or suburban areas. DNL exposure levels of 55 to 65 are typical of urbanized areas with medium to high levels of activity and street traffic. DNL exposure levels above 65 are representative of dense urban sites and areas near large highways or airports.

Various agencies have different standards of noise compatibility. HUD standards are as follows:

- Acceptable. (DNL not exceeding 65 decibels) The noise exposure may be of some concern, but common building constructions will make the indoor environment acceptable, and the outdoor environment will be reasonably pleasant for recreation and play.

- Normally Unacceptable. (DNL above 65 but not exceeding 75 decibels) The noise exposure is significantly more severe; barriers may be necessary between the site and prominent noise sources to make the outdoor environment acceptable; special building constructions may be necessary to ensure that people indoors are sufficiently protected from outdoor noise.

- Unacceptable. (DNL above 75 decibels). The noise exposure at the site is so severe that the construction cost to make the indoor noise environment acceptable may be prohibitive and the outdoor environment would still be unacceptable.

In 2011, the FAA approved the DOT Airports Division's findings in their Noise Compatibility Program (NCP) prepared for the Kona International Airport (KOA) at Keahole in compliance with 49 U.S.C. 47501 et seq. and 14 CFR Part 150. The final report dated April 2011 is available at:

https://www.faa.gov/airports/environmental/airport_noise/part_150/states/hi/media/roaHawaiiKOA20110420.pdf

The NCP for the KOA update makes recommendations for land use measures to improve existing noise-sensitive land use impacts and future impacts. These recommendations include preventing new noise-sensitive development near the airport at the 55, 60, and 65 DNL noise contours. Figure 2.9 in the NELHA Master Plan (Appendix 2) shows the 65 DNL noise contours, and explains noise levels do not preclude development entirely but may limit certain uses, including residences without sound insulation, schools, and public facilities.

The Project Site currently experiences noise less than 65 DNL, a condition which is expected to persist.

*Impacts and Mitigation Measures*

During construction of the Proposed Project, there would be moderate levels of noise from the operation of heavy equipment during grading and construction. Diesel generators and other equipment utilized during construction would comply with DOH noise limits. In cases where construction noise is expected to exceed the State DOH "maximum permissible" property-line noise levels, builders will be required to obtain a permit per Title 11, Chapter 46, HAR (Community Noise Control) prior to construction. The DOH reviews the proposed activity, location, equipment, Project purpose, and timetable in order to decide upon conditions and mitigation measures, such as restriction of equipment type, maintenance requirements, restricted hours, and portable noise barriers. NELHA and/or its construction contractor will consult with DOH to determine if a permit will be required and what, if any, noise reduction measures are necessary. During operation, moderate levels of noise which would be consistent with the level of noise from neighboring tenants is anticipated. Therefore, the Proposed Action is not expected to significantly impact any existing tenants in the vicinity of the Project Site.

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions. There would be no additional impacts to noise from this alternative.

*Cumulative Impacts*

Since there are no noise impacts from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions from noise.

### 3.3.6 Air Quality and Scenic Resources

*Environmental Setting*

Air quality in Hawai'i is generally good, below criteria levels for most pollutants in most locations at almost all times. There are no State DOH air monitoring stations in the immediate vicinity of the Project Site. The nearest site is Kealakekua, approximately 15 miles south of Keahole Point. Kealakekua is a more populated area with more motor vehicle traffic but has consistently demonstrated compliance with ambient standards over the years. Air pollution in West Hawai'i, when present, is mainly derived from volcanic emissions of sulfur dioxide, which convert into particulate sulfate and produce a volcanic haze (vog) that can affect North and South Kona. Vog concentrations are dependent on the amount of sulfur dioxide emitted from Kīlauea Volcano, the distance downwind, and the wind direction and speed on a given day. Minor levels of air pollution also come from urban uses including traffic and other nearby industrial activities.

The general area around HOST Park is a utilitarian landscape devoted to industrial, science and technology and aquaculture uses. Neither the Project Site nor any surrounding areas are mentioned in the County of Hawai'i General Plan as being notable for their natural beauty (County of Hawai'i 2005). The closest such sites are approximately three miles south at Kaloko Pond

and five miles north at Makalawena Beach. While the area is designated for ocean-related industrial operations, a land use where scenic considerations are not paramount, the actual shoreline areas are scenic and used for public recreation. The Project Site lies between developed educational and aquaculture facilities.

*Impacts and Mitigation Measures*

Short-term direct and indirect impacts on air quality could potentially occur due to Project construction, principally through fugitive dust from vehicle movement and soil excavation, and exhaust emissions from onsite construction equipment. Adequate fugitive dust control can typically be accomplished by the establishment of a frequent watering program to keep bare dirt surfaces in construction areas from becoming significant sources of dust. In dust prone or dust sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Onsite mobile and stationary construction equipment also would emit air pollutants from engine exhausts, but no sensitive receptors are present. The contractor will be required to prepare a dust control plan during construction compliant with provisions of HAR, Chapter 11-60.1, "Air Pollution Control," and Section 11-60.1-33, "Fugitive Dust."

The Proposed Project will not detract from the scenic values of the area, which are focused on the coast rather than the Project Site, which exists in a context of other developed facilities. Project facilities have been designed to be inviting, utilize natural light, as well as be practical for research purposes.

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions. There would be no additional impacts to air quality or scenic resources from this alternative.

*Cumulative Impacts*

Since there are only minimal air quality and scenic impacts from the Proposed Project, any potential cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to air quality or scenic resources would be minor.

### 3.3.7 Hazardous Materials and Wastes

*Existing Environment*

A Phase I Environmental Site Assessment (ESA) was performed for the Project Site and neighboring parcels by Stantec Consulting Services Inc. (Stantec). A Phase I ESA aims to identify recognized environmental conditions that exist on the Project Site, and existing recognized environmental conditions in the Project Site area that have the potential to impact the subject property. In a Phase I Environmental Site Assessment, evidence of recognized environmental conditions may be obtained by execution of the following:

- A records search of federal and State databases of hazardous material use, storage, and releases, including, but not limited to, hazardous material generators, leaking underground storage tanks, and reported hazardous material releases;

- Interviews with landowners, nearby residents, and regulatory agency members concerning the subject property's history of land use;

- Other records searches, including tax records, aerial photography, and, when available, fire insurance maps; and

- A visual survey of the property and immediately surrounding areas.

No recognized environmental conditions were observed at the Project Site during the Phase I ESA. The earliest available topographic map, from 1954, show the Project Site and adjoining properties as undeveloped. A 1992 aerial photograph shows the Innovation Center property as developed with structures, and the Hale Wawaloli Visitor Center property appears to be developed with a structure. In the 1996 aerial photograph, aboveground storage tanks (ASTs) are depicted adjacent to the north of the Innovation Center, but no ASTs were shown or known to occur on the Project Site.

*Impacts and Mitigation Measures*

Construction equipment would use fossil fuels, and hydraulic power in grading and construction. There is a possibility of leaks, spills, or accidents during construction and during occupation of the development by residents (from an accidental vehicle leak). The construction contractors will be required to develop and maintain an emergency action plan for management and recovery of any release of petroleum or hazardous materials to the environment. Onsite stormwater treatment would minimize impacts from spills during when the Project Site is occupied by tenants.

The Project does not involve large quantities of hazardous materials or toxic substances. Cleaning products would be used by tenants to maintain cleanliness of laboratory facilities and research tanks. Additionally, a solids interceptor and acid neutralization would be provided at sinks in lab spaces to prevent items from going down the drain. Small storage tanks with a capacity of less than 20 gallons will be used for these chemicals. All storage will be designed in conformance with appropriate standards.

No impacts to hazardous materials or waste are expected from the No Action Alternative.

*Cumulative Impacts*

Since there are minimal potential impacts related to hazardous materials or wastes from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions.

## 3.4 Socioeconomics

The Project would not involve any effects on population or other socioeconomic factors. The only social consideration has to do with land use compatibility. As discussed in Section 3.12, the Project appears to be conformant with all land use designations. Therefore, this section addresses public shoreline recreation.

*Existing Environment*

Although the Innovation Center is approximately 260 feet from the shoreline on a pahoehoe flat not known to be used by the public (see Photo Series 1), the area along the shore consists of vegetated pahoehoe/sand backshore with a public trail and moderate public use for hiking, fishing, and gathering. The Visitor Center is located approximately 220 feet from the shoreline on a previously disturbed pahoehoe flat, with similar uses along the coast.

*Impacts and Mitigation Measures*

The Project will not affect shoreline access in any way; avoiding impacts to sensitive cultural, biological and recreational resources of the shoreline was one of the factors in locating the Project Site well away from the shoreline.

Under the No Action Alternative, the site would remain unchanged from current conditions and the Project would not be constructed.

*Cumulative Impacts*

Since there are no impacts from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to socioeconomics. The Proposed Project does not require any changes to land use designations and would not cumulatively affect land use because it is consistent with community plans.

## 3.5 Cultural Practices and Sites

*Cultural-Historical Background*

According to the model developed by Kirch (1985), the Settlement or Colonization period of Hawai‘i was between A.D. 300-600, with colonists possibly from the southern Marquesas Islands. Early Hawaiian farmers developed new subsistence strategies during this period, adapting familiar patterns and traditional tools for use in their new environment. Order was kept through adherence to their ancient and ingrained philosophy of life and through the principle of genealogical seniority. Hawaiians brought from their homeland a variety of Polynesian customs including the major gods of Kane, Ku and Lono; the *kapu* system of law and order; *pu‘uhonua* or places of refuge or asylum; the *‘aumakua* concept of a family or ancestral spirit and the concept of *mana*.

The Development Period, which lasted from A.D. 600-1100, brought changes that included an evolution of traditional tools as well as some distinctly Hawaiian inventions.

The Expansion Period from A.D. 1100 to 1650 saw an increase in social stratification and major socioeconomic changes. It also was a time of expansive settling, with the development of the most favorable windward areas as well as more marginal areas on the island’s leeward side. This was the time of the greatest population growth as large, irrigated field systems were developed and expanded into more arid areas. *Loko* or fishpond aquaculture also flourished during this period, excellent examples of which are contained three miles south of Keahole Point at Kaloko.

The second major migration to Hawai‘i also occurred during the Expansion Period, with the settlers for this expansion coming from Tahiti in the Society Islands.

The concept of the ahupua‘a was established in Hawai‘i during the 15th century, adding a new component to what was already a well-stratified society. Ahupua‘a were usually wedge or pie-shaped, encompassing all of the eco-zones from the mountains to the sea and extending several hundred yards beyond the shoreline, assuring a diverse subsistence resource base. This land unit became the equivalent of a local community with its own social, economic and political significance.

Ahupua‘a were ruled by ali‘i ‘ai ahupua‘a or lesser chiefs and managed by a konohiki. Ali‘i and maka‘ainana, or commoners, were not confined to the boundaries of ahupua‘a as resources were shared when a need was identified. Ahupua‘a were further divided into smaller sections such as ‘ili, mo‘o‘aina, pauku‘aina, kihapai, koele, hakuone, and kuakua. The chiefs of these land units have their allegiance to a territorial chief or mo‘i (often translated as king).

An increase in war marked the Proto-Historic Period (A.D. 1650-1795), both locally and between islands. Hawai‘i’s history took a sharp turn on January 18, 1778, with the arrival of British Capt. James Cook in the islands. On a return trip to Hawai‘i 10 months later, with the Maui turmoil still raging, Kamehameha visited Cook aboard his ship the Resolution off the east coast of Maui and helped Cook navigate his way to Hawai‘i Island. Cook exchanged gifts with Kalaniopu‘u at Kealakekua Bay the following January, and Cook left Hawai‘i in February. However, Cook’s ship then sustained damage to a mast in a severe storm off Kohala and returned to Kealakekua, setting the stage for his death on the shores of the bay.

The following year, in 1780, Kalaniopu‘u designated his son, Kiwalao, to be his successor, and granted Kamehameha guardianship of the war god Kuka‘ilimoku. When it appeared Kiwalao was not honoring his land claims, Kamehameha usurped Kiwalao’s authority with a sacrificial ritual and retreated to his district of Kohala where he farmed the land, growing taro and sweet potatoes. Civil war broke out when Kalaniopu‘u died in 1782 and Kiwalao was killed. The wars between Maui and Hawai‘i Island would continue until 1795.

Two American vessels visited Hawaiian waters in 1790. The crew of one of the ships, the Eleanor, massacred more than 100 Hawaiians at Olowalu on Maui before leaving crewmember John Young on land. The other vessel, the *Fair American*, was captured off the western coast of Hawai‘i and its entire crew – with the exception of Isaac Davis – was killed. Kamehameha did not take part but kept the *Fair American* as part of his fleet. Young eventually made his way to Hawai‘i Island where he became governor, living at Kawaihae.

By 1796, Kamehameha had conquered every island kingdom except Kauai, but it wasn’t until 1810, after Kaumuali‘i of Kauai pledged his allegiance to Kamehameha, that all of the Hawaiian Islands were unified under a single ruler. Subsequently there was a continuation of the trend toward intensification of agriculture, ali‘i-controlled aquaculture, settling of upland areas and development of traditional oral history. However, the western influence was being felt in the introduction of trade for profit and a market system economy. By 1810, the sandalwood trade established by Europeans and Americans twenty years earlier was flourishing. That contributed to

the breakdown of the traditional subsistence system, as farmers and fishermen were required to toil at logging which resulted in food shortages and a decline in population.

Following the death of Kamehameha I in 1819, the customary relaxing of *kapu* took place. But with the introduction of Christianity shortly thereafter, his successor, Kamehameha II, renounced the traditional religion and ordered that *heiau* structures either be destroyed or left to deteriorate. The family worship of *'aumakua* images was allowed to continue.

The Protestant missionaries who arrived from Boston in 1820 soon were rewarded with land and government positions as many of the *ali'i* were eager to assimilate western-style dress and culture. But at the same time, the continuing sandalwood trade was becoming a heavier burden on commoners. The rampant sandalwood trade resulted in the first Hawaiian national debt, as promissory notes and levies granted by American traders were enforced by American warships. The assimilation of Western ways continued with the short-lived whaling industry to the production of sugarcane, which was more lucrative but carried a heavy environmental price.

The Mahele 'Aina that took place in 1848 placed all land in Hawai'i into three categories: Crown Lands, Government Lands and Konohiki Lands. Ownership rights were "subject to the rights of the native tenants," or those individuals who lived on the land and worked it for their subsistence and for their chiefs. This land tenure change, while useful for promoting a western-style economy, led to alienation of many Hawaiians from the land and disrupted the older subsistence economy and culture. By the late 19th century, Hawai'i was no longer an independent kingdom, having been annexed by the United States as part of its imperial expansion in the Pacific.

The next significant change in the Territory and later State of Hawai'i was the beginning of tourism and the influence of the military, leading to urbanization and modernization, in the context of a multi-ethnic society that had been created by the immigration of sugar cane laborers. For rural areas of Hawai'i such as Kona, the first half of the 20th century years saw less urbanization and instead was dominated by agriculture, cattle ranching, and the initial phases of tourism. Just as native Hawaiian cultural practices became severely threatened by encroaching land use and loss of the language and culture, the native Hawaiian renaissance from the 1970s onward re-energized the culture.

*Project Site*

The following text are excerpts from the Archaeological Inventory Survey (AIS) prepared for the Project Site (Appendix 4). The Project Site is located within the ahupua'a of 'O'oma 1st and Kaloa 4th-5th, in the district of Kona, one of six major moku-o-loko within the island. The ahupua'a of 'O'oma and Kalaoa are two of some twenty ancient ahupua'a within the 'okana of Kekaha-wai-'ole. The place name 'O'oma can be literally translated as concave. The place name Kalaoa can be literally translated as "the choker (as a stick for catching eels)".

While very few native accounts that specifically mention or discuss 'O'oma are known, we do know that the land was so esteemed that Kauikeaouli, the son of Kamehameha I and his sacred wife Keōpūolani who later reigned as Kamehameha III, raised from infancy until he was five years old near the shore of 'O'oma under the care of his stewards. This fact is significant, as great consideration went into all aspects of the young king's upbringing. Kauikeaouli apparently held

some interest in the land of ʻOʻoma 2nd through the Māhele ʻĀina of 1848, as he claimed ʻOʻoma 2nd as his personal property but later relinquished it during the mahele proceedings.

A detailed account of native traditions and historical accounts is included in Appendix 4; in summary, two locations stand out as areas of importance for the Project Area. Ka Punawai o Wawaloli (the pond of Wawaloli, or the area at Wawaloli Beach) on the shore of ʻOʻoma, was named for a supernatural ocean being, who could take the form of the loli (sea cucumber) and of a handsome young man. The kula lands were covered with ʻilima growth and that a variety of fish, seaweeds, and shellfish were harvested along the shore. Ka Loko o Paaiea (the fishpond of Pāʻaiea) was destroyed by the Hualālai lava flows of 1801, and had extended from Kaʻelehuluhulu on the north, and on the south, to the place called Wawaloli (between ʻOʻoma and Kalaoa).

*Cultural Resources*

Valued natural, cultural and historical resources are still present and used in various parts of Kekaha, including Kalaoa. On the widest level, the entire range of wao that make up the *ahupuaʻ*a, from the kahakai (shoreline) to the wao akua (cloud forests), have a level of cultural importance. More specifically, koa fishing grounds and the natural landmarks such as puʻu (hills) that guide fishermen to them are examples. Springs, ponds, and other coastal water features may have not only biological but also cultural significance. Burial sites for ʻiwi kupuna, including caves, are important resources to protect, as are some other archaeological resources. No such resources exist on the Project Site. No caves, springs, puʻu, gathering resources or other natural features are present on or near the Project Site that would support any traditional resource uses. The archaeological sites that are present near but not on the Project Site will be protected (see Section 3.6). There are no known burials on or near the Project Site. Aside from on-going activities on the shoreline, which would not be affected for by the Project, no Hawaiian customary and traditional rights or practices are known to be associated with the area. Two individuals of the rare plant maiapilo (Capparis sandwichiana), used in traditional Hawaiian medicine, is present in and near the Project Site. As discussed in Section 3.3.4, the locations of maiapilo plants have been recorded. Both are outside the Project footprint and would not be affected. Landscaping will incorporate the one plant that is one site and plant maiapilo and other native Hawaiian plants in the facility. Continued traditional use of maiapilo can occur through plants in the Project Area.

*Impacts and Mitigation Measures*

As there appear to be few natural resources of a potential traditional cultural nature (i.e., landform, vegetation, etc.), and none that would be significantly impacted, and no evidence of any traditional gathering uses or other cultural practices on this industrial albeit near the shoreline lot, and because design has ensured that archaeological sites will be fully protected during construction and operation, the proposed construction of the Innovation Center and Hale Wawaloli Visitor Center would not likely impact any culturally valued resources or cultural practices.

Under the No Action Alternative, no impacts to cultural practices or sites would occur.

*Cumulative Impacts*

No cultural practices have been identified in the Project Site. Any potential impacts to cultural sites from the Proposed Project would be mitigated; therefore, no cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions are anticipated to cultural practices or sites.

## 3.6 Historic and Archaeological Resources

An AIS was conducted in 2021 for the entire Project Site (Appendix 4), and the results are summarized below.

*Existing Resources*

In the AIS for the Project Site, one previously recorded archaeological site and two new archaeological sites were recorded. All three sites were located within the Innovation Center site on Parcel 100. Due to the extensive excavations and prior bulldozing at the Hale Wawaloli Visitor Center site, no new or previously recorded archaeological features were observed on Parcel 088 (portion of). The Draft AIS was submitted in January 2021.

The habitat complex (Site 10208) is a precontact to early historic period habitation complex that formerly consisted of 10 features, although bulldozing previously destroyed Features 4 through 10.

The remaining features are in fair condition and retain enough integrity for significance. This site is considered significant under Criterion D for the information it has yielded relative to Precontact/Historic land use in the coastal zone of ‘O‘oma and Kalaoa. Although the site has been set aside for preservation, a formal preservation plan has not yet been prepared or submitted to DLNR-SHPD for approval. Prior to implementing the Proposed Project, NELHA will prepare a Preservation Plan in accordance with HAR §13-277 to ensure that the remaining features of the site be preserved in place. The Preservation Plan would be submitted to DLNR-SHPD for review and acceptance prior to any additional development activities occurring within development of the Innovation Center.

Site T-1 is a complex consisting of three cobble piles (Features A, B, and C) located on TMK: (3) 7-3-043:100. The site is in poor condition but retains enough integrity to be assessed for its significance under Criterion D for the information it has yielded relative to the history of boundary marking at Keahole Point. The research conducted during this study has adequately documented the marker complex and, therefore, the treatment recommendation for Site T-1 is no further work.

Site T-2 is an excavation complex consisting of seven pāhoehoe excavations (Features A through G) located on TMK: (3) 7-3-043:100. The site is in poor condition but retains enough integrity to be assessed for its significance under Criterion D for the information it has yielded relative to the history and prehistory of the current study area and resource procurement in the coastal zone of North Kona. No further work is proposed for Site T-2.

*Impacts and Mitigation*

The current archaeological survey identified three archaeological sites within the proposed Innovation Center Project Area (Parcel 100), including one previously recorded habitation

complex (Site 10208), a newly recorded cobble complex (Site T-1), and a newly recorded excavation complex (Site T-2). Sites T-1 and T-2 have been sufficiently documented as a result of the current study and their research potential has been exhausted. Site 10208 is recommended for preservation. The Preservation Plan, and NELHA's commitment to avoid the site as part of Project design, would prevent impacts to archaeological resources from the Project.

No archaeological sites were identified within the proposed Hale Wawaloli Visitor Center, which has been completely disturbed by prior grading activities. No evidence of two sites previously documented in that area (Sites 1919 and 10185) was observed during the current field work; therefore, the Project is not expected to affect historic properties.

In the unlikely event that significant archaeological resources are discovered during the proposed ground disturbing activities within either the Innovation Center or Hale Wawaloli Visitor Center, work will cease in the area of the discovery and the DLNR-SHPD will be contacted pursuant to HAR 13§13-280-3.

Under the No Action Alternative, no impacts to historic or archaeological resources would occur.

*Cumulative Impacts*

Following implementation of an archaeological preservation plan, there are not expected to be any impacts to historic or archaeological resources from the Project; therefore, no cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions are anticipated to historic or archaeological resources.

## 3.7 Infrastructure

### 3.7.1 Utilities and Public Services including Wastewater Treatment and Solid Waste Management

*Existing Facilities and Services*

Electrical power to the facility would be supplied to the Project Area by Hawai'i Electric Light Company (HELCO), a privately owned utility company regulated by the State Public Utilities Commission, via a line on the HOST Park Access Road. Telephone and data service is available from Hawaiian Telcom. Water service is available via at the existing private water line along the main HOST Park Road.

No sanitary sewer system or other wastewater treatment is available on or near the Project Site. Potential impacts to water quality are discussed in Section 3.3.3.

Fire, police, and emergency management services are readily available in this part of Kona. A police substation is located in Kealakehe, about five road miles way. A fire station is located on Palani Road, approximately seven miles away by road, and there is also a fire station at Kona International Airport, just north of HOST Park. Emergency Medical Technician services are provided by the Hawai'i County Fire Department. Acute care services are available at Kona Hospital, approximately 15 miles to the south.

*Impacts and Mitigation Measures*

As discussed in more detail in Section 1.3, electricity and telephone/data service will be installed from existing lines along the main road adjacent to the Project Site. NELHA-supplied cold and warm seawater, as well as potable water, would be provided via underground water lines installed from the main road along the access road.

Three wastewater treatment systems comprised of septic tanks and leach fields would be installed for human wastewater. Solid waste from the facility will be minimal, and the facility will have an aggressive recycling policy.

A commercial refuse company would dispose of solid waste. Solid waste generated during construction will be dealt with appropriately, in conformance with a solid waste management plan being developed for review by the County Department of Environmental Management. See Section 3.3.3 for discussion of potential impacts to water quality.

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions and no utilities would be needed and no solid waste from the Project would be generated.

*Cumulative Impacts*

Existing utilities and public services have the capacity to accommodate developments such as the Project; therefore, cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions are expected to be minor.

### 3.7.2 Traffic

*Existing and Proposed Facilities*

The HOST Park and Project Site can be accessed from Makako Bay Drive or Kaiminani Street (Figure 1). Makako Bay Drive is a 24-foot-wide road. It is a two-lane, undivided roadway. The right-of-way varies between 80 feet and 110 feet. The wider 110-foot section begins just after the first interior intersection and ends near the main roadway bend near the booster pump station site. The access road is approximately 11,600 feet in length and is a public roadway. The road provides access to HOST Park and tenant facilities, the north end of the Ooma shoreline area, and Wawaloli Beach Park. There is an access gate near Makako Bay Drive's intersection with Queen Ka'ahumanu Highway. This gate is closed between 8 p.m. and 6 a.m. The posted speed limit is 25 miles per hour (mph).

Kaiminani Drive is a collector road that extends west from Mamalahoa Highway, past Queen Ka'ahumanu Highway to Kahilihili Street where it currently transitions into a 90-degree turn southbound. However, the two roadways are terminated as stub-outs forming a four-leg intersection for future expansion within HOST Park. Just *mauka* of Queen Ka'ahumanu Highway, Kaiminani Drive is a two-lane, undivided roadway. It provides eastbound and westbound left-turn lanes and right-turn storage lanes at its signalized intersection with Queen Ka'ahumanu Highway. The posted speed limit is 35 mph.

A traffic study for the Proposed Project conducted by Stantec included analysis at four existing intersections (Appendix 5). The four intersections in the vicinity of the Project Site analyzed include: 1) Queen Ka‘ahumanu Hwy and Keahole Airport Road; 2) Queen Ka‘ahumanu Highway and Kaiminani Street; 3) Queen Ka‘ahumanu Highway and Makako Bay Drive; and 4) Makako Bay Drive and Kahilihili Street.

Queen Ka‘ahumanu Highway (Route 19) in the vicinity of the Project Site has recently been built-out to a four-lane highway (from just north of Keahole Airport Road to just south of Kealakehe Parkway). It is a Class I State Highway with limited access and a posted speed limit of 45 mph near the project location. Queen Ka‘ahumanu Highway is a link in the principal highway system that circles the island.

Keahole Airport Road provides primary airport access from the highway to the passenger terminal as well as other airport facilities. Keahole Airport Road is a two-lane, undivided roadway. The posted speed limit on Keahole Airport Road is 25 mph.

Kahilihili Street is currently a north-south running roadway within HOST Park that terminates just south of Makako Bay Drive. This two-lane, undivided roadway provides access to the West Hawaii Explorations Academy, Keahole Solar Power Plant, and NELHA Gateway Center.

Turning movement counts were recorded in 2018 via traffic counting personnel at the intersections of Queen Ka‘ahumanu Highway and Keahole Airport Road, Queen Ka‘ahumanu Highway and Kaiminani Drive, Queen Ka‘ahumanu Highway and Makako Bay Drive, and Makako Bay Drive and Kahilihili Street. Appendix 5, Figure 8 shows the existing peak hour traffic volumes at the recorded intersection locations. Based upon historical peak hour data and KOA flight schedules, counts were performed between 7 a.m. to 9 a.m., 10 a.m. to noon, and from 2:30 p.m. to 4:30 p.m., respectively. In 2018, turning movement counts were utilized to represent the existing condition due to the COVID-19 slowdown. It is assumed that traffic volumes are getting back to pre-pandemic levels and that, moving forward, the historical traffic growth of 1.6 percent will continue.

The concept of level-of-service (LOS) is often used to describe the quality of traffic flow. There are six levels-of-service, A through F, which relate to the driving conditions from best to worst, respectively. In general, LOS A represents free-flow conditions with no congestion. LOS F, on the other hand, represents severe congestion with stop-and-go conditions. LOS D is typically considered acceptable for peak hour conditions in urban areas. LOS is usually applied to peak hour traffic, which is the “worst-case” scenario. Potential impacts to LOS from the Project are described below.

*Impacts and Mitigation*

The Traffic Impact Analysis Report (TIAR) first calculated the projected increase in background traffic volumes within the local roadway network (without the Proposed Project) in 2024. Background traffic volumes are volumes not directly associated with the development proposed. These volumes are comprised of regional volumes using Queen Ka‘ahumanu Highway and the rest of the local roadway network to travel past the Proposed Project. A background growth rate of 1.6 percent per year was assumed, to account for additional traffic at the intersections. The

TIAR then calculated the projected increase in traffic within the local roadway network with the Proposed Project in 2024. At the intersections evaluated, the Project is projected to generate 38 entering and 13 exiting vehicles per hour during the AM peak, and 28 entering and 123 exiting vehicles per hour during the PM peak.

In summary, the traffic analysis indicates that the existing roadway network can handle the Project's traffic volumes. The only detectable increase to roadway network LOS due to the Proposed Project would be at Queen Ka'ahumanu Highway and Kaiminani Street intersection.

Without mitigating traffic signal timing modifications, the left-turning movements in the northbound (Queen Ka'ahumanu Highway NB to Kahilihili St WB), eastbound (Kaiminani St EB to Queen Ka'ahumanu Highway SB), and westbound (Kaiminani St WB to Queen Ka'ahumanu Highway NB) directions are anticipated to experience increased delay in 2024 accounting for the Project. However, none of the delays result in a decreased LOS for the intersection.

To minimize the effect of the predicted delays, it is recommended that the traffic signal cycle and phase timing be modified by Hawai'i DOT at the Queen Ka'ahumanu Highway and Kaiminani Street/Kahilihili Street intersection to provide more green time to the left turning movements should the projected delays materialize. The thru movements at this intersection are all projected to operate at B or C LOS and could absorb a few seconds of additional delay without lowering their LOS designations.

Under the No Action Alternative, the Proposed Project would not be constructed, and the site would remain unchanged from current conditions and growth would increase as shown in the Without Project tables in Appendix 5.

*Cumulative Impacts*

The predicted impacts from past, present, and reasonably foreseeable future projects are estimated for 2024 in Appendix 5. The predicted cumulative impacts of the Proposed Project in addition to past, present, and reasonably foreseeable future actions are estimated in the Project projections in Appendix 5. Traffic would continue to increase, but without a predicted change to the LOS at the intersections analyzed.

### 3.7.3 Airport Operations

*Existing Environment*

Compatibility of the facility with the expected noise levels of the airport are considered in Section 3.3.5. Regarding potential impacts to other aspects of airport operations, the DOT-Airports Division commented during early consultation (Appendix 1). In summary, the Airports Division is concerned about the safety of airport operations and users adjacent to the airport. The agency asked for assurances that the facility would not be a wildlife attractant for birds. Furthermore, because of the proximity to the airport, the FAA requires NELHA to file a Form 7460-1 for the proposed structure and a separate one for any construction crane that will be used.

*Impacts and Mitigation Measures*

Consultation of maps and communications from the FAA indicate that the property is outside the current and future proposed runway protection zone. The research tanks would be designed to avoid being attractants to birds. NELHA would ensure the filing of Form 7460-1 for the FAA aeronautical study. From current data, it would appear that the Project is compatible with airport operations, and that construction and operation of the Innovation Center and Hale Wawaloli Visitor Center would not pose a hazard to the airport, staff, or the general public.

Under the No Action Alternative, the site would remain unchanged from current conditions and the Project would not be constructed.

*Cumulative Impacts*

Since there are no impacts from the Proposed Project, there are no anticipated cumulative impacts from the Proposed Project in combination with past, present, or reasonably foreseeable future actions to airport operations. The Proposed Project does not require any changes to land use designations and would not cumulatively affect airport operations because it is consistent with Kona Airport Master Plan.

## 3.8 Review of Potentially Applicable Federal Authorities

Federal funding may be used for the Project, and if such funding were secured it would require the lead agency to address various federal authorities. For convenience in those future evaluations (should they occur), potentially applicable federal authorities (or requirements under federal laws and Executive Orders) are preliminarily reviewed below. These should be considered preliminary discussions and no determinations of compliance have been made by any federal agencies. These evaluations would be completed by the lead federal agency, if needed, at a later time.

### 3.8.1 Archeological and Historic Preservation Act (16 U.S.C. § 469a-1) and National Historic Preservation Act (16 U.S.C. § 470) (NHPA)

An archaeological assessment survey conducted under the authority of Chapter 6E, HRS, has properly documented historic properties to ensure that effects to significant historic sites would be avoided. The archaeological survey will be submitted to the SHPD for review. If previously undocumented sites are inadvertently discovered in other areas, SHPD would be contacted immediately and advised of the circumstances of the find, its location, and the presence or absence of associated cultural resources, as outlined in HAR 13§13-275-12.

If federal funding is used for the Project, consultation would be conducted, and an archaeological report would be prepared and submitted by NELHA to the State Historic Preservation Officer for review and concurrence in order to satisfy Section 106 of the NHPA.

### 3.8.2 Clean Air Act as Amended (42 U.S.C. 7401, et seq.)

As discussed in Section 3.3.6, air quality at the Project Site is acceptable. The site is within an air quality attainment area as defined by the State of Hawai‘i DOH in its EPA-approved Air Quality

program. Construction would include plans to minimize fugitive dust through watering and planting as soon as feasible. Diesel-powered construction equipment would produce emissions that slightly degrade air quality for the short period of time that engines are in operation. However, all applicable emission and ambient air quality standards would continue to be met. No sensitive receptors are present within several miles of the Project Site. Occupation of the Innovation Center and the Hale Wawaloli Visitor Center would not produce any on-site air emissions. Consequently, the Project complies with the provision of the Clean Air Act.

### 3.8.3 Coastal Barriers Resource Act (16 U.S.C. 3501)

The Coastal Barrier Resources Act designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the Coastal Barrier Resources System. No coastal barriers are present in the state of Hawai‘i, and the Project is consistent with the Coastal Barriers Resource Act.

### 3.8.4 Endangered Species Act (16 U.S.C. 1536(a)(2) and (4)), Essential Fish Habitat Consultation Process Under the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801), and Fish and Wildlife Coordination Act (16 U.S.C. 661)

The Endangered Species Act (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) provides broad protection for species of plants and animals that are listed as threatened or endangered in the U.S. or elsewhere. The Act mandates that federal agencies seek to conserve endangered and threatened species and use their authorities in furtherance of the Act’s purposes. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions.

Existing biota on and near the Project Site are discussed in detail in Section 3.3.4. In general, the majority of the site is located on bare pahoehoe lava flows with a large portion of these areas having been previously disturbed by grading. Only the portions of the Project Site proximate to the shoreline are vegetated. No threatened or endangered plant species as listed by the USFWS were observed in the Project Site. One rare plant, maiapilo, is present at the proposed Innovation Center location. As mitigation for this impact, the Proposed Project will avoid all direct and indirect impacts to the maiapilo from construction of the Innovation Center. There are no uniquely valuable vegetation types, although the Coastal Strand vegetation is important common habitat for a variety of native shoreline birds and *Hylaeus* bees, including a potentially endangered species (*Hylaeus anthracinus*). The Coastal Strand vegetation would be avoided by the Proposed Project. As discussed above, wide-ranging threatened and endangered animal species may occasionally be present on or fly over the Project Site, as they are throughout most of coastal West Hawai‘i. These include the Hawaiian hoary bat, Blackburn’s sphinx moth, the Hawaiian goose, the Hawaiian stilt, and several species of seabirds that do not land in the Project Area or utilize its resources but may fly over the area at night.

There is very little potential at the properties for use by nēnē for nesting or feeding, because the sparse, open, dry vegetation has little in the way of tender grass shoots or fresh water that attracts

these birds. Nevertheless, the occasional presence of nēnē, which range widely and are unafraid of humans, could occur.

Hawaiian stilts would not be attracted to the site because of the lack of water bodies.

The Project would not disturb any Coastal Strand vegetation during construction of the Innovation Center property or the Hale Wawaloli Visitor Center. The proposed fence at the Innovation Center would be routed around some isolated tree heliotrope and naupaka plants. As such, even in the event that *Hylaeus anthracinus* is occasionally present, the effects to habitat would be minimal.

Outdoor lighting in Hawai'i often attracts threatened or endangered seabirds that may become disoriented by the lighting, resulting in downed birds.

Since impacts to the limited coastal strand vegetation present at the Project Site would be avoided during Project construction, no adverse impacts to federally listed species (including, but not limited to, Hawaiian monk seals and sea turtles) would occur as a result of construction of the Innovation or Hale Wawaloli Visitor Centers, provided that appropriate minimization measures, which will be part of construction documents, are enforced during construction. Specific minimization measures adapted closely from the USFWS are included in Section 3.3.4 and would also be implemented during occupancy (following construction) to prevent future impacts to federally listed species.

The USFWS is being coordinated with as part of preparation of the Draft EA review process to verify the biological characterization of the Project Site and the adequacy of the proposed mitigation measures to protect threatened and endangered species. The Final EA will report the results of the coordination. If the Project uses federal funds, the lead federal agency would undertake Section 7 consultation under the Endangered Species Act to determine the effects to listed species and propose avoidance and minimization measures for review by the USFWS.

Federal aid recipients must also determine whether a proposed project may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. 1801. According to the Western Pacific Regional Fishery Management Council (WESPAC) (2005) in its Fishery Ecosystem Plan for the Hawaii Archipelago, several areas of EFH in nearshore (non-pelagic waters) in the Hawaiian Archipelago have been designated approved by the Secretary of Commerce. The EFH designations for Bottomfish and Seamount Groundfish, Crustaceans, Precious Corals and Pelagic Management Unit Species (MUS) were approved by the Secretary on February 3, 1999 (64 FR 19068). The EFH designations for Coral Reef Ecosystem MUS were approved by the Secretary on June 14, 2002 (69 FR 8336). Maps available at the National Marine Fisheries Service's Essential Fish Habitat Mapper website do not indicate any areas of EFH near the Project Area (http://www.habitat.noaa.gov/protection/efh/habitatmapper.html). No aspect of the Project would affect EFH, as it does not occur near the sea nor affect it directly or indirectly.

Under the Fish and Wildlife Coordination Act, 16 U.S.C. 661, federal aid recipients should seek the assistance of wildlife officials to determine the effect the Proposed Project may have on wildlife and its habitat. As discussed above, the USFWS and the State DLNR were contacted during preparation of the EA. They are also being supplied a link to a copy of the Draft EA to assist in the

preliminary assessment that EFH will not be affected determination, and apart from the endangered species discussed above, impacts to which can be avoided, there are not expected to be any wildlife or habitat concerns.

### 3.8.5 Environmental Justice (Executive Order 12898)

The Environmental Justice Executive Order was issued in 1994 for the purpose of protecting low income and minority residents of the U.S. from disproportionate exposure to environmental and health hazards.

According to the most recent demographic data available from the U.S. Census Bureau for Kailua as a Census Designated Place (CDP) released in the American Community Survey in December of 2019, the largest group in Kailua of Hawai‘i are White (29.3 percent), followed by Asian (20.1%), Native Hawaiians and Pacific Islanders (18.6%), and Two or More Races (17.5%), in terms of major categories recognized by the U.S. Census. As with almost every major census area in Hawai‘i, Kailua is “majority minority.” However, this breakdown inadequately describes the ethnic makeup as perceived by Hawai‘i residents, who distinguish among Native Hawaiians, Samoans, Japanese, Chinese, Koreans, Puerto Ricans, Portuguese and Filipinos. In addition, more than half of all births in Hawai‘i since 1970 involve parents of different or mixed ethnic backgrounds, leading to often inconsistent identifications on census forms. Consequently, the conventional definition of ethnic affiliation is problematic in Hawai‘i. Discussions of environmental justice in Hawai‘i generally center on the Native Hawaiian and Pacific Islander population, which is usually recognized as disadvantaged in terms of income, health, home ownership, and many other measures of socioeconomic well-being. The proportion of Native Hawaiians in Kailua closely tracks that of the County and State as a whole. Other Pacific Islanders are less represented on the neighbor islands as compared to O‘ahu and the State as a whole.

As a measure of the extent of low-income populations, this EA uses poverty rates as representative, because data on poverty are readily available. There are no County or State data concerning income levels or poverty rates in individual communities on the Island of Hawai‘i. The most fine-scaled and recent data are contained in the U.S. Census’s American Community Survey. These data are updated each year. Poverty status is determined by comparing annual income to a set of dollar values called poverty thresholds that vary by family size, number of children and age of householder. If a family’s before-tax monetary income is less than the dollar value of their threshold, then that family and every individual in it are considered to be in poverty. For people not living in families, poverty status is determined by comparing the individual’s income to his or her poverty threshold. For small populations and small sample sizes, high margins of error occur. The poverty rate as of 2019 for Kailua was 6.4 percent, similar to that of the County as a whole, which is 13.1 percent.

It is clear that minority and low-income populations are present, at levels very similar to most of the County and State. The Project is located in the HOST Park an area already identified for research and development and would not have any more than very minor and temporary adverse secondary environmental, economic, or social impacts, as discussed in previous sections. Improvement of the Wawaloli Park area through development of the Hale Wawaloli Visitor Center would serve the general community, including low-income and minority populations who utilize the park. Moreover, the State and federal regulations regarding safe drinking water are

applicable to all water systems in Hawai‘i, irrespective of the economic or demographic characteristics of their residents. Therefore, the Proposed Project is consistent with this Executive Order.

### 3.8.6 Farmland Policy Protection Act (7 U.S.C. 4202(8))

The Farmland Protection Policy Act (FPPA) (Public Law 97-98, Sections 1539-1549) requires identification of projects that would affect any lands classified as prime and unique farmlands. Agencies must consider alternative actions that could reduce adverse effects and ensure that their programs, to the extent practicable, are compatible with State, local government and private programs and policies to protect farmland. The U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) has national leadership for administering the FPPA.

“Farmland,” as used in the FPPA and applied to the State of Hawai‘i, includes Agricultural Lands of Importance in the State of Hawai‘i (ALISH), a system in which the State Department of Agriculture classifies lands into three categories: (1) Prime Agricultural Land, (2) Unique Agricultural Land, and (3) Other Important Agricultural Land.

According to State maps of the area (Hawai‘i State GIS system: https://geoportal.hawaii.gov/search?q=alish), there are no Prime, Unique, or Other Important Agricultural Lands at or near the Project Site, which is too dry and rocky to be included. The Project would not impact such land or the agricultural use of any properties. Therefore, the Project would be compliant with the FPPA.

### 3.8.7 Floodplain Management Act (42 U.S.C., 4321, and Executive Order 11988) Floodplain Management (24 May 1977)

The Floodplain Management Act deals with critical action inside designated floodplains, and Executive Order 11988 requires federal agencies to avoid, to the extent possible, the short- and long-term adverse impacts associated with the occupancy of the floodplain, and to avoid direct and indirect support of floodplain development where there is a practicable alternative. 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 floodplains.”

Impacts to floodplains would be limited to the installation of a perimeter fence, no other Project structures would be constructed in the floodplain. The fence line is not expected to impact floodplains. The Project is consistent with Executive Order 11988 and the Floodplain Management Act.

### 3.8.8 Protection of Wetlands (Executive Order No. 11990 & Executive Order No. 12608), and Clean Water Act, as Amended (33 U.S.C. 1251 et seq.)

Fieldwork confirmed through consultation of maps from the USFWS demonstrated that no wetlands or other waters of the U.S. are present on any part of the Project Site.

The Project would comply with the Clean Water Act, Section 404(b)(1) Guidelines. None of the proposed construction materials would be expected to contain any contaminants.

As discussed in Section 3.3.2, an NPDES permit would need to be obtained by the construction contractor before the Project commences. This permit requires the completion of a Storm Water Pollution Prevention Plan in order to properly manage storm water runoff through appropriate BMPs. Acquisition of the NPDES permit and implementation of the permit conditions would ensure compliance with the Clean Water Act.

### 3.8.9 Safe Drinking Water Act (42 U.S.C., 300H-3(E))

The Safe Drinking Water Act (SDWA) is the principal federal law that ensures the quality of Americans' drinking water. Under the SDWA, EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards. The SWDA requires that all public water systems meet stringent water quality standards. These standards cover a long list of potential chemical, radiological, and biological contaminants.

The SDWA is also the authority for regulatory protection of principal or sole source aquifers. Specifically, once a sole source aquifer is designated, commitments for federal assistance must ensure that projects will not contaminate the aquifer through a recharge zone so as to create a significant hazard to public health.

As identified by the EPA, Region IX groundwater Office (http://water.epa.gov/infrastructure/drinkingwater/sourcewater/protection/upload/SSAGeneralInformation.pdf) (accessed December 2021), there are only two sole source aquifers in Hawai'i. They are the Southern O'ahu Basal Aquifer on the Island of O'ahu and the Moloka'i Aquifer on the island of Moloka'i.

The Project is not expected to impact water quality (as discussed in Section 3.3.3) and there are no sole source aquifers on the Island of Hawai'i; therefore, the Project would be compliant with the SDWA.

### 3.8.10 Wild and Scenic Rivers Act (15 U.S.C. 1271-1287)

The Wild and Scenic Rivers Act makes it the national policy that certain rivers of the U.S. which, along with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition. There are no designated Wild and Scenic Rivers in the State of Hawai'i at this time. Consequently, the Project is consistent with the provisions of the Wild and Scenic Rivers Act.

## 3.9 Irreversible and Irretrievable Commitments of Resources

A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource; an irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use.

The land to be used by the Innovation Center is in a State Land Use Urban District and, therefore, has been characterized by "city-like" concentrations of people, structures, and services. This

District also includes vacant areas for future development. The Visitor Center is in the Conservation District. Conservation lands primarily occur in existing forest and water reserve zones and include areas necessary for protecting watersheds and water resources, scenic and historic areas, parks, wilderness, open space, recreational areas, and habitat for endemic species. No new land would be irreversibly and irretrievably committed as a result of the Innovation Center or Visitor Center.

The Proposed Project would require the commitment of natural, physical, and human resources to plan, design, construct, and operate. Diesel fuel to power equipment would be used during Proposed Project construction and building materials, such as concrete and asphalt, would be consumed. Some of those materials could ultimately be recycled for reuse, those that are not would be expended.

## 3.10 Unavoidable Adverse Impacts

No unavoidable adverse impacts from the Proposed Project are anticipated.

## 3.11 Unresolved Issues

No unresolved issues for this EA have been identified.

## 3.12 Required Permits and Approvals

The Proposed Project requires granting the following permits and approvals, which are listed by responsible agency:

- County of Hawai‘i, Department of Public Works, Building Division Approval and Building Permit
- County of Hawai‘i, Department of Public Works, Engineering Division, Grading Permit
- County of Hawai‘i, Department of Public Works, Engineering Division, Drainage Plan
- State Department of Health, NPDES Permit
- State Historic Preservation Division, Chapter 6E Historic Sites Clearance

## 3.13 Consistency with Government Plans and Policies

### 3.13.1 Hawai‘i State Plan and Hawai‘i State Land Use Law

Adopted in 1978 and last revised in 1991 (Hawai‘i Revised Statutes, Chapter 226, as amended), the Plan establishes a set of themes, goals, objectives and policies that are meant to guide the State's long-run growth and development activities. The three themes that express the basic purpose of the Hawai‘i State Plan are individual and family self-sufficiency, social and economic mobility and community or social well-being. The Proposed Project would improve economic mobility and community well-being by encouraging research and development of blue technology.

Chapter 205 Hawai‘i Revised Statutes classifies all land in the State of Hawai‘i into one of four land use categories – Urban, Rural, Agricultural, or Conservation – and determines permissible uses in each district. The Innovation Center site is in the State Land Use Urban District and the Visitor Center is in the Conservation District. The proposed use is consistent with intended uses for these land use districts.

### 3.13.2 Coastal Zone Management Program (Chapter 205A, HRS)

HRS 205A defines the coastal zone as "all the 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 United States territorial sea", the Project Site is located in the coastal zone management area.

The Project Site is adjacent to the shoreline at an elevations from 10 to 18 feet amsl and would not influence coastal process or conditions. The Proposed Project would also have no impact to coastal recreation opportunities, historic resources, scenic and open space resources, coastal ecosystems, economic uses, coastal hazards, managing development, public participation, beach protection, and marine resources (HAR § 205A-2). Detailed explanations of potential impacts are described above in the environmental consequences sections, and below in Section 3.13.3. As the site and actions on it are not likely to influence coastal processes or conditions within coastal areas, no potential impacts are anticipated.

### 3.13.3 Coastal Zone Management Act (16 U.S.C.1456(c)(1))

The Hawai'i Coastal Zone Management (CZM) Program was established in 1977 through the adoption of the Coastal Zone Management Act, incorporated in Chapter 205A HRS. Projects with federal involvement significantly affecting areas under jurisdiction of the State CZM Agency may be required to undergo review for consistency with the State's approved coastal program. The entire State of Hawai'i is included in the coastal zone for such purposes. The Project's consistency with the ten CZM objectives are reviewed below.

Recreational Resources: Provide coastal recreational opportunities accessible to the public. The Project would facilitate recreational opportunities for researchers at the Innovation Center and would enhance the experience for visitors to the Welcome Center.

Historic Resources: Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the CZM area that are significant in Hawaiian and American history and culture. With the Preservation Plan and NELHA's commitment to avoid impacts, the remaining features of the archaeological site at the Innovation Center site would be protected and preserved.

Scenic and Open Space Resources: Protect, preserve, and where desirable, restore or improve the quality of coastal scenic and open space resources. The Project is located between developed educational and aquaculture facilities and has been designed to enhance the scenic stretch of coastline.

Coastal Ecosystems: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems. No activities near the coastline are involved, and there would be no effect on coastal ecosystems. The Project is not expected to have any adverse effect on the quality or quantity of groundwater for coastal ecosystems.

Economic Uses: Provide public or private facilities and improvements important to the State's economy in suitable locations. The Project would encourage development of research on the emergency renewable energy, aquaculture, and other ocean-based technologies and would provide jobs and promote conservation and education for the benefit of all residents of the State and County of Hawai'i.

Coastal Hazards: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence. The Project has been designed to accommodate increased stormwater run-off from larger storms in the adjacent drainages and on site.

Managing Development: Improve the development review process, communication, and public participation in the management of coastal resources and hazards. The Project occurs in the area that falls within the NELHA Master Plan and is in conformance with all State and County land use plans.

Public Participation: Stimulate public awareness, education, and participation in coastal management, and maintain a public advisory body to identify coastal management problems

and provide policy advice and assistance to the CZM program. The Project is not inconsistent with this objective.

Beach Protection: Protect beaches for public use and recreation; locate new structures inland from the shoreline setback to conserve open space and minimize loss of improvements due to erosion. No beaches would be affected by the Project.

Marine Resources: Implement the State's ocean resources management plan. The Project would not affect marine resources in any adverse way, and the improvements are not inconsistent with this objective. The Hawai'i CZM Program is not authorized to provide federal consistency reviews for projects with Federal Emergency Management Agency assistance. However, this will be submitted by NELHA to the Hawai'i CZM Program for general review.

### 3.13.4 Hawai'i County Zoning, Special Management Area, and General Plan

The subject parcels for the Innovation Center are zoned General Industrial District (minimum land area of 1 acre, required for each building site) (MG-1a) where a wide range of uses are allowed. The Project is consistent with the permitted uses of this zoning district. The portion of the subject parcel proposed for the Hale Wawaloli Visitor Center is zoned Open by the County of Hawai'i, although County zoning per se does not apply in the Conservation District. In any case, the proposed use as a public park appears to be consistent with permitted uses in the Open zoning district.

The General Plan for the County of Hawai'i is a policy document expressing the broad goals and policies for the long-range development of the Island of Hawai'i (County of Hawai'i 2005). The plan was adopted by ordinance in 1989 and revised in 2005 (Hawai'i County Planning Department). The General Plan itself is organized into thirteen functional elements. In general, the Proposed Project would be consistent with the goals, policies and objectives, standards, and principles for several functional areas. This section addresses the consistency of the proposed action with relevant policies of the County.

**Economic Goals**

- Economic development and improvement shall be in balance with the physical and social environments of the Island of Hawai'i.

**Economic Policies**

- The County of Hawai'i shall continue to encourage the expansion of the research and development industry by working with and supporting the university, private sector, and other agencies' programs developed to aid the County of Hawai'i.

- The County shall promote a distinctive identity for the island of Hawai'i to enable government, business and travel industries to promote the County of Hawai'i as an entity separate and unique within the State of Hawai'i.

**Discussion:** The Proposed Project is consistent with the economic goals and policies of the General Plan. The proposed action would encourage development of research on the emergency

renewable energy, aquaculture, and other ocean-based technologies and would provide jobs and promote conservation and education for the benefit of all residents of the State and County of Hawai‘i.

**Environmental Goals**

- Define the most desirable use of land within the County that achieves an ecological balance providing residents and visitors the quality of life and an environment in which the natural resources of the island are viable and sustainable.
- Maintain and, if feasible, improve the existing environmental quality of the island.
- Control pollution.

**Environmental Policies**

- Take positive action to further maintain the quality of the environment.

**Discussion:** The proposed facility incorporates measures to prevent pollution and has as its mission the improvement of environmental quality through research.

**Historic Sites Goals**

- Protect and enhance the sites, buildings and objects of significant historical and cultural importance to Hawai‘i.
- Appropriate access to significant historic sites, buildings and objects of public interest should be made available.

**Discussion:** No impacts to archaeological sites would occur from the Proposed Project.

**Natural Beauty Goals**

- Protect scenic vistas and view planes from becoming obstructed. Maximize opportunities for present and future generations to appreciate and enjoy natural and scenic beauty.

**Natural Beauty Policies**

- Increase public pedestrian access opportunities to scenic places and vistas.

**Discussion:** The Proposed Project would not degrade the scenic environment of the area.

**Natural Resources and Shorelines Goals**

- Protect and promote the prudent use of Hawai‘i's unique, fragile, and significant environmental and natural resources.

**Natural Resources and Shorelines Policies**

- Require users of natural resources to conduct their activities in a manner that avoids or minimizes adverse effects on the environment.
- Protect the shoreline from the encroachment of man-made improvements and structures.
- Ensure public access is provided to the shoreline, public trails and hunting areas, including free public parking where appropriate.

**Natural Resources and Shorelines Standards**

The following shall be considered for the protection and conservation of natural resources.

- Areas necessary for the protection and propagation of specified endangered native wildlife, and conservation for natural ecosystems of endemic plants, fish and wildlife.

**Discussion:** The Proposed Project would not degrade the scenic environment of the shoreline nor inhibit access to the shoreline. By not impacting coastal vegetation, the Project would help protect and maintain the propagation of endangered native wildlife.

**Land Use Goals**

- Designate and allocate land uses in appropriate proportions and mix in keeping with the social, cultural, and physical environments of the County.
- Protect and preserve forest, water, natural and scientific reserves, and open areas.

**Land Use Standards**

- The designated land uses will be delineated on the General Plan Land Use Pattern Allocation Guide Map. The broad-brush boundaries indicated are graphic expressions of the General Plan policies, particularly those relating to land uses. They are long-range guides to general location and will be subject to: a) existing zoning; and b) State Land Use District. Similarly, the acreages allocated represent alternatives for the various levels of economic activity and supporting functions, such as resort, residential, commercial and industrial activities. Land required for community and governmental services and programs as well as new towns and resort centers may be accommodated within the allocated acreages.

**Discussion:** The *Hawai'i County General Plan Land Use Pattern Allocation Guide (LUPAG) and Facilities Map* components of the *General Plan* are graphic representations of the Plan's goals, policies, and standards as well as of the physical relationship between land uses. They also establish the basic urban and non-urban form for areas and the planned public and cultural facilities, public utilities and safety features, and transportation corridors. The Project Site is within the General Industrial and Open zoning districts in the LUPAG. As discussed above in this section, the Project Site has been found to be consistent with these designations. The Proposed Project would be located to similar projects in the vicinity.

The Project Site is within the Special Management Area of the Hawai‘i Coastal Zone. According to a letter from the Hawai‘i County Planning Department in response to early consultation (see Appendix 1), the Project was previously determined by the Department to be covered by SMA permits No. 77 and 239, as amended, which allows for ocean energy and allied research and development facilities and related improvements, as well as the beach park and associated facilities.

### 3.13.5 Kona Community Development Plan

The Kona Community Development Plan (CDP) encompasses the judicial districts of North and South Kona and was developed under the framework of the February 2005 County of Hawai‘i General Plan. The CDP is intended to translate broad General Plan Goals, Policies, and Standards into implementation actions as they apply to specific geographical regions around the County.

The General Plan now requires that a CDP shall be adopted by the County Council as an "ordinance," giving the CDP the force of law. This is in contrast to plans created over past years, adopted by "resolution" that served only as guidelines or reference documents to decision-makers. The Kona CDP was adopted in September 2008 and amended by Ordinance 19-91 in 2019 by the County Council. The version referenced in this EA is at: http://www.hawaiicountycdp.info/north-and-south-kona-cdp/cdp-final-drafts.

The Plan has many elements and wide-ranging implications, but there are several major strategies that embody the guiding principles related to the economy, energy, environmental quality, flooding and other natural hazards, historic sites, natural beauty, natural resources and shoreline, housing, public facilities, public utilities, recreation, transportation, and land use.

The Proposed Project's proposed development is consistent with all aspects of the Kona CDP. It is in keeping with the plan's guiding principles in Chapter 3, including particularly item No. 1:

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

It also conforms with item No. 7:

> **Encourage a diverse and vibrant economy emphasizing agriculture and sustainable economies.**

The project is also consistent with aspects of the economic development strategy expressed in Section 4.8, particularly in its support of initiatives such as:

> **Ecosystem Services. The concept of ecosystem services attempts to make conservation a viable business option. The policies encourage the further exploration and development of this concept.**

In recognition of the sensitive cultural, biological, and recreational resources of the shoreline, the Innovation Center is sited 500 feet from the shoreline on a pahoehoe flat about 260 feet *mauka* of a vegetated pahoehoe/sand backshore with a public trail and moderate public use for hiking, fishing and gathering.

The Hale Wawaloli Visitor Center is sited approximately 220 feet from the shoreline, near the same trail, approximately 0.6 miles south of the Innovation Center.

The Project would not affect shoreline access in any way, and it is not inconsistent with efforts in the CDP to encourage larger shoreline setbacks and protect public use of shoreline areas:

> **Action LU–1.5 b:** Identify priority shorelines for increased setback as part of Policy ENV-2.1 Open Space Network Program (PD, PR, 1-2).
>
> **Policy LU-1.6: 17-Mile Protected Coastline:** As part of any discretionary land use approvals such as SMA major permits, rezonings, and state land use boundary amendments, implement the vision of a 15-mile-long protected stretch of open coastline from Makaeo north to Kikaua Pt. at the Kuki'o development. Most of this area is already publicly owned and much of it has already been set aside for park purposes. This incorporates the Kaloko-Honokōhau National Historical Park, the portion of Kohanaiki that will be deeded to the County under the terms of the existing SMA permit, the makai portion of O'oma 2, NELHA, and state lands *makai* of the airport runway, to the extent that they can be used for public recreation consistent with the requirements of NELHA and the airport, the Kekaha Kai State Park, and Makalawena.

### 3.13.6 Consistency with HRS Chapter 227-D

HRS Chapter 227D states the following:

> "§227D-2 Establishment of the natural energy laboratory of Hawaii authority; purpose. (a) There is established the natural energy laboratory of Hawaii authority, which shall be a body corporate and politic and an instrumentality and agency of the State. The authority shall be placed within the department of business, economic development, and tourism for administrative purposes, pursuant to section 26-35. The purpose of the natural energy laboratory of Hawaii authority shall be to facilitate research, development, and commercialization of natural energy resources and ocean-related research, technology, and industry in Hawaii and to engage in retail, commercial, or tourism activities that will financially support that research, development, and commercialization at a research and technology park in Hawaii. Its duties shall include:"

1) Establishing, managing, and operating facilities that provide sites for:

    a. Research and development;

    b. Commercial projects and businesses utilizing natural resources, such as ocean water or geothermal energy;

    c. Compatible businesses engaged in scientific and technological investigations, or retail, commercial, and tourism activities; and

    d. Businesses or educational facilities that support the primary projects and activities…"

The Proposed Project is consistent with NELHA's enabling legislation as found in Section 227D-2 HRS which states, "The purpose of the natural energy laboratory of Hawaii authority shall be to facilitate research, development, and commercialization of natural energy resources and ocean-related research, technology, and industry in Hawaii and to engage in retail, commercial, or tourism activities that will financially support that research, development, and commercialization at a research and technology park in Hawaii." Establishing, managing, and operating a "blue technology" Innovation Center and Hale Wawaloli Visitor Center are allowable and suitable activities for NELHA.

# PART 4: DETERMINATION

Based on the findings below, the Proposed Project will not significantly alter the environment, as impacts will be minimal, and therefore, a FONSI is anticipated. A final determination will be made upon consideration of comments to the Draft EA.

# PART 5: FINDINGS AND REASONS

Chapter 11-200.1-13, HAR, outlines those factors agencies must consider when determining whether an Action has significant effects:

1. *Irrevocably commit a natural, cultural, or historic resource.* No valuable natural or cultural resources would be committed or lost as a result of the Proposed Project. One relatively rare plant, *maiapilo*, is present on the Innovation Center site. This plant will be avoided, and new *maiapilo* will be used for landscaping. An archaeological site adjacent to the Innovation Center will be protected during construction and operation of the facility.

2. *Curtail the range of beneficial uses of the environment.* The Proposed Project expands the beneficial uses of the environment and is consistent with the General Industrial and Open district zoning in the LUPAG.

3. *Conflict with the State's environmental policies or long-term environmental goals established by law*. The State's long-term environmental policies are set forth in Chapter 344, HRS. The broad goals of this policy are to conserve natural resources and enhance the quality of life. The impact from the Proposed Project is minor and, therefore, is consistent with all elements of the State's long-term environmental policies and environmental goals.

4. *Have a substantial adverse effect on the economic, social welfare, or cultural practices of the community or State.* The State's long-term environmental policies are set forth in Chapter 344, HRS. The broad goals of this policy are to conserve natural resources and enhance the quality of life. The Project is minor and fulfills aspects of these policies calling for an improved environment. It is thus consistent with all elements of the State's long-term environmental policies. The Proposed Project would also generate employment opportunities for the local research and development industry, which would stimulate local economic spending.

5. *Have a substantial adverse effect on public health.* The Proposed Project would not affect public health in any way; stormwater would be appropriately disposed of in drainage structures.

6. *Involve adverse secondary impacts, such as population changes or effects on public facilities*. No adverse secondary effects are expected from the Project.

7. *Involve a substantial degradation of environmental quality*. The impact from the Proposed Project is minor and would thus not contribute to environmental degradation. BMPs and appropriate erosion control measures would be utilized during construction. No long-term adverse impacts are expected from the Proposed Project.

8. *Is individually limited but cumulatively has substantial adverse effect upon the environment or involves a commitment for larger actions.* The Proposed Project is not related to other activities in the region in such a way as to produce adverse cumulative effects or involve

a commitment for larger actions. It is consistent with the projects analyzed in previous EISs that analyzed cumulative impacts of long-term operation and expansion of NELHA operations and contemplated in NELHA's Master Plan.

9. *Have a substantial adverse effect on a rare, threatened, or endangered species, or its habitat.* There are no threatened or endangered species or suitable habitat for these species present at the Project Site, and no effects to these species are anticipated. Project impacts to maiapilo, a rare plant species, would be avoided. Endangered Hawaiian hoary bats and formerly listed Hawaiian hawks, which are island wide-ranging species, would experience no adverse impacts due to mitigation in the form of timing of vegetation removal. Additionally, no rare, threatened, or endangered species of fauna are known to exist on or near the Project Site, and none would be directly affected by any project activities. Potential impacts to *Hylaeus anthracinus* would be avoided since the Project would not disturb any Coastal Strand vegetation during construction of the Innovation Center property or the Hale Wawaloli Visitor Center, and the proposed fence at the Innovation Center would be routed around some isolated tree heliotrope and naupaka plants.

10. *Have a substantial adverse effect on air or water quality or ambient noise levels.* No adverse effects on air quality, water quality, or noise would occur. The increase in noise levels on the Project Site are consistent with their zoning and current use. The on-going CEMP would continue to ensure that no impacts to the nearshore environment occur from activities at NELHA or the HOST Park, including the Proposed Project.

11. *Have a substantial adverse effect on or is likely to suffer damage by being located in an environmentally sensitive area such as a floodplain, tsunami zone, sea level rise exposure area, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters.* Although the property is located in an area with volcanic and seismic risk, the entire Island of Hawai'i shares this risk, and the Proposed Project is not imprudent to construct. The Project Site is adjacent to the shoreline, but development for Phase 2 of the Innovation Center and the Hale Wawaloli Visitor Center is outside any flood plain. Based on potential impacts from climate change, the Proposed Project has been designed to accommodate increased stormwater run-off from larger storms in the adjacent drainages and on site.

12. *Have substantial adverse effect on scenic vistas and viewplanes, during day or night, identified in county or state plans or studies.* No scenic vistas and viewplanes identified in the Hawai'i County General Plan will be adversely affected by the Proposed Project. Scenic effects to the shoreline have been avoided by project siting and design

13. *Require substantial energy consumption or emit substantial greenhouse gases*. The Project includes measures to conserve energy, including the use of cold ocean water for heat transfer in the air conditioning.

# PART 6: REFERENCES


County of Hawai‘i. 2005. County of Hawai‘i General Plan, as amended. February 2005.

East End Beacon. 2020. Suffolk to Require Nitrogen-Reducing Septic Systems for New Construction. https://www.eastendbeacon.com/suffolk-to-require-nitrogen-reducing-septic-systems-for-new-construction/. Accessed March 2022.

Environmental Protection Agency (EPA). 2016. What Climate Change Means for Hawaii. August 2016. EPA 430-F-16-013. https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-hi.pdf.

Florida Department of Health (FDOH). 2021. Nitrogen-reducing systems for areas affected by the Florida Springs and Aquifer Protection Action (updated May 2021). https://www.floridahealth.gov/environmental-health/onsite-sewage/products/_documents/bmap-n-reducing-tech-18-10-29.pdf. Accessed March 2022.

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte. 2013. Online Rainfall Atlas of Hawai‘i. Bull. Amer. Meteor. Soc. 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1. http://rainfall.geography.hawaii.edu/interactivemap.html. Accessed September 2019.

Heliker, C. 1990. *Volcanic and Seismic Hazards on the Island of Hawai‘i.* Washington: U.S. GPO.

Intergovernmental Panel on Climate Change (IPCC). 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. https://www.ipcc.ch/site/assets/uploads/2018/02/ar4_syr_full_report.pdf. Accessed November 2021.

Kirch, P.V. 1985. Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory. University of Hawaii Press, Honolulu.

Natural Energy Laboratory of Hawai‘i Authority (NELHA). 2006. 2006 Annual Report. Accessed January 2022. https://nelha.hawaii.gov/wp-content/uploads/2014/01/NELHA_AnnRpt_2006.pdf

Natural Energy Laboratory of Hawai‘i Authority (NELHA). 2011. Master Plan for Natural Energy Laboratory of Hawai‘i Authority. November 2011. file:///V:/1858/active/185805157/05_report_deliv/!deliverables/!reports/EA/References/NELHA_Master_Plan_Final_Nov11.pdf. Accessed January 2022.

Natural Energy Laboratory of Hawai‘i Authority (NELHA). 2019. 2018-2019 Annual Report. https://nelha.hawaii.gov/wp-content/uploads/2020/11/Annual-Report-2018-2019-nelha-tagged-03.pdf. Accessed January 2022.

Natural Energy Laboratory of Hawai‘i Authority (NELHA). 2020. Annual Report for the Comprehensive Environmental Monitoring Program Covering the period: July 24, 1982 through June 30, 2020. October 2020. https://nelha.hawaii.gov/wp-content/uploads/2020/10/1982-2020_NELHA_CEMP_REPORT2.pdf

Pacific Islands Ocean Observing System (PacIOOS). 2017. Sea Level Rise: Hawai‘i Sea Level Rise Viewer. https://www.pacioos.hawaii.edu/shoreline/slr-hawaii/. Accessed December 2021.

PlanB Consultancy. 2021. NELHA Benthic and Biota Monitoring Program. Annual Survey Report 2021. Accessed February 2022. https://nelha.hawaii.gov/wp-content/uploads/2022/01/NELHA_Biota_Report_2021.pdf.

Tom Nance Water Resource Engineering (TNWRE). 2001. The Hydraulics of Seawater Disposal at the Natural Energy Laboratory of Hawaii. March 20, 2001.

United States Fish and Wildlife Service (USFWS). 2019. Environmental Conservation Online System (ECOS): USFWS Threatened & Endangered Species Active Critical Habitat Report. https://ecos.fws.gov/ecp/report/table/critical-habitat.html. Accessed December 2021.

University of Hawai‘i Economic Research Organization (UHERO). 2012. Economic Impact of the Natural Energy Laboratory Hawaii Authority Tenants on the State of Hawaii. May 18, 2012. Prepared for: Natural Energy Laboratory Hawaii Authority. http://nelha.hawaii.gov/wp-content/uploads/2013/05/NELHA-Tenants-Impact-Study-UHERO-2012_Color.pdf. Accessed March 2022.

University of Hawai‘i Economic Research Organization (UHERO). 2015. Economic Impact of the Natural Energy Laboratory Hawaii Authority Tenants on the State of Hawaii. February 10, 2015. http://nelha.hawaii.gov/wp-content/uploads/2015/03/Economic.Impact.2013.Report.Final_.pdf. Accessed March 2022.

University of Hawai‘i Economic Research Organization (UHERO). 2019. Economic Impact of the Natural Energy Laboratory Hawaii Authority Tenant on the State of Hawaii in 2018. Prepared for: Natural Energy Laboratory Hawaii Authority. September 18, 2019. https://nelha.hawaii.gov/wp-content/uploads/2019/10/NELHA_Report_2019_Final.pdf. Accessed March 2022.

University of Hawai‘i at Mānoa Sea Grant College Program. 2014. Climate Change Impacts in Hawai‘i - A summary of climate change and its impacts to Hawai‘i’s ecosystems and communities. UNIHI-SEAGRANT-TT-12-04. http://seagrant.soest.hawaii.edu/wp-content/uploads/2018/05/smFINAL-HawaiiClimateChange.pdf. Accessed December 2019.

University of Hawai‘i at Hilo, Dept. of Geography. 1998. Atlas of Hawai‘i. 3rd ed. Honolulu: University of Hawai‘i Press.

U.S. Geological Survey (USGS). 2019a. About Earthquakes in Hawaii. https://volcanoes.usgs.gov/observatories/hvo/about_earthquakes.html. Accessed November 2019.

U.S. Geological Survey (USGS). 2019b. Damaging Earthquakes – A Common Hazard in Hawaii. USGS Volcano Hazards Program. Hawaii Volcano Observatory.

https://volcanoes.usgs.gov/observatories/hvo/hazards_earthquakes.html Accessed November 2019.

U.S. Soil Conservation Service. 1973. Soil Survey of Island of Hawai‘i, State of Hawai‘i. Washington: U.S. GPO.

Wolfe, E.W. and J. Morris. 1996. *Geologic Map of the Island of Hawai‘i.* USGS Misc. Investigations Series Map i-2524-A. Washington, D.C.: U.S. Geological Survey.

# APPENDIX 1

## Early Consultation Letters

**Mitchell D. Roth**
*Mayor*

**Paul K. Ferreira**
*Police Chief*

**Kenneth Bugado, Jr.**
*Deputy Police Chief*

# County of Hawai'i

**POLICE DEPARTMENT**
349 Kapi'olani Street • Hilo, Hawai'i 96720-3998
(808) 935-3311 • Fax (808) 961-2389

November 1, 2021

Ms. Michele Lefebvre, PhD
Project Manager/Environmental Scientist
Stantec Consulting Services Inc.
P.O. Box 191
Hilo, HI 96721

Dear Ms. Lefebvre:

SUBJECT: ENVIRONMENTAL ASSESSMENT EARLY CONSULTATION FOR NELHA'S PROPOSED INNOVATION CENTER AND WELCOME CENTER, ISLAND OF HAWAI'I, NORTH KONA DISTRICT, TMKS: 7-3-043:051, 7-3-043:100, AND 7-3-043:088 (PORTION)

This is in response to your letter dated October 18, 2021 requesting comments related to your project.

Thank you for allowing the Hawai'i Police Department the opportunity to participate, however, at this time, we offer no comments.

Should you have questions, please contact Captain Gilbert Gaspar Jr., Commander of the Kona District, at (808) 326-4646, extension 299.

Sincerely,

PAUL K. FERREIRA
POLICE CHIEF

CHAD BASQUE
ASSISTANT POLICE CHIEF
AREA II OPERATIONS

GG/jaj
21HQ1077

Mitchell D. Roth
*Mayor*

Lee E. Lord
*Managing Director*

West Hawai'i Office
74-5044 Ane Keohokālole Hwy
Kailua-Kona, Hawai'i 96740
Phone (808) 323-4770
Fax (808) 327-3563

# County of Hawai'i

PLANNING DEPARTMENT

Zendo Kern
*Director*

Jeffrey W. Darrow
*Deputy Director*

East Hawai'i Office
101 Pauahi Street, Suite 3
Hilo, Hawai'i 96720
Phone (808) 961-8288
Fax (808) 961-8742

October 29, 2021

Michele Lefebvre
c/o Stantec Consulting Services, Inc.
P.O. Box 191
Hilo, HI 96721

Dear Ms. Lefebvre:

**SUBJECT: Special Management Area Use Permit No. 239 (SMA No. 239)**
**Special Management Area Use Permit No. 77 (SMA No. 77)**
**(PL-INT-2021-000741)**
**Landowner: State of Hawai'i**
**Applicant: Natural Energy Laboratory of Hawai'i Authority (NELHA)**
**Request: NELHA's Proposed Innovation Center and Welcome Center**
**Tax Map Key: (3) 7-3-043:051; 100; and 088, North Kona District, Hawai'i**

This is to acknowledge receipt on October 20, 2021, of the Environmental Assessment Early Consultation for NELHA's Proposed Innovation Center and Welcome Center to be developed on the subject parcels.

Two (2) of the subject parcels are zoned General Industrial 1-acre (MG-1a) (TMK's 373043051 & 373043100) while the third parcel (TMK 373043088) is zoned Open (ope) by the County of Hawai'i. Similarly, two (2) of the subject parcels (TMK's 373043051 & 373043100) are within the State Land Use (SLU) Urban district while the third parcel (TMK 373043088) is located with the SLU Conservation District. The General Plan Land Use Pattern Allocation Guide (LUPAG) Map designates the coastal areas of the subject parcel as Open, with mauka (landward) areas designated as Industrial (ind). The subject parcels are located entirely within the Special Management Area (SMA) and are considered "shoreline parcels" as defined by Hawai'i Revised Statutes (HRS) Chapter 205A-41. Based on the distance of the proposed activities from the shoreline (>40 feet) the Director has waived the requirement of a Shoreline Certification; no work will occur in the shoreline setback area.

**Proposed Project:**

The proposed project consists of the following (Note: Phase I was completed under SMA 77):

Phase II:

- 20,000 square feet (sq. ft.) facility under roof, includes offices, conference rooms, and laboratories.
- 48,200 sq. ft. of graded outdoor space for research storage (tankage).
- New parking area (50 stalls).
- Road and Drainage improvements.
- Septic System upgrades

Phase IIa:

- 30,000 sq. ft. facility under roof.
- 66,400 sq. ft. of graded outdoor space for tenant research activities and storage (tankage).
- New parking area (88 stalls)

Visitor Education Center (Hale Wawaloli):

- New 2,250 sq. ft. Welcome Center Building.
- Outdoor covered pavilion.
- Open amphitheater for community and public events.
- Three (3) additional buildings for office and storage.
- Parking will be at the existing Wawaloli Beach Park.

**Special Management Area Determination:**

The Planning Commission hearing on November 16, 1978, granted SMA Use Permit No. 77 (SMA 77) for *ocean energy and allied research and development facilities and related improvements* for Keāhole Point. It was stated in the SMA approval that *the proposed development is in the category of "clean" scientific industry and the development of a scientific center of this stature is in keeping with the State and County long-term development policies.*

The Planning Commission hearing on May 28, 1986, granted SMA Use Permit No. 239 (SMA 239) for the *development of the Hawaii Ocean Science and Technology (HOST) Park subdivision and related improvements, including all future improvements and structures proposed throughout the Keāhole Point area.* Additionally, the Planning Commission hearing on September 22, 1994, granted approval to amend SMA 239 by adding 83 acres to the area covered under the original permit, and allowing for additional uses such as aquaculture research and farms, biotechnology research and commercial development, ocean water related specialty agriculture, and other related projects. Additional listed approved uses include, visitor information center, commercial aquaculture production facility, commercial research and

development facility, and other incidental and subordinate uses such as a restaurant, bakery and print shop.

After a review of the proposal, we find that the proposed project, as represented in documents submitted under PL-INT-2021-000741, meets or is consistent with SMA No. 77 and *Amended* SMA No. 239. The project will not require further review against the SMA rules and regulations; however, it is the responsibility of the landowner to comply with the conditions of SMA No. 77 and *Amended* SMA No. 239; particularly Conditions No. 3 (requirement for Plan Approval) and 7 (no structural improvements with 40-foot shoreline setback area without approved Variance) of SMA 239. Copies of these SMA permits can be found under the PL-INT-2021-000741 "Files" tab of the County's online permitting system.

While further SMA review is no longer required, the Planning Department requests to be provided opportunity to review the Draft Environmental Assessment (DEA) when it is submitted to the Office of Environmental Quality Control (OEQC) for publication in the Environmental Notice.

If you have questions, please feel free to contact Alex Roy at (808) 961-8140 or via email at alex.roy@hawaiicounty.gov

Sincerely,

Maija Jackson for

Maija Jackson for (Oct 30, 2021 14:01 HST)

ZENDO KERN
Planning Director

AJR:jaa
\\Coh01\Planning\Public\Wpwin60\CZM\Letters\2021\PL-INT-2021-000741_NELHA.Doc

**DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAI'I**
345 KEKŪANAŌ'A STREET, SUITE 20 • HILO, HAWAI'I 96720
TELEPHONE (808) 961-8050 • FAX (808) 961-8657

November 8, 2021

Ms. Michele Lefebvre
Stantec Consulting Services Inc.
P. O. Box 191
Hilo, HI 96721

Dear Ms. Lefebvre:

**Subject: Pre-Environmental Assessment Consultation for NELHA's Proposed Innovation Center and Welcome Center, Island of Hawai'i, North Kona District Tax Map Key 7-3-043:051, 7-3-043:100 and 7-3-043:088 (Portion)**

This is in response to your Pre-Environmental Assessment Consultation request dated October 18, 2021.

Please be informed that the existing water system along the Natural Energy Laboratory Hawai'i Authority (NELHA) access road, from the Queen Ka'ahumanu Highway intersection to the subject properties, is privately owned and operated. The existing water system is served by a 6-inch master meter.

The Department will note that the average daily water usage through the existing master meter, over the past 2 years, is approximately 488,220 gallons per day, which is equivalent to approximately 1,221 units of water and exceeds the total amount of water units allotted for NELHA.

Therefore, the Department cannot provide any additional water at this time, extensive improvements and additions, which may include, but not be limited to source, storage, booster pumps, transmission, and distribution facilities, would be required. Currently, sufficient funding is not available from the Department for such improvements and no time schedule is set.

Should there be any questions, please contact Mr. Ryan Quitoriano of our Water Resources and Planning Branch at (808) 961-8070, extension 256.

Sincerely yours,

Keith K. Okamoto, P.E.
Manager-Chief Engineer

RQ:dfg

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE
MANAGEMENT

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

Nov 17, 2021

Stantec Consulting Services Inc.
Attention: Michele Lefebvre, Ph.D. via email: michele.lefebvre@stantec.com
Project Manager, Environmental Scientist
P.O. Box 191
Hilo, Hawaii 96721

Dear Dr. Lefebvre:

SUBJECT: Environmental Assessment Early Consultation for **NELHA's Proposed Innovation Center and Welcome Center** located at North Kona District, Island of Hawaii; TMKs: (3) 7-3-043:051, 100, and 088 (portion) on behalf of Natural Energy Laboratory of Hawaii Authority (NELHA)

Thank you for the opportunity to review and comment on the subject matter. The Land Division of the Department of Land and Natural Resources (DLNR) distributed or made available a copy of your request pertaining to the subject matter to DLNR's Divisions for their review and comments.

At this time, enclosed are comments from the (a) Engineering Division, (b) Office of Conservation & Coastal Lands, and (c) Land Division-Hawaii District on the subject matter. Should you have any questions, please feel free to contact Darlene Nakamura at (808) 587-0417 or email: darlene.k.nakamura@hawaii.gov. Thank you.

Sincerely,

*Russell Tsuji*

Russell Y. Tsuji
Land Administrator

Enclosures
cc: Central Files

HA 22-71

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RECEIVED
OFFICE OF CONSERVATION AND COASTAL LANDS
2021 OCT 28 P 12: 10
DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

October 26, 2021

**MEMORANDUM**

TO: **DLNR Agencies:**
X Div. of Aquatic Resources (kendall.l.tucker@hawaii.gov)
__Div. of Boating & Ocean Recreation
X Engineering Division (DLNR.ENGR@hawaii.gov)
X Div. of Forestry & Wildlife (rubyrosa.t.terrago@hawaii.gov)
__Div. of State Parks
X Commission on Water Resource Management (DLNR.CWRM@hawaii.gov)
X Office of Conservation & Coastal Lands (sharleen.k.kuba@hawaii.gov)
X Land Division – Hawaii District (gordon.c.heit@hawaii.gov)

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Environmental Assessment Early Consultation for **NELHA's Proposed Innovation Center and Welcome Center**
LOCATION: North Kona District, Island of Hawaii; TMKs: (3) 7-3-043:051, 100, and 088 (portion)
APPLICANT: Stantec Consulting Services, Inc. on behalf of Natural Energy Laboratory of Hawaii Authority (NELHA)

Transmitted for your review and comment is information on the above-referenced subject matter. Please submit comments by **November 17, 2021.**

If no response is received by the above date, we will assume your agency has no comments. Should you have any questions about this request, please contact Darlene Nakamura at darlene.k.nakamura@hawaii.gov. Thank you.

**BRIEF COMMENTS:**

(3) 7-3-043:088
in the Conservation District

( ) We have no objections.
( ) We have no comments.
( ) We have no additional comments.
(✓) Comments are included/attached.

Signed: K. Tiger Mills
Print Name: K. Tiger Mills
Division: DLNR - DLL
Date: November 5 2021

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF
HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**

OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:TM

Correspondence: HA 22-71

**MEMORANDUM**

**TO:** Russ Tsuji, Administrator
Land Division

NOV - 5 2021

**FROM:** K. Tiger Mills, Staff Planner
Office of Conservation and Coastal Lands

**SUBJECT:** NELHA's Proposed Innovation Center and Welcome Center Located at North Kona, Island of Hawai'i, Tax Map Keys: (3) 7-3-044:051, 100 and 088

The Office of Conservation and Coastal Lands (OCCL) has reviewed Stantec Consulting Services early consultation proposal for the subject matter and note parcel 088 where the Hale Wawaoli Visitor Education Center is proposed lies within the Resource subzone of the Conservation District. Proposed land uses in the Conservation District also triggers an environmental assessment under HRS, §343-5 Applicability and requirements.

The proposed Hale Wawaoli Visitor Education Center that includes an outdoor covered pavilion, an open amphitheater, spaces for community gatherings and public events, enclosed spaces and appropriate landscaping appears to be an identified land use in the Conservation District pursuant to the Hawai'i Administrative Rules (HAR) §13-5-22 P-6 PUBLIC PURPOSE USE (D-1) 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, energy generation from_renewable sources, 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.

The proposed land use would require a Board permit. To allow, modify or deny the proposed land use would be at the discretion of the Board of Land and Natural Resources. If commercial purposes are proposed, a Public Hearing would also be required. Any proposed landscaping shall give preference to plant materials that are endemic or indigenous to Hawai'i. The introduction of invasive species is prohibited in the Conservation District.

The proposed Education Center requires the filing of a Conservation District Use Application (CDUA) and all required attachments such as, but not limited to, the final Environmental Assessment (EA) and the filing of an HRS, 6E Intake Form for historic preservation compliance. A certified shoreline most likely will be required for the CDUA. The OCCL also requests that a SMA determination be included with the proposed application.

Regarding the draft EA, proposed mitigation, and best management practices before, during, and after the proposed construction should be described. This area appears to be in a moderately high coastal hazard area. Coastal hazards such as sea level rise, tsunami, and volcanic/seismic events in addition to other potential hazards along the coastline should be discussed and addressed in the DEA.

The OCCL would like the opportunity to review and comment on the draft EA. The rules and regulations and the CDUA may be found on the OCCL website at dlnr.hawaii.gov/occl. Should there be any questions regarding this memorandum, contact Tiger Mills of the OCCL at (808) 587-0382 or at kimberly.mills@hawaii.gov.

C: HDLO
County of Hawai'i
-Planning

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

October 26, 2021

**MEMORANDUM**

FROM: ~~TO:~~ **DLNR Agencies:**
X Div. of Aquatic Resources (kendall.l.tucker@hawaii.gov)
__Div. of Boating & Ocean Recreation
X Engineering Division (DLNR.ENGR@hawaii.gov)
X Div. of Forestry & Wildlife (rubyrosa.t.terrago@hawaii.gov)
__Div. of State Parks
X Commission on Water Resource Management (DLNR.CWRM@hawaii.gov)
X Office of Conservation & Coastal Lands (sharleen.k.kuba@hawaii.gov)
X Land Division – Hawaii District (gordon.c.heit@hawaii.gov)

TO: ~~FROM:~~ Russell Y. Tsuji, Land Administrator

SUBJECT: Environmental Assessment Early Consultation for **NELHA's Proposed Innovation Center and Welcome Center**

LOCATION: North Kona District, Island of Hawaii; TMKs: (3) 7-3-043:051, 100, and 088 (portion)

APPLICANT: Stantec Consulting Services, Inc. on behalf of Natural Energy Laboratory of Hawaii Authority (NELHA)

Transmitted for your review and comment is information on the above-referenced subject matter. Please submit comments by **November 17, 2021.**

If no response is received by the above date, we will assume your agency has no comments. Should you have any questions about this request, please contact Darlene Nakamura at darlene.k.nakamura@hawaii.gov. Thank you.

**BRIEF COMMENTS:**

( ) We have no objections.
( ) We have no comments.
( ) We have no additional comments.
(✓) Comments are included/attached.

Signed: CSC
Print Name: Carty S. Chang, Chief Engineer
Division: Engineering Division
Date: Nov 15, 2021

Attachments
cc: Central Files

**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**ENGINEERING DIVISION**

**LD/Russell Y. Tsuji**

**Ref: Environmental Assessment Early Consultation for NELHA's Proposed Innovation Center and Welcome Center**
**Location: North Kona District, Island of Hawaii**
**TMK(s): (3) 7-3-043:051, 100, and 088 (portion)**
**Applicant: Stantec Consulting Services, Inc. on behalf of Natural Energy Laboratory of Hawaii Authority (NELHA)**

**COMMENTS**

The rules and regulations of the National Flood Insurance Program (NFIP), Title 44 of the Code of Federal Regulations (44CFR), are in effect when development falls within a Special Flood Hazard Area (high-risk areas). State projects are required to comply with 44CFR regulations as stipulated in Section 60.12. Be advised that 44CFR, Chapter 1, Subchapter B, part 60 reflects the minimum standards as set forth by the NFIP. Local community flood ordinances may stipulate higher standards that can be more restrictive and would take precedence over the minimum NFIP standards.

The owner of the project property and/or their representative is responsible to research the Flood Hazard Zone designation for the project. Flood Hazard Zones are designated on FEMA's Flood Insurance Rate Maps (FIRM). The official FIRMs can be accessed through FEMA's Map Service Center (msc.fema.gov). Our Flood Hazard Assessment Tool (FHAT) (http://gis.hawaiinfip.org/FHAT) could also be used to research flood hazard information.

If there are questions regarding the local flood ordinances, please contact the applicable County NFIP coordinating agency below:

- Oahu: City and County of Honolulu, Department of Planning and Permitting (808) 768-8098.
- Hawaii Island: County of Hawaii, Department of Public Works (808) 961-8327.
- Maui/Molokai/Lanai County of Maui, Department of Planning (808) 270-7139.
- Kauai: County of Kauai, Department of Public Works (808) 241-4896.

**The applicant should include water demands and infrastructure required to meet project needs.** Please note that all State projects requiring water service from their local Department/Board of Water Supply system will be required to pay a resource development charge, in addition to Water Facilities Charges for transmission and daily storage.

**The applicant is required to provide water demands and calculations to the Engineering Division so it can be included in the State Water Projects Plan Update projections.**

Signed: _____
CARTY S. CHANG, CHIEF ENGINEER

Date: Nov 15, 2021

11/12/21

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

October 26, 2021

**MEMORANDUM**

TO: **DLNR Agencies:**
X Div. of Aquatic Resources (kendall.l.tucker@hawaii.gov)
__Div. of Boating & Ocean Recreation
X Engineering Division (DLNR.ENGR@hawaii.gov)
X Div. of Forestry & Wildlife (rubyrosa.t.terrago@hawaii.gov)
__Div. of State Parks
X Commission on Water Resource Management (DLNR.CWRM@hawaii.gov)
X Office of Conservation & Coastal Lands (sharleen.k.kuba@hawaii.gov)
X Land Division – Hawaii District (gordon.c.heit@hawaii.gov)

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Environmental Assessment Early Consultation for **NELHA's Proposed Innovation Center and Welcome Center**
LOCATION: North Kona District, Island of Hawaii; TMKs: (3) 7-3-043:051, 100, and 088 (portion)
APPLICANT: Stantec Consulting Services, Inc. on behalf of Natural Energy Laboratory of Hawaii Authority (NELHA)

Transmitted for your review and comment is information on the above-referenced subject matter. Please submit comments by **November 17, 2021.**

If no response is received by the above date, we will assume your agency has no comments. Should you have any questions about this request, please contact Darlene Nakamura at darlene.k.nakamura@hawaii.gov. Thank you.

**BRIEF COMMENTS:**

( ) We have no objections.
(✓) We have no comments.
( ) We have no additional comments.
( ) Comments are included/attached.

Signed: [signature]
Print Name: GORDON C. HEIT
Division: Land Division
Date: 11/04/21

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE
MANAGEMENT

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

Nov 18, 2021

Stantec Consulting Services Inc.
Attention: Michele Lefebvre, Ph.D. via email: michele.lefebvre@stantec.com
Project Manager, Environmental Scientist
P.O. Box 191
Hilo, Hawaii 96721

Dear Dr. Lefebvre:

SUBJECT: Environmental Assessment Early Consultation for **NELHA's Proposed Innovation Center and Welcome Center** located at North Kona District, Island of Hawaii; TMKs: (3) 7-3-043:051, 100, and 088 (portion) on behalf of Natural Energy Laboratory of Hawaii Authority (NELHA)

Thank you for the opportunity to review and comment on the subject matter. In addition to our previous comments dated November 17, 2021, enclosed are comments from the Division of Forestry & Wildlife on the subject matter. Should you have any questions, please feel free to contact Darlene Nakamura at (808) 587-0417 or email: darlene.k.nakamura@hawaii.gov. Thank you.

Sincerely,

*Russell Tsuji*

Russell Y. Tsuji
Land Administrator

Enclosures
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

October 26, 2021

**MEMORANDUM**

TO: **DLNR Agencies:**
X Div. of Aquatic Resources (kendall.l.tucker@hawaii.gov)
__Div. of Boating & Ocean Recreation
X Engineering Division (DLNR.ENGR@hawaii.gov)
X Div. of Forestry & Wildlife (rubyrosa.t.terrago@hawaii.gov)
__Div. of State Parks
X Commission on Water Resource Management (DLNR.CWRM@hawaii.gov)
X Office of Conservation & Coastal Lands (sharleen.k.kuba@hawaii.gov)
X Land Division – Hawaii District (gordon.c.heit@hawaii.gov)

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Environmental Assessment Early Consultation for **NELHA's Proposed Innovation Center and Welcome Center**
LOCATION: North Kona District, Island of Hawaii; TMKs: (3) 7-3-043:051, 100, and 088 (portion)
APPLICANT: Stantec Consulting Services, Inc. on behalf of Natural Energy Laboratory of Hawaii Authority (NELHA)

Transmitted for your review and comment is information on the above-referenced subject matter. Please submit comments by **November 17, 2021.**

If no response is received by the above date, we will assume your agency has no comments. Should you have any questions about this request, please contact Darlene Nakamura at darlene.k.nakamura@hawaii.gov. Thank you.

**BRIEF COMMENTS:**

( ) We have no objections.
( ) We have no comments.
( ) We have no additional comments.
(☑) Comments are included/attached.

Signed:
Print Name: DAVID G. SMITH, Administration
Division: Division of Forestry and Wildlife
Date: Nov 18, 2021

Attachments
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
FIRST DEPUTY

M. KALEO MANUEL
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

**STATE OF HAWAII**
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET, ROOM 325
HONOLULU, HAWAII 96813

November 17, 2021

**MEMORANDUM** *Log no. 3398*

**TO:** RUSSELL Y. TSUJI, Administrator
Land Division

**FROM:** DAVID G. SMITH, Administrator
Division of Forestry and Wildlife

**SUBJECT: Division of Forestry and Wildlife Comments for Early Consultation for an Environmental Assessment (EA) for NELHA's Proposed a Innovation Center and Welcome Center, North Kona, Hawai‘i**

The Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) has received your inquiry regarding an early consultation request for an EA for the Natural Energy Laboratory of Hawai‘i Authority's (NELHA) proposed Innovation and Welcome Centers development in the Hawai‘i Ocean Science and Technology Park (HOST Park) at Keahole Point, North Kona, Hawai‘i Island, TMKs: (3) 7-3-043:051, 7-3-043:100, and 7-3-043:088. The proposed project would be completed in two phases. Phase 2 will consist of developing an Innovation Center with approximately 20,000 square feet of facilities under roof and 48,000 square feet of graded outdoor space and would include 50 stalls of parking area, road and drainage improvements, and a septic wastewater system. Phase 2A (begun 10 years after Phase 2) would include approximately 30,000 square feet of under roof facilities, 88 additional parking stalls, and 66,400 square feet of graded outdoor space. The "Hale Wawaloli" visitor education center will cover 2,250 square feet and include an outdoor covered pavilion, an open amphitheater, and three (3) fully enclosed spaces. All development would include appropriate environmental landscaping.

The State listed Hawaiian Hoary Bat or ‘Ōpe‘ape‘a (*Lasiurus cinereus semotus*) could potentially occur in the vicinity of the project area and may roost in nearby trees. Any required site clearing should be timed to avoid disturbance to bats during their birthing and pup rearing season (June 1 through September 15). During this period woody plants greater than 15 feet (4.6 meters) tall should not be disturbed, removed, or trimmed. Barbed wire should be avoided for any construction because bat mortalities have been documented as a result of becoming ensnared by barbed wire during flight.

Artificial lighting can adversely impact seabirds that may pass through the area at night by causing disorientation. This disorientation can result in collision with manmade structures or grounding of birds. For nighttime work that might be required, DOFAW recommends that all lights used be fully shielded to minimize impacts. Nighttime work that requires outdoor lighting should be avoided during the seabird fledging season from September 15 through December 15. This is the period when young seabirds take their maiden voyage to the open sea. For illustrations and

guidance related to seabird-friendly light styles that also protect the dark, starry skies of Hawai‘i please visit: https://dlnr.hawaii.gov/wildlife/files/2016/03/DOC439.pdf.

State listed Hawaiian Goose or Nēnē (*Branta sandvicensis*) could potentially occur in the vicinity of the proposed project site. It is against State law to harm or harass this species. If any Hawaiian Geese are present during construction activities, all activities within 100 feet (30 meters) of them should cease, and the birds should not be approached. Work may continue after the birds leave the area of their own accord. If a nest is discovered at any point, please contact the Hawai‘i Island Branch DOFAW Office at (808) 974-4221.

The State listed Hawaiian Hawk or ‘Io (*Buteo solitarius*) may occur in the project vicinity. DOFAW recommends surveying the area to ensure no Hawaiian Hawk nests are present if trees are to be cut. ‘Io nests may be present during the breeding season from March to September.

The project area falls within or is encompassed the historic range of the State listed Blackburn’s Sphinx Moth (BSM; *Manduca blackburni*). Larvae of BSM feed on many nonnative hostplants that include tree tobacco (Nicotiana glauca) which grows in disturbed soil. We recommend contacting our Hawai‘i Island Branch DOFAW office at (808) 974-4221 for further information about where BSM may be present and whether a vegetation survey should be conducted to determine the presence of plants preferred by BSM. DOFAW recommends removing plants less than one meter in height or during the dry time of the year to avoid harm to BSM. If you intend to either remove tree tobacco over one meter in height or to disturb the ground around or within several meters of these plants they must be thoroughly inspected by a qualified biologist for the presence of BSM eggs and larvae.

Coastal plants such as naupaka (*Scaevola sericea*) and pa‘uohi‘iaka (*Jacquemontia ovalifolia ssp. sandwicensis*) are likely present in the project area and are host to the State endangered Yellow-faced Bee. These listed bees have been noted at other shoreline areas near the project area. DOFAW recommends surveys done by an entomologist be conducted before work occurs in the vicinity. Yellow-faced Bee surveys should occur between the months of April to November.

DOFAW recommends minimizing the movement of plant or soil material between worksites, such as in fill. Soil and plant material may contain invasive fungal pathogens (e.g., Rapid ‘Ōhi‘a Death), vertebrate and invertebrate pests (e.g., Little Fire Ants), or invasive plant parts that could harm our native species and ecosystems. We recommend consulting the Big Island Invasive Species Committee (BISC) at (808) 933-3340 in planning, design, and construction of the project to learn of any high-risk invasive species in the area and ways to mitigate spread. All equipment, materials, and personnel should be cleaned of excess soil and debris to minimize the risk of spreading invasive species. Gear that may contain soil, such as work boots and vehicles, should be thoroughly cleaned with water and sprayed with 70% alcohol solution to prevent the spread of Rapid ‘Ōhi‘a Death and other harmful fungal pathogens.

DOFAW recommends using native plant species for landscaping that are appropriate for the area (i.e. climate conditions are suitable for the plants to thrive, historically occurred there, etc.). Please do not plant invasive species. Please consult the Hawai‘i-Pacific Weed Risk Assessment website to determine the potential invasiveness of plants proposed for use in the project (https://sites.google.com/site/weedriskassessment/home). We recommend that you refer to www.plantpono.org for guidance on selection and evaluation for landscaping plants.

We appreciate your efforts to work with our office for the conservation of our native species. Should the scope of the project change significantly, or should it become apparent that threatened or endangered species may be impacted, please contact our staff as soon as possible. If you have any questions, please contact Paul Radley, Protected Species Habitat Conservation Planning Coordinator at (808) 295-1123 or paul.m.radley@hawaii.gov.

Sincerely,

DAVID G. SMITH
Administrator

DAVID Y. IGE
GOVERNOR

JADE T. BUTAY
DIRECTOR

Deputy Directors
DEREK J. CHOW
ROSS M. HIGASHI
EDWIN H. SNIFFEN

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

IN REPLY REFER TO:
DIR 1019
STP 8.3305

November 19, 2021

Ms. Michele Lefebvre Ph.D.
Project Manager, Environmental Scientist
Stantec Consulting Services Inc.
P.O. Box 191
Hilo, Hawaii 96721

Dear Ms. Lefebvre:

Subject: Early Consultation for Environmental Assessment (EA)
Natural Energy Laboratory of Hawaii Authority (NELHA)
Innovation Center and Welcome Center
Keahole Point, North Kona, Hawaii
Tax Map Keys: (3) 7-3-043: 051, 088 (portion), and 100

Thank you for your letter dated October 18, 2021 requesting early consultation for the subject NELHA project. The Hawaii Department of Transportation (HDOT) has reviewed the provided materials and understands that NELHA is proposing an Innovation Center consisting of a variety of conference, office, and workspaces, parking, and graded outdoor spaces. In addition, the Hale Wawaloli visitor center will be developed as a visitor education center consisting of approximately 2,250 square feet of space, an outdoor covered pavilion, open amphitheater spaces, and three enclosed spaces.

Both facilities will be accessed via existing driveways on Makako Bay Drive, which intersects with Queen Kaahumanu Highway (State Route 19).

The HDOT has the following comments:

Airports Division (HDOT-A)

1. The NELHA Innovation Center and Welcome Center are approximately 0.2 miles and immediately adjacent to the Ellison Onizuka Kona International Airport (KOA). All projects within 5 miles from Hawaii State airports are advised to read the Technical Assistance Memorandum (TAM) for guidance with development and activities that may require further review and permits. The TAM can be viewed at this link: http://files.hawaii.gov/dbedt/op/docs/TAM-FAA-DOT-Airports_08-01-2016.pdf.

2. The Innovation Center and Welcome Center are approximately 0.6 miles and 0.46 miles, respectively, from the end of Runway 35 at KOA. Federal Aviation Administration (FAA) regulation requires the submittal of FAA Form 7460-1 Notice of Proposed

Construction or alteration pursuant to the Code of Federal Regulations, Title 14, Part 77.9, if the construction or alteration is within 20,000 feet of 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. Construction equipment and staging area heights, including heights of temporary construction cranes, must be included in the submittal. The form and criteria for submittal can be found at the following website: https://oeaaa.faa.gov/oeaaa/external/portal.jsp. Please note that latitude, longitude, ground elevation, and above ground elevation data will be needed to complete the form.

3. The KOA 2013 Noise Exposure Map shows that the proposed Welcome Center is inside the 65 DNL (Day-Night average sound level) noise contour and the Innovation Center is within the 60 DNL noise contour. The applicant should be aware of potential single event noise from aircraft operations due to the proximity of the airport. There is also a potential for fumes, smoke, vibrations, odors, etc., resulting from daily aircraft flight operations over the project location. These impacts may increase or decrease over time depending on airport operations.

4. If a photovoltaic (PV) system is going to be installed, be aware that PV systems located in or near the approach path of aircrafts can create a hazardous condition for pilots due to possible glint and glare reflected from the PV array. If glint or glare from the PV array creates a hazardous condition for pilots, the owner of the PV system shall be prepared to immediately mitigate the hazard upon notification by the HDOT-A and/or FAA.

   PV systems have also been known to emit radio frequency interference (RFI) to aviation-dedicated radio signals, thereby disrupting the reliability of air-to-ground communications. Again, the owner of the PV system shall be prepared to immediately mitigate the RFI hazard upon notification by the HDOT-A and/or FAA.

   The HDOT-A recommends that the developer submit a separate FAA Form 7460-1 for the site of the proposed PV system. Note that you will need latitude, longitude, ground elevation, and the above-ground elevation data for the installation site to fully complete this form.

   A glint and glare analysis must be attached to your submittal of FAA Form 7460-1. The following website may assist you with the preparation of a glint and glare analysis: www.sandia.gov/glare. When you have received the FAA determination from your submittal of FAA Form 7460-1, please provide a copy for HDOT-A's files.

5. The HDOT-A requires that any drainage improvements and landscaping do not create conditions that attract wildlife, which can potentially become a hazard to aircraft operations. Please review the FAA Advisory Circular 150/5200-33C, Hazardous Wildlife Attractants On Or Near Airports for guidance. If landscaping includes trees, the maturity heights of trees shall be taken into consideration as they may create an obstruction hazard to aircraft operations. If the proposed improvements and landscaping

create a wildlife attractant and/or an obstruction to aircraft operations, NELHA shall immediately mitigate the hazard upon notification by the HDOT-A and/or FAA.

Highways Division (HDOT-HWY)

1. We understand a traffic study is underway for inclusion in the Draft EA. We anticipate it is being prepared and stamped by a licensed engineer and would include but not be limited to the following:

    a. Description of existing trip generation at the site(s), existing traffic conditions, and multimodal routes on Queen Kaahumanu Highway within the study area.

    b. Forecasted traffic and multimodal conditions for the year of Phase 1 completion (2023) and the year of full project buildout (2033), with the project and without the project-related traffic.

    c. Existing and future safety conditions.

    d. Recommended mitigation, as warranted.

2. The proposed sites are not adjacent to Queen Kaahumanu Highway and are not anticipated to involve utility work or result in additional stormwater flow to the State right-of-way (ROW). The Draft EA should identify any action within the HDOT ROW to support the project and HDOT permits that may be applicable.

If there are any questions, please contact Mr. Blayne Nikaido of the HDOT Statewide Transportation Planning Office at (808) 831-7979 or via email at blayne.h.nikaido@hawaii.gov.

Sincerely,

JADE T. BUTAY
Director of Transportation

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE
MANAGEMENT

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

Nov 23, 2021

Stantec Consulting Services Inc.
Attention: Michele Lefebvre, Ph.D. via email: michele.lefebvre@stantec.com
Project Manager, Environmental Scientist
P.O. Box 191
Hilo, Hawaii 96721

Dear Dr. Lefebvre:

SUBJECT: Environmental Assessment Early Consultation for **NELHA's Proposed Innovation Center and Welcome Center** located at North Kona District, Island of Hawaii; TMKs: (3) 7-3-043:051, 100, and 088 (portion) on behalf of Natural Energy Laboratory of Hawaii Authority (NELHA)

Thank you for the opportunity to review and comment on the subject matter. In addition to our previous comments dated November 17 and 18, 2021, enclosed are comments from the Commission on Water Resource Management on the subject matter. Should you have any questions, please feel free to contact Darlene Nakamura at (808) 587-0417 or email: darlene.k.nakamura@hawaii.gov. Thank you.

Sincerely,

*Russell Tsuji*

Russell Y. Tsuji
Land Administrator

Enclosures
cc: Central Files

DAVID Y. IGE
GOVERNOR OF HAWAII

SUZANNE D. CASE
CHAIRPERSON

MICHAEL G. BUCK
ELIZABETH A. CHAR, M.D.
NEIL J. HANNAHS
AURORA KAGAWA-VIVIANI, PH.D.
WAYNE K. KATAYAMA
PAUL J. MEYER

M. KALEO MANUEL
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
**COMMISSION ON WATER RESOURCE MANAGEMENT**
P.O. BOX 621
HONOLULU, HAWAII 96809

November 16, 2021

REF: RFD.5825.8

TO: Mr. Russell Tsuji, Administrator
Land Division

FROM: M. Kaleo Manuel, Deputy Director
Commission on Water Resource Management

SUBJECT: Environmental Assessment Early Consultation for NELHA's Proposed Innovation Center and Welcome Center

FILE NO.: RFD.5825.8
TMK NO.: (3) 7-3-043:051, (3) 7-3-043:088, (3) 7-3-043:100

Thank you for the opportunity to review the subject document. The Commission on Water Resource Management (CWRM) is the agency responsible for administering the State Water Code (Code). Under the Code, all waters of the State are held in trust for the benefit of the citizens of the State, therefore all water use is subject to legally protected water rights. CWRM strongly promotes the efficient use of Hawaii's water resources through conservation measures and appropriate resource management. For more information, please refer to the State Water Code, Chapter 174C, Hawaii Revised Statutes, and Hawaii Administrative Rules, Chapters 13-167 to 13-171. These documents are available via the Internet at http://dlnr.hawaii.gov/cwrm.

Our comments related to water resources are checked off below.

☐ 1. We recommend coordination with the county to incorporate this project into the county's Water Use and Development Plan. Please contact the respective Planning Department and/or Department of Water Supply for further information.

☐ 2. We recommend coordination with the Engineering Division of the State Department of Land and Natural Resources to incorporate this project into the State Water Projects Plan.

☐ 3. We recommend coordination with the Hawaii Department of Agriculture (HDOA) to incorporate the reclassification of agricultural zoned land and the redistribution of agricultural resources into the State's Agricultural Water Use and Development Plan (AWUDP). Please contact the HDOA for more information.

☒ 4. We recommend that water efficient fixtures be installed and water efficient practices implemented throughout the development to reduce the increased demand on the area's freshwater resources. Reducing the water usage of a home or building may earn credit towards Leadership in Energy and Environmental Design (LEED) certification. More information on LEED certification is available at http://www.usgbc.org/leed. A listing of fixtures certified by the EAP as having high water efficiency can be found at http://www.epa.gov/watersense.

☒ 5. We recommend the use of best management practices (BMP) for stormwater management to minimize the impact of the project to the existing area's hydrology while maintaining on-site infiltration and preventing polluted runoff from storm events. Stormwater management BMPs may earn credit toward LEED certification. More information on stormwater BMPs can be found at http://planning.hawaii.gov/czm/initiatives/low-impact-development/

☒ 6. We recommend the use of alternative water sources, wherever practicable.

☒ 7. We recommend participating in the Hawaii Green Business Program, that assists and recognizes businesses that strive to operate in an environmentally and socially responsible manner. The program description can be found online at http://energy.hawaii.gov/green-business-program.

☒ 8. We recommend adopting landscape irrigation conservation best management practices endorsed by the Landscape Industry Council of Hawaii. These practices can be found online at

http://www.hawaiiscape.com/wp-content/uploads/2013/04/LICH_Irrigation_Conservation_BMPs.pdf.

[X] 9. There may be the potential for ground or surface water degradation/contamination and recommend that approvals for this project be conditioned upon a review by the State Department of Health and the developer's acceptance of any resulting requirements related to water quality.

[ ] 10. The proposed water supply source for the project is located in a designated water management area, and a Water Use Permit is required prior to use of water. The Water Use Permit may be conditioned on the requirement to use dual line water supply systems for new industrial and commercial developments.

[X] 11. The Hawaii Water Plan is directed toward the achievement of the utilization of reclaimed water for uses other than drinking and for potable water needs in one hundred per cent of State and County facilities by December 31, 2045 (§174C-31(g)(6), Hawaii Revised Statutes). We strongly recommend that this project consider using reclaimed water for its non-potable water needs, such as irrigation. Reclaimed water may include, but is not limited to, recycled wastewater, gray water, and captured rainwater/stormwater. Please contact the Hawaiʻi Department of Health, Wastewater Branch, for more information on their reuse guidelines and the availability of reclaimed water in the project area.

[X] 12. A Well Construction Permit(s) is (are) are required before the commencement of any well construction work.

[X] 13. A Pump Installation Permit(s) is (are) required before ground water is developed as a source of supply for the project.

[X] 14. There is (are) well(s) located on or adjacent to this project. If wells are not planned to be used and will be affected by any new construction, they must be properly abandoned and sealed. A permit for well abandonment must be obtained.

[ ] 15. Ground-water withdrawals from this project may affect streamflows, which may require an instream flow standard amendment.

[ ] 16. A Stream Channel Alteration Permit(s) is (are) required before any alteration can be made to the bed and/or banks of a steam channel.

[ ] 17. A Stream Diversion Works Permit(s) is (are) required before any stream diversion works is constructed or altered.

[ ] 18. A Petition to Amend the Interim Instream Flow Standard is required for any new or expanded diversion(s) of surface water.

[X] 19. The planned source of water for this project has not been identified in this report. Therefore, we cannot determine what permits or petitions are required from our office, or whether there are potential impacts to water resources.

[X] OTHER: Planning - The Commission supports the use of alternative resources wherever practicable to conserve natural supplies. It is the policy of the Water Commission to promote the viable and appropriate reuse of reclaimed water insofar as it does not compromise beneficial uses of existing water resources.

Regulation - If a new well source is developed to supply water to this facility, in addition to the required permits, potential impacts to groundwater dependent ecosystems and traditional and customary Hawaiian practices must be evaluated.

If you have any questions, please contact Neal Fujii of the Planning Branch at 587-0216 or Ryan Imata of the Regulation Branch at 587-0225.

# Resending RFD.5825.8 NELHA Innovation Center and Welcome Center, North Kona

Final Audit Report 2021-11-22

| | |
|---|---|
| Created: | 2021-11-17 |
| By: | Kathy Yoda (kathy.s.yoda@hawaii.gov) |
| Status: | Signed |
| Transaction ID: | CBJCHBCAABAADHR6wAfMgZ5nQkSR7xqAiT6HV478Mf_t |

## "Resending RFD.5825.8 NELHA Innovation Center and Welcome Center, North Kona" History

Document created by Kathy Yoda (kathy.s.yoda@hawaii.gov)
2021-11-17 - 3:32:50 AM GMT- IP address: 162.221.246.37

Document emailed to Kaleo Manuel (Kaleo.L.Manuel@hawaii.gov) for signature
2021-11-17 - 3:34:07 AM GMT

Document e-signed by Kaleo Manuel (Kaleo.L.Manuel@hawaii.gov)
Signature Date: 2021-11-22 - 8:37:22 PM GMT - Time Source: server- IP address: 162.221.246.37

Agreement completed.
2021-11-22 - 8:37:22 PM GMT

# United States Department of the Interior

NATIONAL PARK SERVICE
Kaloko-Honokōhau National Historical Park
73-4786 Kanalani Street, # 14
Kailua-Kona, Hawai‘i 96740


IN REPLY REFER TO:
L7621 (2021-8)

Dr. Michele Lefebvre Ph.D.
Stantec Consulting Services Inc.
P.O. Box 191
Hilo, Hawai‘i 96721

Dear Dr. Lefebvre:

Thank you for providing the National Park Service (NPS) with the opportunity to provide input on the development of a Draft Environmental Assessment (EA) in compliance with Chapter 343, Hawai'i Revised Statutes. The Draft EA is for a for Proposed Innovation Center and Welcome Center in the Hawaii Ocean Science and Technology Park at Keahole Point, North Kona.

**Background**

Congress established Kaloko-Honokōhau National Historical Park (Park) in 1978 to preserve, interpret, and perpetuate traditional native Hawaiian activities and culture by protecting the cultural and natural resources within the Park (16 U.S.C. § 396d(a)). The 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. The land and waters within the Park provide habitat for approximately 17 federally listed, and candidate species for listing, under the Endangered Species Act. ‘Aimakapā Fishpond and wetland are listed as “Core Wetlands” 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 waterfowl. Kaloko Fishpond is a loko kuapā and is being restored so that it can be managed as a traditional Hawaiian fishpond. In addition to the fishponds and pools, the Park boundary encompasses 596 acres of marine waters and coral reef habitat.

Approximately 150,000 visitors per year visit the Park (https://irma.nps.gov/Stats/). Local residents, cultural practitioners, and visitors from around the world come to experience Kaloko-Honokōhau’s unique seascape, cultural and natural history, and to understand and exercise traditional Hawaiian practices.

While the proposed project is considerable distance (~ 2.5 miles) from Kaloko-Honokōhau National Historical Park, we are concerned about contaminants, water, air, fish, birds, insects, etc., all of which move in and out of various administrative jurisdictions. Moreover, our coastal

natural and cultural resources in West Hawai‘i are fragile. Specific concerns are addressed below.

**Nighttime Lighting**

The NPS Natural Sounds and Night Skies Division has six principles of sustainable lighting that go beyond minimizing and downshielding. The NPS suggests that project's planners and designers consider a full suite of measures that would more fully protect resources and values from artificial light. We recommend that lights be of a color, intensity, placement, directionality, and operational cycle to minimize both impacts to nocturnal species and the natural visual character of the night. In designing, selecting, and operating outdoor lighting, the following approaches can achieve fully a sustainable solution:

1) Light only where it is needed;
2) Light only when it is needed;
3) Shield lights and direct them downward;
4) Use the minimum amount of light necessary;
5) Select lamps with warmer colors (less blue light); and
6) Select the most energy efficient lamps and fixture.

We recommend that impacts to the dark night skies from lighting be addressed in the Draft EA in context to the project's contribution to the cumulative night-sky impacts to Kaloko-Honokōhau NHP. Natural lightscapes are vital to the protection of wilderness character, fundamental to the historical and cultural context, and critical for Park wildlife.

**Potable and Non-Potable Water Systems**

We recommend the Draft EA identify the sources of drinking and irrigation the water for the project and analyze the impacts of water withdrawal on groundwater-dependent ecosystems. The NPS is concerned about the direct and cumulative impacts of groundwater withdrawals on the cultural and natural resources within the Park that are dependent upon groundwater flow. The NPS requests that the Draft EA include information as to the amount of water required for the project and how that amount adds cumulatively to the current usage of groundwater and the proposed needs of the surrounding developments. Although the water demand for this project may be small given this project's size, the NPS notes that this project is only one of many projects that are proposed in the vicinity, and that the projected cumulative impacts of these withdrawals would be substantial.

**Wastewater Treatment**

We recommend the Draft EA thoroughly analyze the direct, indirect, and cumulative impacts of the disposal of treated wastewater on aquatic and marine ecosystems. This would include analysis of individual wastewater system's ability to adequately remove nutrients, pharmaceuticals and personal care products, and function as designed beyond the initial phase of operation.

**Non-Point Source Pollution and Surface Water Drainage**

The NPS recommends that the Draft EA address, in detail, how polluted runoff from parking lots, driveways, and other surfaces would be controlled and treated. The proposed project is located in highly permeable lava with few accumulated soils. Rain and runoff carry pollutants quickly to groundwater, to coastal anchialine pools, and into nearshore waters. Although average rainfall is ~20 inches per year, rainfall accumulation is typically concentrated in a few intense events that cause a pulse of pollution flushing to drainage systems, to the water table, and into nearshore waters. For over a decade, Hawai'i County and the Hawai'i Land Use Commission have recognized the need to implement additional measures to control nonpoint source pollution flowing into the Park's inland and nearshore waters and surrounding areas (LUC Docket A00-732; COH Ord 02-114 and 04-110). Standard county, state and federal regulations for drainage wells (i.e. dry wells) are designed to address flood control but not to prevent polluted surface water runoff from impacting the inland and coastal waters. We recommend that best management practices be discussed in the Draft EA.

**Cumulative Impacts**

The proposed project would contribute to the growing cumulative impacts from development adjacent to the Park and in the surrounding area. We recommend a thorough analysis in the Draft EA of the project's contribution to these cumulative impacts, especially for those topics listed above, from development near the Park and along the Kona coast.

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). We wish to receive an electronic copy of the completed EA.

Sincerely,

John Broward
Superintendent
Kaloko-Honokōhau National Historical Park

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawai‘i 96850


In Reply Refer To:
01EPIF00-2022-TA-0044

December 7, 2021

Michele Lefebvre
Stantec Consulting Services, Inc.
P.O. Box 191
Hilo, Hawai‘i 96721

Subject: Technical Assistance for the Proposed NELHA Innovation and Welcome Center, North Kona, Hawai‘i

The U.S. Fish and Wildlife Service (Service) received your correspondence on October 22, 2021, requesting technical assistance for the Natural Energy Laboratory of Hawai‘i Authority's (NELHA's) proposed Innovation Center and visitor center at the Hawai‘i Ocean Science and Technology Park at Keahole Point, North Kona. We appreciate the additional project information you provided via email on November 10, 2021.

NELHA plans to construct and operate two new facilities, an Innovation Center at the existing Research Village (TMKs 7-3-043:051 and 7-3-043:100) and a separate new "Hale Wawaloli" visitor center as an addition to the existing Wawaloli Beach Park facilities (TMK 7-3-043:088, portion). Facilities would be constructed in phases, but ultimately, the proposed Innovation Center will include approximately 50,000 square feet (sq ft) of facilities under roof, including offices, conference spaces, laboratories, and wet-room research space with flowing seawater, a "maker-space" workshop, and meeting nooks. Outside covered areas will consist of workspaces and support areas for maintenance and storage. The Innovation Center will also include 114,400 sq ft of graded outdoor space for research tankage with access to seawater, fresh water, electricity, vehicular and pedestrian accessible routes, parking areas with 138 stalls, security area and landscaped areas. Road and drainage improvements will be required and a septic wastewater system will be built in compliance with State Department of Health regulations.

Hale Wawaloli will serve as the visitor education center, and will include 2,250 sq ft of covered spaces, including a covered pavilion, and fully enclosed spaces for office and storage uses. Additional outdoor development will include an open amphitheater space for community

gatherings and public events and a sidewalk that connects to the parking area. It will be accessible from the existing parking area at the Wawaloli Beach Park and will include landscaped areas.

We have reviewed the information you provided, and pertinent information in our files, including data compiled by the Hawai‘i Biodiversity and Mapping Program as it pertains to federally listed species and designated critical habitat under the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*), as amended (ESA). Our data indicate the following listed species may occur or transit through the vicinity of the proposed project area: the threatened nēnē or Hawaiian goose (*Branta sandvicensis*), the endangered ‘ōpe‘ape‘a or Hawaiian hoary bat (*Lasiurus cinereus semotus*), the endangered ‘ua‘u or Hawaiian petrel (*Pterodroma sandwicensis*), the endangered ‘ake‘ake or Hawai‘i distinct population segment of the band-rumped storm-petrel (*Oceanodroma castro*), the threatened ‘a‘o or Newell’s shearwater (*Puffinus auricularis newelli*), the endangered ae‘o or Hawaiian stilt (*Himantopus mexicanus knudseni*), the endangered ‘alae ke‘oke‘o or Hawaiian coot (*Fulica alai*), the threatened honu or Central North Pacific DPS of green sea turtle (*Chelonia mydas*), the endangered honu ‘ea or hawksbill sea turtle (*Eretmochelys imbricata*), the endangered anthricinan yellow-faced bee (*Hylaeus anthracinus*), and the endangered Blackburn’s sphinx moth (*Manduca blackburni*). The Hawaiian petrel, band-rumped storm-petrel, and Newell’s shearwater will hereafter, collectively be referred to as “Hawaiian seabirds,” the Hawaiian stilt and Hawaiian coot will be referred to as “Hawaiian waterbirds,” and the green and hawksbill sea turtles will be referred to as “Sea turtles.”

The ‘io or Hawaiian hawk (*Buteo solitarius*), a species that was recently removed from the Federal list of threatened and endangered species, is known to occur in the area. While the Service no longer consults on the Hawaiian hawk, this species is still protected under Hawaiian state regulations (H.R.S. §195D-4) and the Migratory Bird Treaty Act (16 U.S.C. 703-712).

Hawaiian monk seals (*Neomonachus schauinslandi*) have been recorded in the vicinity of the proposed project. The National Marine Fisheries Service (NMFS) is the Federal agency that consults on potential impacts to Hawaiian monk seals in both their onshore and ocean habitats. We recommend that you contact NMFS regarding the presence of Hawaiian monk seals in the area and potential impacts to the species from the project.

There are several anchialine pools in the vicinity of the proposed project that may provide important habitat for ESA listed species.

We provide the following recommendations to assist in the planning process and avoiding adverse effects to federally listed species and their habitat. In addition to our recommendations below, please reference state regulations for any additional consultation or mitigation requirements for state listed species (H.R.S. §195D-4).

**Hawaiian goose**

The Hawaiian goose is found on the islands of Hawai‘i, Maui, Moloka‘i, and Kaua‘i. They are observed in a variety of habitats, but prefer open areas, such as pastures, golf courses, wetlands,

natural grasslands and shrublands, and lava flows. Threats to this species include introduced mammalian and avian predators, wind facilities, and vehicle strikes.

To avoid and minimize potential project impacts to the Hawaiian goose we recommend you incorporate the following measures into your project description:

- Do not approach, feed, or disturb the Hawaiian goose.
- If a Hawaiian goose is observed loafing or foraging within the project area during the breeding season (September through April), have a biologist familiar with Hawaiian goose nesting behavior survey for nests in and around the project area prior to the resumption of any work. Repeat surveys after any subsequent delay of work of 3 or more days (during which the birds may attempt to nest).
- Cease all work immediately and contact the Service for further guidance if a nest is discovered within a radius of 150 feet (ft) of proposed project, or a previously undiscovered nest is found within the 150-ft radius after work begins.
- In areas where Hawaiian goose presence is known, post and implement reduced speed limits, and inform project personnel and contractors about the presence of endangered species on-site.

4(d) rule – A 4(d) rule was established at the time the Hawaiian goose was down listed to threatened status. Under the 4(d) rule, the following actions are not prohibited under the ESA, provided the additional measures described in the downlisting rule are adhered to:

- Take by landowners, or their agents, conducting intentional harassment in the form of hazing or other deterrent measures not likely to cause direct injury or mortality, or Hawaiian goose surveys.
- Take that is incidental to conducting lawful control of introduced predators or habitat management activities for the Hawaiian goose.
- Take by authorized law enforcement officers for the purpose of aiding or euthanizing sick, injured, or orphaned Hawaiian geese; disposing of dead specimens; and salvaging a dead specimen that may be used for scientific study.

**Hawaiian hoary bat**

The Hawaiian hoary bat roosts in both exotic and native woody vegetation across all islands and will leave young unattended in trees and shrubs when they forage. If trees or shrubs 15 ft or taller are cleared during the pupping season, there is a risk that young bats could inadvertently be harmed or killed since they are too young to fly or may not move away. Additionally, Hawaiian hoary bats forage for insects from as low as 3 ft to higher than 500 ft above the ground and can become entangled in barbed wire used for fencing.

To avoid and minimize impacts to the endangered Hawaiian hoary bat we recommend you incorporate the following applicable measures into your project operations:

- Do not disturb, remove, or trim woody plants greater than 15-ft tall during the bat birthing and pup-rearing season (June 1 through September 15).
- Do not use barbed wire for fencing.

**Hawaiian seabirds**

Hawaiian seabirds may traverse the project area at night during the breeding, nesting, and fledging seasons (March 1 to December 15). Outdoor lighting could result in seabird disorientation, fallout, and injury or mortality. Seabirds are attracted to lights and after circling the lights, they may become exhausted and collide with nearby wires, buildings, or other structures or they may land on the ground. Downed seabirds are subject to increased mortality due to collision with automobiles, starvation, and predation by dogs, cats, and other predators. Young birds (fledglings) traversing the project area between September 15 and December 15, in their first flights from their mountain nests to the sea, are particularly vulnerable to light attraction.

To avoid and minimize adverse effects to seabirds we recommend you incorporate the following measures into your project operations:

- Fully shield all outdoor lights so the bulb can only be seen from below.
- Install automatic motion sensor switches and controls on all outdoor lights or turn off lights when human activity is not occurring in the lighted area.
- Avoid nighttime construction during the seabird-fledging period, September 15 through December 15.

**Hawaiian waterbirds**

Hawaiian waterbirds are currently found in a variety of wetland habitats including freshwater marshes and ponds, coastal estuaries and ponds, artificial reservoirs, *Colocasia esculenta* (kalo or taro) lo‘i or patches, irrigation ditches, and sewage treatment ponds. Hawaiian stilts may also be found wherever ephemeral or persistent standing water may occur. Threats to these species include non-native predators, habitat loss, and habitat degradation.

Based on the project details provided, your project may result in the creation of standing water or open water that could attract Hawaiian waterbirds to the project site. In particular, the Hawaiian stilt is known to nest in sub-optimal locations (e.g., any ponding water), if water is present. Hawaiian waterbirds attracted to sub-optimal habitat may suffer adverse impacts, such as predation and reduced reproductive success, and thus the project may create an attractive nuisance. Therefore, we recommend you work with our office during project planning so that we may assist you in developing measures to avoid impacts to listed species (e.g., fencing, vegetation control, predator management).

To avoid and minimize potential project impacts to Hawaiian stilts, we recommend you incorporate the following applicable measures into your project operations:

- In areas where waterbirds are known to be present, post and implement reduced speed limits, and inform project personnel and contractors about the presence of endangered species on-site.
- If water resources are located within or adjacent to the project site, incorporate applicable best management practices regarding work in aquatic environments into the project design (see enclosed Aquatic Best Management Practices).
- Have a biological monitor that is familiar with the species’ biology conduct Hawaiian waterbird nest surveys where appropriate habitat occurs within the vicinity of the proposed project site prior to project initiation. Repeat surveys again within 3 days of

project initiation and after any subsequent delay of work of 3 or more days (during which the birds may attempt to nest). If a nest or active brood is found:

- Contact the Service within 48 hours for further guidance.
- Establish and maintain a 100-ft buffer around all active nests and/or broods until the chicks have fledged. Do not conduct potentially disruptive activities or habitat alteration within this buffer.
- Have a biological monitor that is familiar with the species' biology present on the project site during all construction or earth moving activities until the chicks fledge to ensure that Hawaiian waterbirds and nests are not adversely impacted.

**Sea turtles**

The Service consults on sea turtles and their use of terrestrial habitats (beaches where nesting and/or basking is known to occur), whereas the National Oceanic and Atmospheric Administration (NOAA) Fisheries consults on sea turtles in aquatic habitats. We recommend that you consult with NOAA Fisheries regarding the potential impacts from the proposed project if it may affect offshore or open ocean habitats.

Green sea turtles may nest on any sandy beach area in the Pacific Islands. Hawksbill sea turtles exhibit a wide tolerance for nesting substrate (ranging from sandy beach to crushed coral) with nests typically placed under vegetation. Both species exhibit strong nesting site fidelity. Nesting occurs on beaches from May through September, peaking in June and July, with hatchlings emerging through November and December.

Construction on, or in the vicinity of, beaches can result in sand and sediment compaction, sea turtle nest destruction, beach erosion, contaminant and nutrient runoff, and an increase in direct and ambient light pollution which may disorient hatchlings or deter nesting females. Off-road vehicle traffic may result in direct impacts to sea turtles or nests, and also contributes to habitat degradation through erosion and compaction.

Projects that alter the natural beach profile, such as nourishment and hardening, including the placement of seawalls, jetties, sandbags, and other structures, are known to reduce the suitability of onshore habitat for sea turtles. These types of projects often result in sand compaction, erosion, and additional sedimentation in nearshore habitats, resulting in adverse effects to the ecological community and may inhibit future sea turtle nesting. The hardening of a shoreline increases the potential for erosion in adjacent areas, resulting in subsequent requests to install stabilization structures or conduct beach nourishment in adjacent areas. Given projected sea level rise estimates, the likelihood of increase in storm surge intensity, and other factors associated with climate change, we anticipate that beach erosion will continue and likely increase.

Where possible, projects should consider alternatives that avoid the modification or hardening of coastlines. Beach nourishment or beach hardening projects should evaluate the long-term effect to sea turtle nesting habitat and consider the cumulative effects.

To avoid and minimize project impacts to sea turtles and their nests we recommend you incorporate the following measures into your project description:

- No vehicle use on or modification of the beach/dune environment during the sea turtle nesting or hatching season (May to December).
- Do not remove native dune vegetation.
- Incorporate applicable best management practices regarding Work in Aquatic Environments (see enclosed) into the project design.
- Have a biologist familiar with sea turtles conduct a visual survey of the project site to ensure no basking sea turtles are present.
    - If a basking sea turtle is found within the project area, cease all mechanical or construction activities within 100 feet until the animal voluntarily leaves the area.
    - Cease all activities between the basking turtle and the ocean.
- Remove any project-related debris, trash, or equipment from the beach or dune if not actively being used.
- Do not stockpile project-related materials in the intertidal zone, reef flats, sandy beach and adjacent vegetated areas, or stream channels.

Optimal sea turtle nesting habitat is a dark beach free of barriers that restrict sea turtle movement. Nesting turtles may be deterred from approaching or laying successful nests on lighted or disturbed beaches. They may become disoriented by artificial lighting, leading to exhaustion and placement of a nest in an inappropriate location (such as at or below the high tide line). Hatchlings that emerge from nests may also be disoriented by artificial lighting. Inland areas visible from the beach should be sufficiently dark to allow for successful navigation by hatchlings to the ocean.

To avoid and minimize project impacts to sea turtles from lighting we recommend incorporating the following applicable measures into your project description:

- Avoid nighttime work during the nesting and hatching season (May to December).
- Minimize the use of lighting on or near beaches and shield all project-related lights so the light is not visible from any beach.
    - If lights can't be fully shielded or if headlights must be used, fully enclose the light source with light filtering tape or filters.
- Incorporate design measures into the construction or operation of buildings adjacent to the beach to reduce ambient outdoor lighting such as:
    - tinting or using automatic window shades for exterior windows that face the beach;
    - reducing the height of exterior lighting to below 3 feet and pointed downward or away from the beach; and
    - minimize light intensity to the lowest level feasible and, when possible, include timers and motion sensors.

**Yellow-faced bees**

Of the seven yellow-faced bee species that are listed as endangered, only one is known to be extant on the island of Hawai'i (*Hylaeus anthracinus*). Coastal populations of yellow-faced bees occur in habitat along rocky shorelines with *Scaevola taccada* (naupaka) and *Heliotropium foertherianum* (tree heliotrope) with either landscaped vegetation, alien *Prosopis pallida* (kiawe), or bare rock inland. The majority of the known plants visited by yellow-faced bees that may occur in the lowlands are native plants, with the exception of nonnative *Heliotropium arboreum*

(tree heliotrope) (only found on the coast). Some documented pollen and nectar plants include naupaka, *Sida fallax* (‘ilima), *Chamaesyce* spp. (‘akoko), *Argemone glauca* (pua kala), *Myoporum sandwicense* (naio), and tree heliotrope, but this is not a comprehensive list. Threats to yellow-faced bees include habitat destruction and modification from land use change, nonnative plants, ungulates, and fire, along with predation by nonnative ants and wasps.

*Hylaeus anthracinus* has been documented at both sites proposed for development as part of this project. Therefore, we recommend you work with our office during project planning so that we may assist you in developing measures to avoid impacts to yellow-faced bees as described below.

To avoid and minimize project impacts to yellow-faced bees and their nests, we recommend you incorporate the following applicable measures into your project:

- Have a qualified biologist survey area of proposed activities for yellow-faced bees. Depending on survey methodology, a permit may be required to conduct surveys.
- If an action will occur in or adjacent to known occupied yellow-faced bee habitat, a buffer area around the habitat may be required and can be developed on a site-specific basis through consultation with the Service.
- For coastal species, protect all coastal strand habitat from human disturbance, including:
    - Allow no fires or wood collecting;
    - Leave woody debris in place;
    - Restrict vehicles to existing roads and trails; and
    - Post educational signs to inform people of the presence of sensitive species.

**Blackburn’s sphinx moth**

The adult Blackburn’s sphinx moth feeds on nectar from native plants, including *Ipomoea pes-caprae* (beach morning glory), *Plumbago zeylanica* (‘ilie‘e), *Capparis sandwichiana* (maiapilo), and others. Blackburn’s sphinx moth larvae feed on nonnative *Nicotiana glauca* (tree tobacco) and native *Nothocestrum* sp. (‘aiea). To pupate, the larvae burrow into the soil and can remain in a state of torpor for a year or more before emerging from the soil. Soil disturbance can result in death of the pupae.

We offer the following survey recommendations to assess whether the Blackburn’s sphinx moth occurs within the project area:

- A biologist familiar with the species should survey areas of proposed activities for Blackburn’s sphinx moth and its larval host plants prior to work initiation.
    - Surveys should be conducted during the wettest portion of the year (usually November-to-April or several weeks after a significant rain) and within 4-to-6 weeks prior to construction.
    - Surveys should include searches for adults, eggs, larvae, and signs of larval feeding (i.e., chewed stems, frass, or leaf damage).
    - If moths, eggs, larvae, or native ‘aiea or tree tobacco over 3-ft tall, are found during the survey, please contact the Service for additional guidance to avoid impacts to this species.

If no Blackburn's sphinx moth, 'aiea, or tree tobacco are found during surveys, it is imperative that measures be taken to avoid attraction of Blackburn's sphinx moth to the project location and prohibit tree tobacco from entering the site. Tree tobacco can grow greater than 3-ft tall in approximately 6 weeks. If it grows over 3-ft, the plants may become a host plant for Blackburn's sphinx moth. We therefore recommend that you:

- Remove any tree tobacco less than 3-ft tall.
- Monitor the site every 4-to-6 weeks for new tree tobacco growth before, during, and after the proposed ground-disturbing activity.
    - Monitoring for tree tobacco can be completed by any staff, such as groundskeeper or regular maintenance crew, provided with picture placards of tree tobacco at different life stages.

**Hawaiian hawk**

The Hawaiian hawk was recently federally delisted but remains a listed species under Hawai'i State law. The Hawaiian hawk is known to occur across a broad range of forest habitats throughout the island of Hawai'i. Loud, irregular, and unpredictable activities, such as using heavy equipment or building a structure, near an endangered Hawaiian hawk nest may cause nest failure. Harassment of Hawaiian hawk nesting sites can alter feeding and breeding patterns or result in nest or chick abandonment. Nest disturbance can also increase exposure of chicks and juveniles to inclement weather or predators.

To avoid and minimize impacts to Hawaiian hawks we recommend you incorporate the following applicable measures into your project plan:

- If work must be conducted between March 1 through September 30, during the Hawaiian hawk breeding season, have a biologist familiar with the species conduct a nest search of the project footprint and surrounding areas immediately prior to the start of construction activities.
    - Pre-disturbance surveys for Hawaiian hawks are only valid for 14 days. If disturbance for the specific location does not occur within 14 days of the survey, conduct another survey.
- Clearing of vegetation or construction activities should not occur within 1,600 ft of any active Hawaiian hawk nest during the breeding season until the young have fledged.
- Regardless of the time of year, avoid trimming or cutting trees containing a hawk nest, as nests may be re-used during consecutive breeding seasons.

**Anchialine pools**

Anchialine pools provide habitat to a variety of ESA listed species. There are several anchialine pools near the proposed project area. Threats to species associated with this habitat include habitat loss due to in-filling and bulldozing of anchialine pools, waste disposal including used oil and grease into pools, nonnative fish, human use of pools for bathing, water extraction, in-flow of fertilizer and pesticides, and collection for the aquarium trade. The Service recommends a survey of the proposed project sites to determine if any anchialine pools are present that will be impacted by this project. Should anchialine pools be located, please incorporate the following measures as applicable:

- Best management practices regarding work in aquatic environments (see enclosure) should be incorporated into the project description to minimize the degradation of water quality and impacts to fish and wildlife resources.
- Protect anchialine pools (both in and around) from human disturbance by implementing the following measures:
    - Restrict vehicles to existing roads and trails
    - Prevent trash, and other waste from entering anchialine pools
    - Avoid or limit to the maximum extent practicable entrance into the anchialine pools
- Install educational signs near anchialine pools to inform people of the presence of sensitive species and habitats.

The Service recommends incorporating all applicable avoidance and minimization measures into your project design to avoid and minimize effects on protected species. If it is determined that your proposed project may affect federally listed species, we recommend you contact our office early in the planning process so that we may assist you with ESA compliance. If the proposed project is funded, authorized, or permitted, or implemented by a Federal agency, then that agency should consult with us pursuant to section 7(a)(2) of the ESA. If no federal action agency is involved but take of listed species cannot be fully avoided, the project should begin development of a Habitat Conservation Plan in order to obtain an Incidental Take Permit under section 10(a)(1)(B) of the ESA. We appreciate your efforts to conserve protected species. If you have questions regarding this letter, please contact Melissa Cady, Fish and Wildlife Biologist, at 808-933-6963, or melissa_cady@fws.gov. When referring to this project, please include this reference number: 01EPIF00-2022-TA-0044.

Sincerely,

Island Team Manager
Maui Nui and Hawai‘i Island

Enclosure: Aquatic Best Management Practices

cc: Pacific Islands Fish and Wildlife Office Administration

**U.S. Fish and Wildlife Service**
**Recommended Standard Best Management Practices**

The U.S. Fish and Wildlife Service (USFWS) recommends the following measures to be incorporated into project planning to avoid or minimize impacts to fish and wildlife resources. Best Management Practices (BMPs) include the incorporation of procedures or materials that may be used to reduce either direct or indirect negative impacts to aquatic habitats that result from project construction-related activities. These BMPs are recommended in addition to, and do not over-ride any terms, conditions, or other recommendations prepared by the USFWS, other federal, state, or local agencies. If you have questions concerning these BMPs, please contact the USFWS Aquatic Ecosystems Conservation Program at 808-792-9400.

1. Authorized dredging and filling-related activities that may result in the temporary or permanent loss of aquatic habitats should be designed to avoid indirect, negative impacts to aquatic habitats beyond the planned project area.

2. Dredging/filling in the marine environment should be scheduled to avoid coral spawning and recruitment periods, and sea turtle nesting and hatching periods. Because these periods are variable throughout the Pacific islands, we recommend contacting the relevant local, state, or federal fish and wildlife resource agency for site specific guidance.

3. Turbidity and siltation from project-related work should be minimized and contained within the project area by silt containment devices and curtailing work during flooding or adverse tidal and weather conditions. BMPs should be maintained for the life of the construction period until turbidity and siltation within the project area is stabilized. All project construction-related debris and sediment containment devices should be removed and disposed of at an approved site.

4. All project construction-related materials and equipment (dredges, vessels, backhoes, silt curtains, etc.) to be placed in an aquatic environment should be inspected for pollutants including, but not limited to; marine fouling organisms, grease, oil, etc., and cleaned to remove pollutants prior to use. Project related activities should not result in any debris disposal, non-native species introductions, or attraction of non-native pests to the affected or adjacent aquatic or terrestrial habitats. Implementing both a litter-control plan and a Hazard Analysis and Critical Control Point plan (HACCP – see https://www.fws.gov/policy/A1750fw1.html) can help to prevent attraction and introduction of non-native species.

5. Project construction-related materials (fill, revetment rock, pipe, etc.) should not be stockpiled in, or in close proximity to aquatic habitats and should be protected from erosion (*e.g.*, with filter fabric, etc.), to prevent materials from being carried into waters by wind, rain, or high surf.

6. Fueling of project-related vehicles and equipment should take place away from the aquatic environment and a contingency plan to control petroleum products accidentally spilled during the project should be developed. The plan should be retained on site with the person responsible for compliance with the plan. Absorbent pads and containment booms should be stored on-site to facilitate the clean-up of accidental petroleum releases.

7. All deliberately exposed soil or under-layer materials used in the project near water should be protected from erosion and stabilized as soon as possible with geotextile, filter fabric or native or non-invasive vegetation matting, hydro-seeding, etc.

# APPENDIX 2

## Cited Figures from NELHA Master Plan

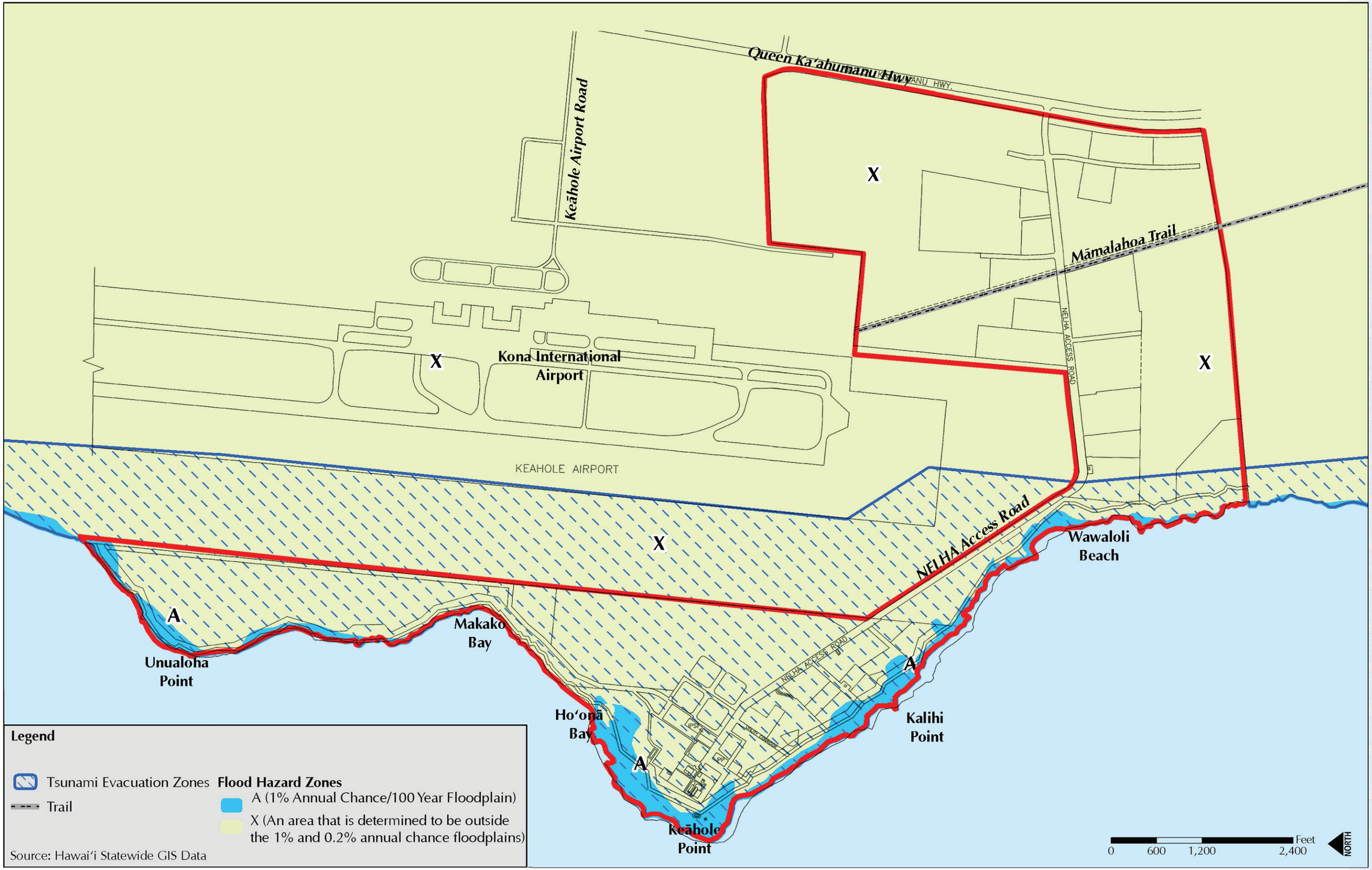



**Figure 2.8 DFIRM and Tsunami Evacuation Zone**

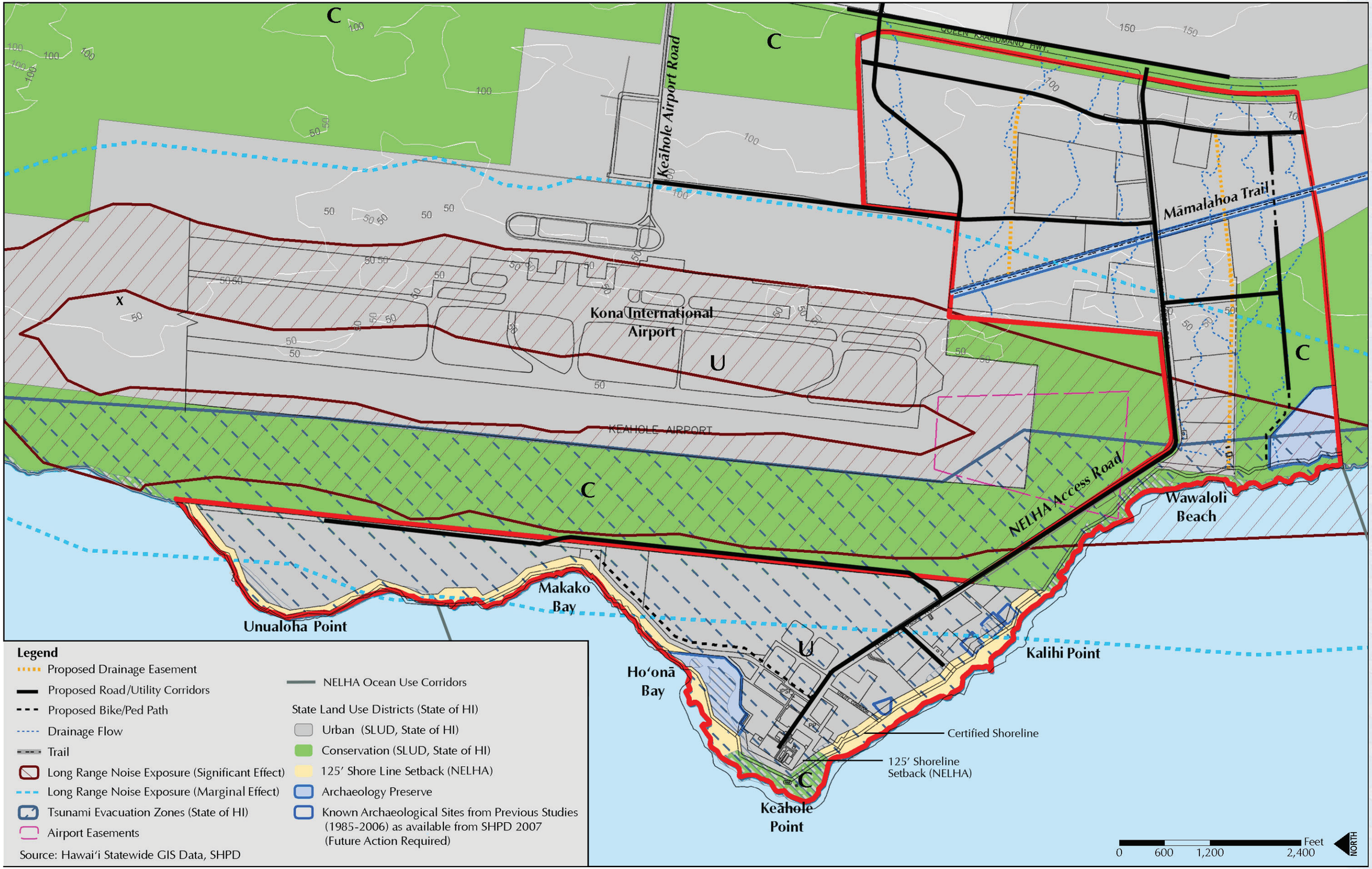



**Figure 2.9 Constraints Map**

# APPENDIX 3

## Biological Survey Results

# *Biological Report*
# *NELHA Innovation Center and Hale Wawaloli*
# *TMKs (3rd.) 7-3-043:051 and 088*
# *North Kona District, Island of Hawai'i*

By Ron Terry, Ph.D.
Geometrician Associates, LLC
December 2021

## *Introduction*

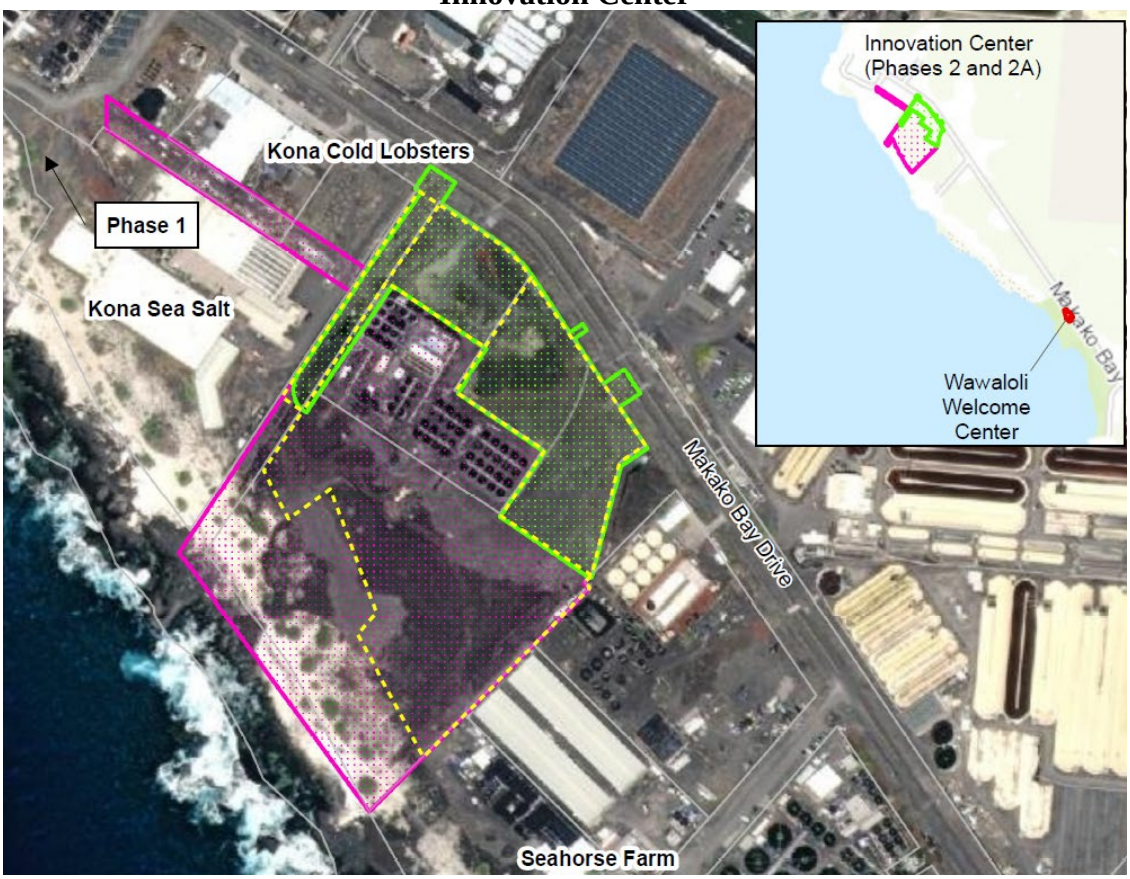
This biological report was prepared as part of environmental investigations being conducted for a project by the Natural Energy Laboratory of Hawai'i Authority (NELHA) to build a new Innovation Center and the Hale Wawaloli Welcome Center within the Hawaii Ocean Science and Technology Park (HOST Park) at Keahole Point, North Kona. The purpose is to inventory the existing biological environment prior to development, assess the potential for biological impacts from the proposed development, and devise mitigation measures to avoid or minimize impacts. The land in question ("the properties") consists of two separate sites located about 3,500 feet apart (Figure 1).

The 9.53-acre Innovation Center property includes 675 feet of shoreline frontage on a sandy "storm beach" on basalt lava (Figure 2a). A well-used shoreline recreational trail is present on the makai portion of this property (Figure 2b). From the shoreline area with its strand vegetation, the property extends back about 1,000 feet to Makako Bay Drive. The land here is nearly barren basalt lava flows that have been modified over about half the property through grading and construction of various aquaculture infrastructure facilities (Figures 2c-d). NELHA proposes to construct all the new facilities at the Innovation Center in the mauka parts of the property, leaving the makai area of the property untouched except for a chain-link fence to be constructed mostly on the lava mauka of the coastal strand (see location in Figure 2e). The facilities here would accommodate program growth for the NELHA Research Center for the foreseeable future. They would feature approximately 50,000 square feet (sf) of facilities under roof including offices, conference spaces, laboratories and wet-room research space with flowing seawater, a "maker-space" workshop, meeting nooks, and outside covered workspaces, as well as support areas for maintenance and storage. They would also include approximately 114,000 square feet of graded outdoor space for research tankage with access to sea water, fresh water, and electricity, vehicular and pedestrian accessible routes, 138 parking spaces, security, and environmentally appropriate landscaping. Road and drainage improvements as well as a septic wastewater system would be also built.

The Hale Wawaloli property has an approximately 0.2-acre footprint and about 120 feet of frontage along Makako Bay Drive, from where it extends makai about 100 feet (Figure 2f). It is adjacent to an existing parking lot and restroom supporting Wawaloli Beach Park and was previously graded and disturbed as part of work to construct these facilities. NELHA proposes to utilize Hale Wawaloli as its visitor education center. The proposed 2,250-sf center would include an outdoor covered pavilion, an open amphitheater space

**Figure 1. Subject Properties**

**Innovation Center**




**Hale Wawaloli**

**Figure 2. Photos**

2a. Innovation Center Coastal Strand habitat ▲

▼ 2b. Recreational trail and shoreline lava flats and tidepools

**Figure 2. Photos**

2c. Inland portion of Innovation Center property with nearly barren lava ▲

▼ 2d. Much of interior of Innovation Center property previously disturbed by grading and aquaculture infrastructure

**Figure 2. Photos**

2e. Alignment of proposed fence extends across fountain grass mauka of coastal strand and then turns inland across boulder disturbance area, avoiding coastal strand ▲

▼ 2f. Hale Wawaloli property, where all work is confined to disturbed area mauka of naupaka

**Figure 2. Photos**

▼ 2g. Maiapilo at Innovation Center property

for community gatherings and public events, and three enclosed spaces for office and storage uses. Around the center landscaping is proposed.

The properties were surveyed by Ron Terry at various dates in the spring, summer and fall of 2021. The objectives of the botanical survey component of this report were to: 1) describe the vegetation; 2) list all species encountered; and 3) identify and evaluate any rare, threatened or endangered plant species that might be present on the properties. Plant species were identified in the field and, as necessary, collected and keyed out in the laboratory. Special attention was given to the possible presence of any federally listed (USFWS 2021) threatened or endangered (T&E) plant species.

The work also included a faunal survey restricted to a tally of birds and introduced mammals, reptiles, and amphibians observed during the botanical survey, as well as two additional one-hour bird observations. The field survey also assessed the general value of the various habitat areas for native fauna. Although there were no radar or ultrasound observations conducted that might have detected the endangered Hawaiian hoary bat, the general value of the habitat for bats was evaluated.

Generally not included in the field survey was assessment of invertebrates or aquatic species or habitat, with limited exceptions. The properties were searched for tree tobacco *(Nicotiana glauca*), the principal plant species in the area known to support the larvae

and pupae of the endangered Blackburn's sphinx moth (*Manduca blackburnii*), and the habitat for an endangered yellow-faced bee was also evaluated.

*Sources on Biological Resources of the Area*

Useful guides to the potential location of threatened and endangered species are critical habitat maps. An online mapping tool provided by the U.S. Fish and Wildlife Service (USFWS) (http://ecos.fws.gov/ecp/report/table/critical-habitat.html) indicates that no designated or proposed critical habitat for endangered plant (or animal) species is located on or near the properties (Figure 3). The nearest designated critical habitat units are four polygons associated with critical habitat for three plants: koʻokoʻolau (*Bidens micrantha* ssp. *ctenophylla*), uhiuhi (*Mezoneuron kavaiense*) and wahine noho kula (*Isodendrion pyrfolium*). Due to substrate habitat requirements, none of these plants are currently found on the properties or have the potential to be found naturally. The critical habitat unit at Kaloko-Honokohau National Historical Park includes extensive ponds and wetlands and is also designated for two Hawaiian seabirds, Hawaiian coot (*Fulica alai*) and Hawaiian stilt (*Himantopus mexicanus knudseni*), which are discussed in this report.

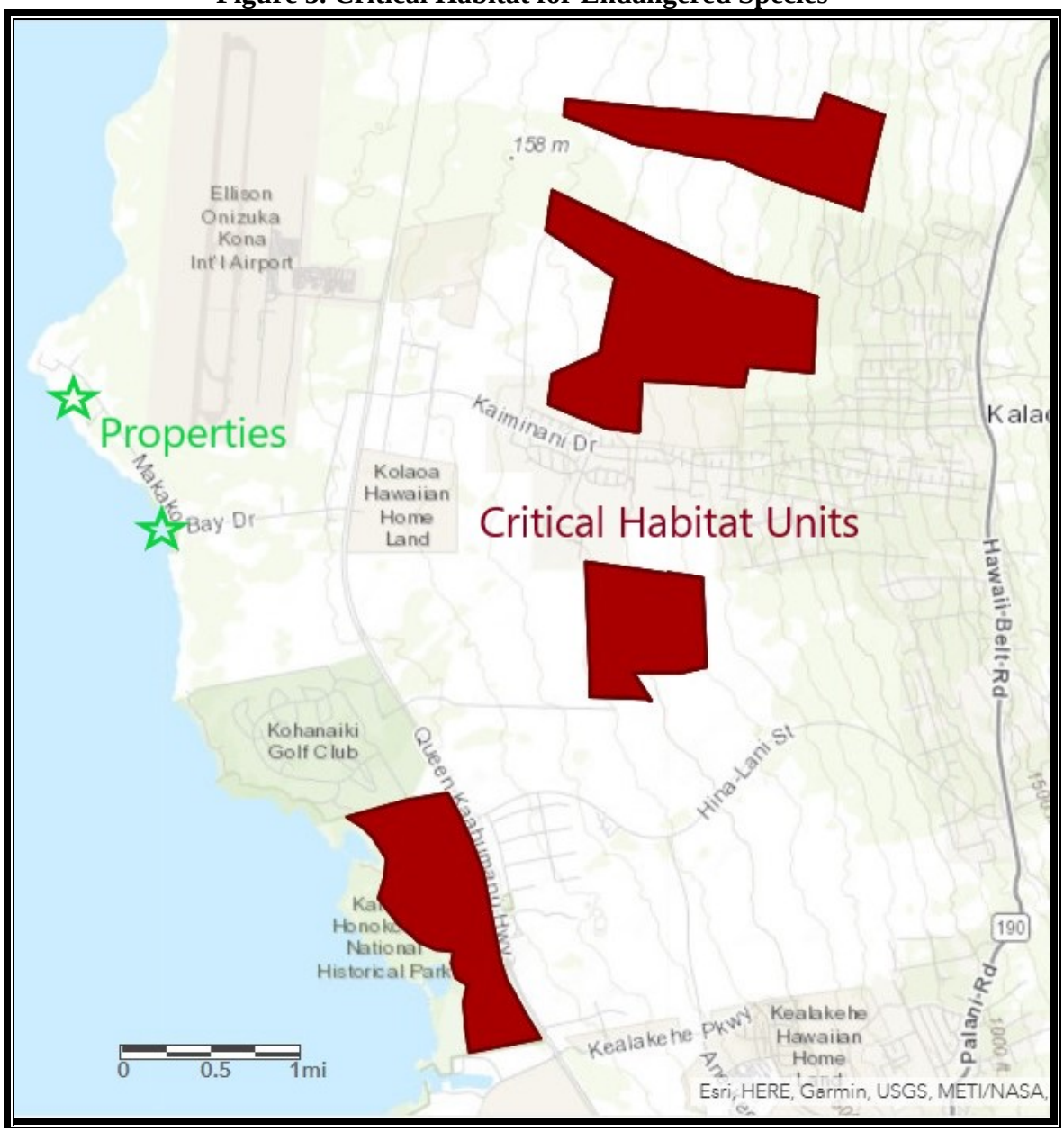
As part of preparation of a State of Hawaiʻi EA for the project, Stantec Consulting Inc. requested Technical Assistance from the USFWS. In a letter of December 7, 2021, the agency replied with the names of listed T&E species that could be present at the site or in the area. The letter is attached to this report as an appendix. All species listed in the letter with a potential to be present are discussed in this report.

Flora and fauna detected in the following studies for sites nearby were also reviewed. All but the first were prepared by Geometrician Associates.

1. *Environmental Impact Statement for the Natural Energy Laboratory of Hawaiʻi at Ke-Ahole Point, Hawaii (Phase 1)*. 1976.
2. *Botanical Survey, TMKs 7-3-09:04 and 22, Oʻoma, North Kona, Island of Hawaiʻi*. 2006.
3. *Final Environmental Assessment, West Hawaiʻi Explorations Academy Relocation, TMK (3rd. Div.) 7-3-043:083 (por.)*. 2011
4. *Final Environmental Assessment, Monk Seal Rehabilitation Facility at NELHA, TMK (3rd. Div.) 7-3-043:042*. 2011.
5. *Flora and Fauna Survey, Oʻoma PONC Property, North Kona District, Island of Hawaiʻi*. Hawaiʻi County Department of Parks and Recreation. 2014.

These sources all provided general information on vegetation types and habitat in the region. They indicated the potential presence of two endangered plant species (*Sesbania tomentosa* and *Fimbristylis hawaiiensis*) and one rare plant species (*Capparis sandwichiana*). They also included information on several wide-ranging endangered animals, and a more restricted one, the yellow-faced bee *Hylaeus anthracinus*.

**Figure 3. Critical Habitat for Endangered Species**




Source: U.S. Fish and Wildlife Service (http://ecos.fws.gov/ecp/report/table/critical-habitat.html accessed October 2021)

*Vegetational Influences*

The climate in this region of Kona known as Kekaha can be described as hot and arid, with a mean annual temperature of approximately 80 degrees Fahrenheit (U.H. Hilo-Geography 1998:57). Annual rainfall is about 15 inches (Giambelluca, Chen et al 2014). With a minimum potential evapotranspiration of 60 inches (Giambelluca, Chen et al 2014), the vegetation is extremely arid. The elevation of the property ranges from sea level to about 30 feet above sea level. The surface geology consists of basaltic pahoehoe lava flows (with scattered ‘a‘a inclusions) from Hualālai volcano dated at 1,500-3,000 years ago (Wolfe and Morris 1996). The soil here is classified by the U.S. Natural

Resources Conservation Service (formerly Soil Conservation Service) as Lava flows, pahoehoe, 2-20 percent slope, and Beaches, 2-6 percent slope, without true soil development (U.S. Soil Conservation Service 1973).

No natural overland drainage courses are present. An open, rock-lined seepage pit that drains cleaned water from the Cyanotech facility cuts across a corner of the Innovation Center property near Makako Bay Drive (as part of the project, this will be covered and no longer open). Groundwater exists in the form of a freshwater lens, floating within permeable lava flows just above sea level on denser, underlying salt water. Because of the elevation of the properties, the ground surface does not intersect the water table. There are thus no anchialine ponds (tidal bodies with no surface connection to the sea) on the properties. The depth to groundwater is such that it does not appear to markedly influence vegetation, although some of the low trees in the strand area may have roots that penetrate to the brackish groundwater.

The pre-human vegetation of the general area was very likely quite similar to that of today: Coastal Strand near the shoreline and Coastal Dry Shrubland in areas mauka (per Gagne and Cuddihy 1990), although with somewhat different species assemblages than today. The Coastal Strand vegetation consisted of the typical Hawaiian Island pan-tropical herbs, grasses, vines and low shrubs adapted to a sandy/rocky, salty substrate. These include naupaka (*Scaevola taccada*), beach morning glory (*Ipomoea pes-caprae*), ‘uhuloa (*Waltheria indica*), akulikuli (*Sesuvium portulacastrum*), mau‘u ‘aki‘aki (*Fimbristylis cymosa*), hinahina (*Heliotropium* spp.),‘aki‘aki (*Sporobolus virginicus*), pili (*Heteropogon contortus*), ‘ilima (*Sida fallax*), pa‘ū o Hi‘iaka (*Jacquemontia ovalifolia*), ‘uhaloa (*Waltheria indica*), and koali pehu (*Ipomoea indica*). Now rare elements such as maiapilo (*Capparis sandwichiana*) and ‘ohai (*Sesbania tomentosa*) were likely much more common. The Coastal Dry Shrubland probably included many of the herbs and grasses discussed above, plus puakala (*Argemone glauca*) and red ‘ilima (*Abutilon menziesii*), as well as low trees such as naio (*Myoporum sandwicense*) and a‘ali‘i (*Dodonea viscosa*), and ferns such as *Nephrolepis exaltata* subsp. *hawaiiensis*.

The pre-human fauna of the area would have contained the same shorebirds and seabirds as today along with others that have since become extinct. Because of the lack of ponds or fresh or brackish water bodies, few waterbirds would have found habitat in the area, but they would have flown over as they passed between the wetlands of Kaloko-Honokohau and areas further north. The absence of forests likely precluded any major concentrations of forest birds, although unlike today, many of their ranges extended to sea level. Other native fauna would have included Hawaiian hoary bats and various species of invertebrates.

Since the arrival of humans most of Hawai‘i‘s lowland vegetation has drastically changed. The landscape of much of urban Kona has been radically altered by centuries of settlements, over a century of grazing, and particularly urban development, which has occurred all around the properties. Western contact brought with it a wide variety of invasive weeds and feral mammals that grazed or fed on seeds. The vegetation of the hot and arid Kekaha region of Kona remained sparse but changed in composition, with highly invasive grasses such as fountain grass (*Cenchrus setaceus)*, buffelgrass (*Cenchrus*

*ciliaris*) and fescue (*Festuca* spp.) replacing most native grasses, herbs and shrubs. Kiawe trees (*Prosopis pallida*) are among the few woody plants that can survive in this area. These invasive species tolerate goat grazing and fire and thus slowly gain a competitive advantage over natives. A few hardy natives such as ‘uhaloa have managed to thrive in such environments. Dozens of non-native birds were also introduced. The development of landscaped resorts and golf courses has provided lush habitats for both native and non-native birds.

## *Survey Results*

*Vegetation*

The Innovation Center area has two basic vegetation types: Coastal Strand, at the far makai end where no development is proposed, and mostly barren lava in the inland portion (see photos in Figure 2). The Coastal Strand has a mixture of alien weeds along with common, pan-tropical native herbs, vines and grasses. The only prevalent large shrub or tree on the site is the alien tree heliotrope (*Tournefortia argentea*). Among natives, naupaka, ‘uhaloa, ‘aki‘aki and hinahina are very common, as are the aliens sourbush (*Pluchea symphytifolia*) and fountain grass. In the mostly barren inland section, areas that have been disturbed support fountain grass and other weeds. The alien sword fern *Nephrolepis multiflora* is also sparingly present in lava cracks. The only rare plant located on the site is one maiapilo, which is found just outside the Coastal Strand, adjacent to the fence on the eastern end of the property (Figure 2g).

The proposed Hale Wawaloli property is on previously graded land mauka of the Coastal Strand vegetation (see photos in Figure 2). The flora here is composed of weeds and parking lot landscaping, and includes fountain grass, ‘uhaloa, noni (*Morinda citrifolia*), cocoplum (*Chrysobalanus icaco*), and various weedy herbs and grasses.

*Flora and Rare, Threatened or Endangered Plants*

All plant species found on the properties during the survey are listed in Table 1. Of the 38 species detected, most were non-native. One Polynesian-introduced species, noni, was present. Ten species were indigenous (native to the Hawaiian Islands and elsewhere) and one was endemic (found only in the Hawaiian Islands). No threatened or endangered species were found. The very rare *Fimbristylis hawaiiensis*, which is often less than an inch in height and may be shriveled in dry conditions and difficult to spot, was not seen. With the exception of the endemic and rare maiapilo, all the native species detected are very common in the area, on the island, and throughout the Hawaiian Islands. Maiapilo is a fragrant-flowered relative of the caper bush plant that is found patchily, if sometimes commonly, in ever-more restricted dry coastal areas of the Hawaiian Islands (see Figure 2f). It has been proposed at various times for listing as endangered, but is currently considered only rare, with no legal protections. From a conservation perspective, where feasible, it should be protected and/or incorporated in project landscaping, where it often thrives.

**Table 1. Plant Species Observed at NELHA Properties, 2021**

| Scientific Name | Family | Common Name | Life Form | Status* |
|---|---|---|---|---|
| *Boerhavia coccinea* | Nyctaginaceae | Boerhavia | Herb | A |
| *Boerhavia acutifolia* | Nyctaginaceae | Alena | Herb | I |
| *Capparis sandwichiana* | Capparaceae | Maiapilo | Shrub | E |
| *Cenchrus setaceus* | Poaceae | Fountain grass | Grass | A |
| *Chenopodium murale* | Amaranthaceae | Lamb's quarters | Herb | A |
| *Chloris barbata* | Poaceae | Swollen fingergrass | Grass | A |
| *Chrysobalanus icaco* | Chrysobalanaceae | Cocoplum | Shrub | A |
| *Coccoloba uvifera* | Polygonaceae | Sea grape | Tree | A |
| *Cynodon dactylon* | Poaceae | Bermuda grass | Grass | A |
| *Eragrostis amabilis* | Poaceae | Lovegrass | Grass | A |
| *Euphorbia hirta* | Euphorbiaceae | Garden spurge | Herb | A |
| *Fimbristylis cymosa* | Cyperaceae | Mau'u 'aki'aki | Sedge | I |
| *Heliotropium amplexicaule* | Boraginaceae | Heliotrope | Herb | A |
| *Heliotropium curassavicum* | Boraginaceae | Seaside heliotrope | Vine | I |
| *Indigofera suffruticosa* | Fabaceae | Indigo | Shrub | A |
| *Ipomoea pes-caprae* | Convolvulaceae | Pohuehue | Vine | I |
| *Jacquemontia ovalifolia* | Convolvulaceae | Pa'u o Hi'iaka | Vine | I |
| *Leucaena leucocephala* | Fabaceae | Haole koa | Tree | A |
| *Macroptilium lathyroides* | Fabaceae | Cow pea | Shrub | A |
| *Melinis repens* | Poaceae | Natal red-top | Grass | A |
| *Morinda citrifolia* | Rubiaceae | Noni | Shrub | A |
| *Nephrolepis multiflora* | Nephrolepidaceae | Sword fern | Herb | A |
| *Phyllanthus debilis* | Euphorbiaceae | Niruri | Herb | A |
| *Pluchea symphytifolia* | Asteraceae | Sourbush | Shrub | A |
| *Portulaca pilosa* | Portulacaceae | Portulaca | Herb | A |
| *Prosopis pallida* | Fabaceae | Kiawe | Tree | A |
| *Scaevola taccada* | Goodeniaceae | Naupaka kahakai | Shrub | I |
| *Schinus terebinthifolius* | Anacardiaceae | Christmas-berry | Shrub | A |
| *Sesuvium portulacastrum* | Aizoaceae | Akulikuli | Herb | I |
| *Sida fallax* | Malvaceae | 'Ilima | Shrub | I |
| *Spergula arvensis* | Caryophyllaceae | Corn spurrie | Herb | A |
| *Sonchus oleraceus* | Asteraceae | Sow thistle | Herb | A |
| *Sporobolus diandrus* | Poaceae | Indian dropseed | Grass | A |
| *Sporobolus virginicus* | Poaceae | 'Aki 'aki grass | Grass | I |
| *Tournefourtia argentea* | Boraginaceae | Tree heliotrope | Tree | A |
| *Tribulus terrestris* | Zygophyllaceae | Goat head | Herb | A |
| *Tridax procumbens* | Asteraceae | Coat buttons | Herb | A |
| *Waltheria indica* | Sterculiaceae | 'Uhaloa | Herb | I |

A = alien, E = endemic, I = indigenous, End = Federal and State listed Endangered Species (none)

The common, non-native tree tobacco, which provides habitat for the endangered Blackburn's sphinx moth, was not detected on or near either of the properties.

*Birds*

The eight species of birds detected during the survey were seen and heard mainly in the strand vegetation, shoreline lava flats and tidepool areas (Table 2). The lava-covered inland area of the properties had extremely few birds. Most observed species were non-natives. The most abundant were common mynas (*Acridotheres tristis)*, Japanese white-eyes (*Zosterops japonicus*) and spotted doves (*Streptopelia chinensis*). Despite the predominance of non-native birds, several native birds naturally associated in Hawai‘i with shorelines, ponds or streams were also seen in the shoreline area, and in one case, near the open, rock-lined seepage pit from Cyanotech. These included ruddy turnstone or ‘akekeke (*Arenaria interpres*), wandering tattler or ‘ulili (*Tringa incana*), black-crowned night heron or auku‘u (*Nycticorax nycticorax hoactli*) and Pacific golden-plover or kolea (*Pluvialis fulva*). No rare, threatened or endangered birds were seen, although all native birds found here are protected under the Migratory Bird Treaty Act.

No native landbirds were detected during the survey. The only one that might be seen is *Asio flammeus sandwichensis*, the Hawaiian endemic sub-species of the short-eared owl. Also called pueo, this diurnal bird of prey is regularly seen within the grasslands, shrublands and forests of Kona. The properties do not provide habitat for pueo. This species is currently widespread on the Big Island and does not have special protected status under either State or federal endangered species statutes on this island. The pueo is culturally important and is considered an ‘aumakua or family-specific spirit for some families. Although the Hawaiian hawk (*Buteo solitarius*; listed as endangered by the State of Hawai‘i but delisted by the USFWS) was noted in the USFWS letter, it is unlikely to be present. No trees suitable for hawk nesting are located on either property.

Two listed T&E birds are frequently seen nearby and probably overfly the area, even though it does not represent habitat for either. These are the endangered Hawaiian stilt or ae‘o (*Himantopus mexicanus knudseni*) and threatened Hawaiian geese or nēnē (*Branta sandvicensis*). They are often seen in coastal ponds, golf course irrigation pond/water hazards and even wastewater treatment ponds, and sometimes they fly and land in nearby areas. Of these two, only the nēnē has any reasonable potential to land and linger on the properties. One other listed Hawaiian waterbird found nearby at Kaloko-Honokohau National Historical Park, the Hawaiian coot or ‘alae ke‘oke‘o (*Fulica alai*), would almost never be found on the properties because of its behavior as well as the lack of habitat.

Like the entire island of Hawai‘i, several listed seabirds may overfly the Kona shoreline: the endangered Hawaiian petrel (*Pterodroma sandwichensis*), the endangered band-rumped storm petrel (*Oceanodroma castro*), and the threatened Newell’s shearwater (*Puffinus auricularis newelli*). They may fly over various locations near Keahole area on their way to and from mountain nesting areas and the open ocean, but no suitable nesting habitat for these seabird species is present in the area. The primary mortality cause in these species in Hawai‘i is thought to be predation by alien mammals at the nesting colonies. Collision with man-made structures is another significant cause. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. Disoriented seabirds may collide with manmade structures and, if not killed outright, become easy targets of predatory mammals.

**Table 2. Bird Species Observed at NELHA Properties, 2021**

| Scientific name | Common Name | Status |
|---|---|---|
| *Acridotheres tristis* | Common Myna | Alien Resident |
| *Arenaria interpres* [2] | Ruddy Turnstone (‘Akekeke) | Indigenous Resident |
| *Carpodacus mexicanus* | House Finch | Alien Resident |
| *Estrilda astrild* | Common Waxbill | Alien Resident |
| *Francolinus pondicerianus* | Gray Francolin | Alien Resident |
| *Tringa incana* [2] | Wandering Tattler (‘Ulili) | Indigenous Resident |
| *Nycticorax nycticorax hoactli* [2] | Black-Crowned Night Heron (Auku‘u) | Indigenous Resident |
| *Pluvialis fulva* [2] | Pacific Golden-Plover (Kolea) | Migratory Resident |
| *Streptopelia chinensis* | Spotted Dove | Alien Resident |
| *Zosterops japonicus* | Japanese White-eye | Alien Resident |

[1] Protected under Endangered Species Act (none) [2] Protected under Migratory Bird Treaty Act

*Hawaiian Hoary Bat*

The Hawaiian hoary bat (*Lasiurus cinereus semotus*) is the only native Hawaiian land mammal. This bat is solitary and roost in trees rather than caves. It is found throughout the island of Hawai‘i and has been observed in leafy kiawe scrub vegetation that dominates much of coastal North Kona. Bats may forage for flying insects over the properties on a seasonal basis, but there are no shrubs and trees tall enough to provide suitable roosting habitat. Bats are often visible while they are feeding on flying insects near dusk and dawn at various locations around the island of Hawai‘i. The presence of these bats can also be verified by echolocation detectors. If a bat is detected during a night’s study, this merely indicates that they were present in the area. Conversely, the absence of bat detections does not indicate an absence of bats, which may have been absent for only a night, a week, or a season, or may have simply gone undetected. Determination of bat populations or usage patterns requires sophisticated, long term studies. No bats were observed in our surveys, which took place in daylight and did not use any detection equipment. For the purposes of this assessment, it is assumed that Hawaiian hoary bats are present at least some of the time, as they have been frequently seen near the coast. Hawaiian hoary bats are vulnerable to disturbance during the summer pupping season.

*Introduced Mammals, Reptiles, and Amphibians*

During the survey we observed numerous small Indian mongooses (*Herpestes a. auropunctatus*) and sign of wild goats (*Capra h. hircus*). It is likely that feral cats (*Felis catus*), mice (*Mus* spp.), rats (*Rattus* spp.) and domestic dogs, (*Canis f. familiaris*) are occasionally present on the properties. None of these alien mammals has conservation value and all are deleterious to native flora and fauna.

There are no native terrestrial reptiles or amphibians in Hawai‘i. None were observed during the survey, but various anoles, skinks and geckoes may be present, as they are common on the island.

*Invertebrates*

No invertebrate surveys were undertaken as part of the fieldwork, as these require highly trained specialists and long-term observations and were not justified by the habitat. In general, rare or T&E invertebrates on the Island of Hawai‘i tend to be associated with either higher-elevation, older substrate rainforests (e.g., various *Drosophila*); coastal dry shrubland (*Hylaeus anthracinus*); the summit of Mauna Kea (*Nysius wekiuicola*); extremely dry, disturbed lava flows below 3,000 feet in elevation (the Blackburn's sphinx moth, *Manduca blackburnii*); or freshwater or estuarine aquatic settings (various *Megalagrion*). As such, it was recognized that there was some potential for both *Manduca blackburnii* and *Hylaeus anthracinus*.

The endangered Blackburn's sphinx moth has been found at various locations throughout West Hawai‘i, including many areas in North Kona. The adult moth feeds on nectar from native plants including beach morning glory (*Ipomoea pes-caprae*), ilie‘e (*Plumbago zeylanica*), and maiapilo (*Capparis sandwichiana*). Moth larvae feed upon non-native tree tobacco (*Nicotiana glauca*), which occupies disturbed areas such as open fields and roadway margins, and the native aiea (*Nothocestrum* sp.), which is found in dry to moist forests at elevations ranging from 1,500 to 5,000 feet. There is no aiea near the properties, but tree tobacco is common throughout disturbed sites in North Kona, and it can rapidly spread into adjacent undisturbed areas. Systematic survey of the properties and nearby areas determined that no tree tobacco was present. However, ground disturbance during construction affords a site for the weed to sprout from seeds, and the fast-growing weed can quickly overrun a construction site, creating an attractive nuisance.

Seven species of the endemic yellow-faced bee (*Hylaeus* spp.) in the Hawaiian Islands have been listed as endangered because of their vital role as pollinators of native plants, their limited or threatened habitat, and their vulnerability to predators. One of these, *Hylaeus anthracinus*, has within modern times been found in various entomological surveys at locations on the Island of Hawai‘i in coastal and lowland dry ecosystems such as Kealakekua and South Point. *Hylaeus anthracinus* is apparently restricted to small patches of habitat on each island. The largest area is probably on Molokai, where an area of sand dunes stretching from Moomomi to Kalaupapa may support a large population. Elsewhere it is found at Kaena Point on Oahu; Pali o Kalapakea on Kahoolawe; Kanaio and Manawainui on Maui; and various locations on the Big Island including Pohakuloa Training Area, South Point and several sites both north and south of the NELHA properties in Kohanaiki, Kaloko-Honokohau National Historical Park, Makalawena and Mahaiula. Additional sites may exist, but it is likely that they too will be small areas.

A report by the Xerces Society discussed surveys in North Kona and South Kohala that found it in diverse shoreline vegetation in salt-adapted coastal vegetation. (https://xerces.org/sites/default/files/publications/21_019.pdf). The ideal species mix is a mixture of favorable host/habitat species including some combination of naupaka (*Scaevola sericea*), ‘ilima (*Sida fallax*), ‘akoko (*Chamaesyce* spp.), naio (*Myoporum sandwicense*), tree heliotrope (*Tournefortia argentea*), maiapilo (*Capparis sandwichiana*), and various native species in the Boraginaceae, Nyctaginaceae and Convolvulaceae

families. Coral rubble is also a key factor. All of these elements are present at the properties, particularly the Coastal Strand of the Innovation Center property.

*Hawaiian Monk Seal*

As noted in the USFWS letter, Hawaiian monk seals (*Neomonachus schauinslandi*) have been recorded in the vicinity of the properties. These seals are known to haul out on sandy and rocky beaches throughout the island of Hawai‘i. No aspect of the project involves use of or effects to sandy or rocky beaches or adjacent land. At the appropriate time, it is expected that a federal agency will consult with the National Marine Fisheries Service (NMFS) on potential impacts to Hawaiian monk seals in both their onshore and ocean habitats.

*Sea Turtles*

The threatened honu or Central North Pacific distinct population segment of green sea turtle (*Chelonia mydas*) and the endangered honu ‘ea or hawksbill sea turtle (*Eretmochelys imbricata*) are present in all Hawaiian waters. As noted in the USFWS letter, green sea turtles may nest on any sandy beach in the Pacific Islands, while hawksbills show a wide tolerance for nesting substrate ranging from sandy beach to crushed coral, with nests typically placed under vegetation. Both species exhibit strong nesting site fidelity. Although very restricted in their nesting sites, with none known in this area, both turtles appear to be expanding the number of nesting sites in the Hawaiian Islands. Nesting occurs on beaches from May through September, peaking in June and July, with hatchlings emerging through November and December. Construction on or near beaches can result in sand and sediment compaction, sea turtle nest destruction, beach erosion, contaminant and nutrient runoff, and an increase in direct and ambient light pollution which may disorient hatchlings or deter nesting females. Off-road vehicle traffic may result in direct impacts to sea turtles or nests, and also contributes to habitat degradation through erosion and compaction. As discussed above, no aspect of the project involves use of or effects to sandy, rocky or coral beaches or adjacent land. No outdoor lights are planned that will shine towards the sandy areas. At the appropriate time, it is expected that a federal agency will consult with the National Marine Fisheries Service (NMFS) on potential impacts to sea turtles in both their onshore and ocean habitats.

## *Impacts and Mitigation Measures*

The standard for assessing impacts used in this report is adverse effects on valuable biological resources. These include rare, threatened or endangered and otherwise protected biological species, valuable native vegetation, and native animal habitat.

Important considerations are the federal and state laws meant to protect these resources The primary federal law protecting threatened and endangered species is the Endangered Species Act (ESA): 16 USC Section 1531, et seq., along with its implementing regulations at 50 CFR Part 402. This act and subsequent amendments provide for the conservation of T&E species and the ecosystems upon which they depend. The ESA mandates that federal agencies seek to conserve endangered and threatened species and

use their authorities in furtherance of the ESA's purposes. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions. A parallel State law is found in Chapter 195D, HRS. Under these laws, "take" of T&E species, defined "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or any attempt at such conduct," is prohibited. In addition to the Endangered Species Act, the Migratory Bird Treaty Act (MBTA) (16 USC 701-715), provides protection for certain birds. It is illegal to "take, kill, or possess," under the MBTA. The MBTA provides federal protection to all migratory birds, as well as their nests and eggs.

As discussed above, no threatened or endangered plant species listed by the U.S. Fish and Wildlife Service appear to be present on the properties. One rare plant, maiapilo, is present at the Innovation Center property, but it will not be affected. There are no uniquely valuable vegetation types, although the Coastal Strand vegetation is important if common habitat for a variety of native shoreline birds and *Hylaeus* bees, including a potentially endangered species. The Coastal Strand is being avoided. As discussed above, wide-ranging threatened and endangered animal species may occasionally be present on or overfly the properties, as they are throughout most of coastal West Hawai'i. These include the Hawaiian hoary bat, Blackburn's sphinx moth, the Hawaiian goose, the Hawaiian stilt, and several species of seabirds that do not land in the project area or utilize its resources but may fly over the area at night. The following represents GEO's considerations regarding impacts and potential mitigation for each of these species.

- In all areas of Hawai'i, disturbance and cutting of woody vegetation may disrupt Hawaiian hoary bat roosting. As bats use multiple roosts within their home territories, this disturbance from the removal of vegetation is usually minimal. However, during the pupping season, from about June 1 to September 15 each year, female bats carrying pups may be less able to rapidly vacate a roost site when the vegetation is cleared. In order to prevent impacts to Hawaiian hoary bats, seasonal woody vegetation clearing restrictions are necessary. No tall woody vegetation exists on the properties and there should be no impacts to roosting bats. Bats may also be wounded or killed by snagging on barbed wire. No barbed wire will be installed as part of the project.
- No tree tobacco or other hosts of Blackburn's sphinx moth larvae, eggs or pupae are present, and no impact to this species is expected as a result of initial construction. However, if tree tobacco sprouts and is allowed to grow, clearing of individuals over three feet may result in harm to the species, necessitating vegetation management.
- There is very little potential at the properties for use by nēnē for nesting or feeding, because the sparse, open, dry vegetation has little in the way of tender grass shoots or fresh water that attracts these birds. Nevertheless, the occasional presence of nēnē, which range widely and are unafraid of humans, could occur.
- Hawaiian stilts and Hawaiian coots would not be attracted to the site because of the lack of existing water bodies and the fact that the neither project construction nor operation will involve standing water.

- The project will not disturb any beach, shoreline pahoehoe or Coastal Strand vegetation at either the Innovation Center property or the Hale Wawaloli property. The fence at the Innovation Center will be routed around some isolated tree heliotrope and naupaka plants. As such, even in the event that *Hylaeus anthracinus* is occasionally present, the effects to habitat would be miniscule and inconsequential. No areas where monk seals haul out or sea turtles bask or nest will be affected in any way.
- Outdoor lighting in Hawai‘i often attracts threatened or endangered seabirds that may become disoriented by the lighting, resulting in downed birds. It is important to mitigate lighting in order to avoid or minimize these impacts.

The following mitigation measures are proposed. The first set includes proposed measures that have been closely adapted from USFWS avoidance and mitigation measures for listed species. The second set are more general, additional recommendations.

*Proposed Avoidance and Minimization Measures for Listed Species*

1. To minimize potential impacts to Hawaiian hoary bats:

- NELHA and its contractors will not disturb, remove or trim woody plants taller than 15 feet during the bat birthing and pup rearing season (June 1 through September 15).
- NELHA will not use barbed wire for fencing.

2. To avoid and minimize potential project impacts to seabirds:

- NELHA will fully shield all permanent outdoor lights so the bulb can only be seen from below bulb height and only use when necessary. Any permanent fixtures would use only energy efficient outdoor lamps with warmer colors (less blue light) and would install lighting only where and when it is needed for safety purposes, with automatic motion sensors for appropriate fixtures.
- NELHA will avoid nighttime construction altogether during the seabird fledging period, September 15 through December 15.

3. To avoid and minimize potential project impacts to Hawaiian geese, Hawaiian stilts, and Hawaiian coots, in the unlikely event that any are observed on the properties:

- NELHA will ensure that construction personnel do not approach, feed, or disturb these birds.
- If Hawaiian geese are observed loafing or foraging within the project area during the breeding season (September through April), or if Hawaiian stilts or Hawaiian coots are observed utilizing the area, NELHA will ensure that contractors halt work and engage a biologist familiar with their nesting behavior surveys for nests in and around the project area prior to the resumption of any work.
    - o The surveys will be repeated after any subsequent delay of work of 3 or more days (during which the birds may attempt to nest).
    - o The contractor will inform project personnel and other contractors about the presence of the listed bird(s).

- NELHA will include a condition in the construction contract that if nests of Hawaiian geese, Hawaiian stilts, or Hawaiian coots are discovered within a radius of 150 feet of proposed work, or a previously undiscovered nest is found within said radius after work begins, all work will cease immediately and the USFWS will be contacted for further guidance.
- NELHA will include a condition in the construction contract that if there are areas where the Hawaiian goose, the Hawaiian stilt, or the Hawaiian coot is known to be present, the contractor must post and implement reduced speed limits, and inform project personnel and contractors about the presence of Hawaiian geese on-site.

4. To avoid and minimize potential project impacts to Blackburn's sphinx moth:

- A biologist familiar with Blackburn's sphinx moth will survey areas of proposed activities for Blackburn's sphinx moth and its larval host plants prior to work initiation.
    - o Surveys will be conducted during the wettest portion of the year (November-April) if possible, and in any case within 4-6 weeks prior to construction.
    - o Surveys will include searches for eggs, larvae, and signs of larval feeding (chewed stems, frass, or leaf damage).
    - o If moths, or the native aiea, or tree tobacco over 3 feet tall are found during the survey, NELHA will inform the federal agency, which will contact the USFWS for additional guidance to avoid take.
- If no Blackburn's sphinx moth, aiea, or tree tobacco are found during surveys, measures will be taken to avoid attraction of Blackburn's sphinx moth to the project location and prohibit tree tobacco from entering the site. NELHA will ensure that the contractor or facility manager has trained personnel who will:
    - o Remove any tree tobacco less than 3 feet tall.
    - o Monitor the site every 4-6 weeks for new tree tobacco growth before, during and after the proposed ground-disturbing activity.

5. To minimize potential impacts to Hawaiian yellow-faced bees:

- A qualified biologist will survey area of proposed activities for yellow-faced bees.
- Construction will avoid coastal strand habitat. Orange construction fencing will be installed at the makai boundary of both footprints. Construction will remain strictly within footprints that avoid any disturbance of coastal strand habitat.
- In the unlikely event that an action will occur in or adjacent to known occupied yellow-faced bee habitat, a buffer area around the habitat may be required and can be developed on a site-specific basis through consultation with the USFWS.
- Outside this area, woody debris and coral rubble will be left in place, and no vehicular activity will be permitted.
- NELHA will post educational signs to inform people of the presence of sensitive coastal strand species, and no fires or wood-collecting will be allowed.

6. To avoid and minimize project impacts to Hawaiian monks seals as well as sea turtles and their nests:
   - The project will not involve any modification of the beach or shoreline environment at any time, including clearing, removal of native shoreline vegetation and stockpiling of any material or trash.
   - The project will not involve any work in the aquatic environment.
   - In the extremely unlikely even a basking sea turtle is found within the project area (i.e., has left the shoreline area and crawled onto the lava area 200 feet back from the shoreline, to where some construction activity will occur), NELHA will ensure that workers cease all mechanical or construction activities within 100 feet and/or between the basking turtle and the ocean until the animal voluntarily leaves the area.

*Proposed General Biological Mitigation Measures*

- The large maiapilo individual at the Innovation Center property will be avoided entirely and protected.
- Biosecurity protocols including cleaning and inspection of construction equipment for invasive species including fire ants, frogs, rats, and mice will be applied during construction, as applicable, as well as later during operation.
- Landscaping will avoid invasive species and utilize primarily native and Polynesian-introduced species, including loulu (*Pritchardia* spp.), milo (*Thespesia populnea*), coconut, hala (*Pandanus tectorius*), naupaka, pohinahina (*Vitex rotundifolia*), ‘akulikuli and ‘aki’aki grass. In bio-swale infiltration areas, plantings of ‘aki’aki, kupukupu (*Nephrolepis cordifolia*), ‘uki (*Cladium jamaicense*) and makaloa (*Cyperus laevigatus*) will be used.

*Section 7 Endangered Species Act*

If and when the project becomes subject to federal funding or oversight, NELHA will cooperate with the appropriate federal agency to undertake Section 7 consultation with USFWS and the National Marine Fisheries Service (NMFS). It appears to the project proponents at this time that the potential for adverse effects to all listed species are insignificant (undetectable) or discountable (extremely unlikely to occur) if standard USFWS avoidance and minimization measures listed above are diligently incorporated into the project. This determination, however, can only be made by a federal agency, which then transmits the determination to USFWS and NMFS for review. Table 3 provides *preliminary* recommended determinations for each listed species that could be reasonably assumed to have at least some potential to be affected by the proposed action.

**Table 3. Preliminary Recommended Section 7 Determinations of Effect**

| Species | Critical Habitat | Status | Notes | Proposed (Unofficial) ESA Determination |
|---|---|---|---|---|
| Hawaiian hoary bat | None | Endangered | Marginally suitable habitat present nearby but no tall trees or shrubs for roosting habitat on properties. No barbed wire fencing proposed. | No effect |
| Hawaiian goose | None | Threatened | No suitable habitat present; species rarely if ever present because of lack of water bodies and appropriately dense grassy areas. Survey conducted on several dates in 2021: negative. | May affect, not likely to adversely affect |
| Hawaiian waterbirds | None | Endangered | Suitable habitat not present because of lack of nearby water bodies or open water within proposed facilities and bird behavior. Species presence not expected. | No effect |
| Hawaiian seabirds | None | Threatened or Endangered | No suitable habitat for nesting present, but birds may overfly general area. All construction lighting will be regulated in season and permanent lighting will be shielded and incorporate low-blue spectra. No towers, wires or other such structures are planned. | May affect, not likely to adversely affect |
| Hawaiian yellow-faced bee | None | Endangered | The project footprint avoids the Coastal Strand habitat. | May affect, not likely to adversely affect |
| Blackburn's sphinx moth | None | Endangered | No host plant species (e.g., *Nicotiana glauca*) present. Survey conducted on several dates in Spring 2021: negative. | May affect, not likely to adversely affect |
| Sea turtles and Hawaiian monk seal | None | Threatened or Endangered | The project footprint completely avoids the shoreline area where all basking and nesting could occur. | No effect |

*Report Limitations*

No biological survey of a large area can claim to have detected every species present. Some plant species are cryptic in juvenile or even mature stages of their life cycle. Dry conditions can render almost undetectable plants that extended rainfall may later invigorate and make obvious. Thick brush can obscure even large, healthy specimens. Birds utilize different patches of habitat during different times of the day and seasons, and only long-term study can determine the exact species composition. The findings of this survey must therefore be interpreted with proper caution; in particular, there is no warranty as to the absence of any particular species.

*Literature Cited or Consulted*


Banko, W. E. 1980. *Population Histories – Species Accounts Seabirds: Newell's Shearwater (ʻAʻo)*. Cooperative National Park Resources Studies Unit, University of Hawaiʻi at Manoa, Department of Botany, Technical Report #5A.

Day, R. H., B. Cooper, and T. C. Telfer. 2003. "Decline of Townsend's (Newell's Shearwaters (Puffinus auricularis newelli) on Kauai, Hawaii." *The Auk* 120: 669-679.

Gagne, W., and L. Cuddihy. 1990. "Vegetation," pp. 45-114 in W.L. Wagner, D.R. Herbst, and S.H. Sohmer, eds., *Manual of the Flowering Plants of Hawaiʻi*. 2 vols. Honolulu: University of Hawaiʻi Press.

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte. 2013. "Online Rainfall Atlas of Hawaiʻi." *Bull. Amer. Meteor. Soc*. 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1.

Geometrician Associates, LLC. 2006. *Botanical Survey, TMKs 7-3-09:04 and 22, Oʻoma, North Kona, Island of Hawaiʻi*. Prep. for PBR Hawaii.

_____. 2008a. *Botanical Survey, TMK 6-9-01:01 (por.), Puako, South Kohala, Island of Hawaiʻi*. Prep. for Helber Hastert Fee. Appendix C in *Final Environmental Assessment, Puakō Marine Education and Research Center*. University of Hawaiʻi at Hilo, Hilo, HI.

_____. 2011a. *Final Environmental Assessment, Monk Seal Rehabilitation Facility at NELHA, TMK (3rd. Div.) 7-3-043:042*. Prep. for Marine Mammal Institute and Natural Energy Laboratory of Hawaiʻi Authority (NELHA).

_____. 2011b. *Final Environmental Assessment, West Hawaiʻi Explorations Academy Relocation, TMK (3rd. Div.) 7-3-043:083 (por.)*. Prep. for WHEA and Natural Energy Laboratory of Hawaiʻi Authority (NELHA).

_____. 2013a. *Botanical Survey, Samuel M. Spencer Park, Kawaihae, South Kohala, Island of Hawaiʻi* Prep. for Environet Inc.

_____. 2013b. *Biological Survey, Area D, Task Order 20, Former Waikoloa Maneuver Area. Waikoloa, South Kohala, Island of Hawaiʻi*. Prep. for Environet Inc.

_____. 2014a. *Biological Survey, Puʻukoholā Heiau National Historic Site, Kawaihae, South Kohala, Island of Hawaiʻi* Prep. for Environet Inc.

_____. 2014b. *Flora and Fauna Survey, Oʻoma Property, North Kona District, Island of Hawaiʻi*. Prep. for Hawaiʻi County Department of Parks and Recreation.

____. 2016. *Biological Survey Sector 17A, 17B, 17C, 17E, and 17F. Remedial Investigation (RI) Former Waikoloa Maneuver Area Waikoloa, South Kohala, Island of Hawai‘i*. Prep. for GSI Pacific, Inc.

Hawai‘i State Department of Land and Natural Resources (DLNR-DOFAW). 2015. State Wildlife Action Plan (SWAP) Fact Sheets. (all accessed May 2020).
https://dlnr.hawaii.gov/wildlife/files/2019/03/SWAP-2015-Hawaiian-hoary-bat-Final.pdf
https://dlnr.hawaii.gov/wildlife/files/2019/03/SWAP-2015-Hawaiian-duck-Final.pdf
https://dlnr.hawaii.gov/wildlife/files/2019/02/SWAP-2015-Odonata-Final.pdf
https://dlnr.hawaii.gov/wildlife/files/2019/03/SWAP-2015-Hawaiian-coot-Final.pdf;
https://dlnr.hawaii.gov/wildlife/files/2013/09/Fact-Sheet-hawaiian-stilt.pdf
https://dlnr.hawaii.gov/wildlife/files/2013/09/Fact-Sheet-Black-crowned-night-heron.pdf
https://dlnr.hawaii.gov/wildlife/files/2013/09/Fact-Sheet-Wandering_Tattler.pdf
https://dlnr.hawaii.gov/wildlife/files/2019/03/SWAP-2015-Ruddy_Turnstone-Final.pdf

U.S. Army Corps of Engineers (USACE). 2010. *Implementation Plan, Pōhakuloa Training Area Island of Hawaii. Prepared by United States Army Garrison, Hawaii*. Directorate of Public Works, Environmental Division Pōhakuloa Natural Resources Office.

U.S. Fish and Wildlife Service (USFWS). 2004. *Recovery Plan for the Nēnē or Hawaiian Goose (Branta sandvicensis)*. Region 1, U.S. Fish and Wildlife Service. Portland, Oregon.

_____. 2012. *Endangered Species in the Pacific: Hawaiian Goose/Branta Sandvicensis/Nēnē*. Available at: http://www.fws.gov/pacificislands/fauna/HIgoose.html. Accessed March 2015.

_____. 2021. *USFWS Threatened and Endangered Species System (TESS).* http://ecos.fws.gov/tess_public/.

U.S. Soil Conservation Service. 1973. *Soil Survey of Island of Hawai‘i, State of Hawai‘i*. Washington: U.S. GPO.

University of Hawai‘i at Hilo, Dept. of Geography. 1998. *Atlas of Hawai‘i.* 3rd ed. Honolulu: University of Hawai‘i Press.

Wolfe, E.W., and J. Morris. 1996. *Geologic Map of the Island of Hawai‘i*. USGS Misc Investigations Series Map i-2524-A. Washington, D.C.: U.S. Geological Survey.

# APPENDIX 4

# Archaeological Inventory Survey Report

# An Archaeological Inventory Survey in Support of the Natural Energy Laboratory of Hawai‘i Authority’s Proposed Innovation Center and Hale Wawaloli Project

TMKs: (3) 7-3-043:042 (por.), 051, 088 (por.), 100, and 101 (por.)

Kalaoa 4th-5th and ‘O‘oma 1st *ahupua‘a*
North Kona District
Island of Hawai‘i

DRAFT VERSION

*Prepared By:*

Matthew R. Clark, M.A.
and
Amy L. Ketner, B.A.


*Prepared For:*

Stantec
P.O. Box 191
Hilo, HI 96721

January 2022


ASM affiliates
Archaeology • History • Anthropology • Architectural History

Hilo Office: (808) 969-6066 Fax: (808) 443-0065
507-A E. Lanikaula Street, Hilo, HI 96720

Honolulu Office: (808) 439-8089 Fax: (808) 439-8087
820 Mililani Street, Suite 700, Honolulu, HI 96813



ASM Project Number 37120.00

# An Archaeological Inventory Survey in Support of the Natural Energy Laboratory of Hawai‘i Authority’s Proposed Innovation Center and Hale Wawaloli Project

TMKs: (3) 7-3-043:042 (por.), 051, 088 (por.), 100, and 101 (por.)

Kalaoa 4th-5th and ‘O‘oma 1st Ahupua‘a
North Kona District
Island of Hawai‘i

ASM affiliates

# EXECUTIVE SUMMARY

At the request of Stantec, on behalf of WRNS Studio and the Natural Energy Laboratory of Hawai‘i Authority (NELHA), ASM Affiliates (ASM) conducted an Archaeological Inventory Survey (AIS) in support of the planning and design of a new Innovation Center and Hale Wawaloli Welcome Center within the NELHA Hawai‘i Ocean Science and Technology (HOST) Park at Keahole Point in ‘O‘oma 1st, Kalaoa 4th-5th *ahupua‘a*, North Kona District, Island of Hawai‘i. The new Innovation Center will be an expansion of the existing NELHA Research Village and is intended to become a world-leading focal-point for state-of-the art research and development of ocean or blue economy technologies. Hale Wawaloli Welcome Center is an addition to the existing Wawaloli Beach Park facilities and is intended to be the public viewport on the science, engineering, and business activities at the HOST Park, as well as a *ho’okupu* (gift) to the people of West Hawai‘i. The survey area for the AIS encompassed Tax Map Keys (TMK): (3) 7-3-043:051 and 100 as well as portions of TMKs: (3) 7-3-043:042, 088, and 101. The immediate purpose of this AIS was to provide information regarding the type, location, potential significance, and recommended treatments of the cultural resources contained within the project area in order to assist in project planning and design, and to inform the preparation of an Environmental Assessment (EA) currently being prepared for the project. Ultimately the AIS will satisfy the requirements of the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) with respect to the Hawai‘i Revised Statutes (HRS) §6E-8 review of this proposed state project and fulfill the requirements of the County of Hawai‘i Planning Department and the DLNR with respect to permit approvals for land-altering and development activities.

As a result of the current fieldwork, three archaeological sites containing 13 features were documented within the survey area for the proposed Innovation Center. The sites include a Precontact/Historic Period habitation complex (50-10-28-10208), a complex of cobble piles (Site T-1), and a complex of *pāhoehoe* excavations (Site T-2). All three sites are assessed as significant under Criterion d. Sites T-1 and T-2 have been sufficiently documented as a result of the current study and no further work is the recommended treatment. Site 10208 is recommended for preservation. The proposed Hale Wawaloli Welcome Center project area was completely disturbed by prior grading activities, therefore no archaeological sites, including two sites previously documented in that area (Sites 1919 and 10185), were observed during the current AIS.

The HRS Chapter 6E-8 effect determination for the proposed Hale Wawaloli Welcome Center project on TMK: (3) 7-3-043:088 (por.) is “no historic properties affected.” With respect to the historic preservation review process of the DLNR–SHPD, our recommendation is that no further work needs to be conducted within the Hale Wawaloli project area prior to or during project implementation. The HRS Chapter 6E-8 effect determination for the proposed Innovation Center project on TMK: (3) 7-3-043:042 (por.), 051, 100, and 101 (por.) is “effect, with proposed mitigation commitments.” The proposed mitigation commitments include the preparation of an Archaeological Preservation Plan for Site 10208 in accordance with HAR §13-277. In the unlikely event that significant archaeological resources are discovered during the proposed ground disturbing activities within either the Innovation Center or Hale Wawaloli project areas, work will cease in the area of the discovery and the DLNR-SHPD will be contacted pursuant to HAR 13§13-280-3.

# CHAPTERS

**Page**

**1. INTRODUCTION ..... 7**
THE PROPOSED PROJECT ..... 7
PROJECT AREA DESCRIPTION ..... 13
**2. BACKGROUND ..... 18**
CULTURE-HISTORICAL CONTEXT ..... 18
Natural and Cultural Resources in a Hawaiian Context ..... 18
A Generalized model of Hawaiian Prehistory ..... 19
‘O‘oma 1st and Kalaoa 4th-5th *ahupua‘a* and the Greater North Kona District ..... 20
The Environmental Setting of ‘O‘oma and Kalaoa ..... 21
Native Traditions and Historical Accounts of ‘O‘oma, Kalaoa and the Kekaha Region ..... 22
Land Tenure in ‘O‘oma, Kalaoa, and Vicinity ..... 32
PREVIOUS ARCHAEOLOGICAL STUDIES ..... 60
**3. PROJECT AREA EXPECTATIONS ..... 70**
**4. FIELDWORK ..... 71**
FIELD METHODS ..... 71
FINDINGS ..... 71
Site 50-10-27-10208 ..... 71
Site 50-10-27-T-1 ..... 83
Site 50-10-27-T-2 ..... 87
**5. SIGNIFICANCE EVALUATIONS AND TREATMENT RECOMMENDATIONS ..... 95**
SITE 50-10-27-10208 ..... 95
SITE 50-10-27-T-1 ..... 95
SITE 50-10-27-T-2 ..... 95
**6. DETERMINATION OF EFFECT ..... 96**
**REFERENCES CITED ..... 97**

# FIGURES

**Page**

1. Project area location. ..... 8
2. Aerial photograph showing the project area outlined in red. ..... 9
3. Tax Map Key (TMK): (3) 7-3-043 showing the Innovation Center survey area (Parcels 042 por., 051, 100, and 101 por.). ..... 10
4. Tax Map Key (TMK): (3) 7-3-043 showing the Hale Wawaloli survey area (portion of Parcel 088). ..... 10
5. Innovation Center survey area showing the Phase 2 and Phase 2A of the development plan. ..... 11
6. Proposed development plan for the new Innovation Center within the NELHA Hawai‘i Ocean Science and Technology (HOST) Park. ..... 12

# FIGURES

**Page**

7. Proposed development plan for the Hale Wawaloli Welcome Center within the NELHA Hawai‘i Ocean Science and Technology (HOST) Park. 12
8. Existing development on TMK: (3) 7-3-043:051, view to the northeast. 14
9. Developed parcels to the south of the proposed Innovation Center, view to the southwest. 14
10. A portion of Parcel 088 slated for the proposed Hale Wawaloli Welcome Center with the existing Wawaloli Beach Park amenities in the background, view to the southeast. 15
11. Eastern portion of the proposed area for the Innovation Center showing extensive bulldozing, view to the east. 15
12. Western edge of Parcel 100 showing the bulldozed area adjacent to the western boundary of the parcel, view to the south. 16
13. The narrow strip of intact *pāhoehoe* bedrock adjacent to bulldozed area within Parcel 100, view to the southeast. 16
14. Area for the proposed Hale Wawaloli Welcome Center on Parcel 088 (por.) showing extent of bulldozing, view to the southeast. 17
15. Geology within the project areas. 17
16. Soils within the project areas. 18
17. Copy of Native Register Vol. 8:543 Helu 9162, claim of Kahelekahi for *kuleana* at ‘O‘oma. 33
18. LCAw. 7899 awarded to Kupuoe (*Māhele* Book Vol. 7:185). 34
19. LCAw. 7937 awarded to Kukaaui (*Māhele* Book Vol. 7:184). 35
20. Copy of Native Register Vol. 8:514 Helu 7926, claim of Kanahele for *kuleana* at Kalaoa 5th. 36
21. Copy of Native Register Vol. 8:516 Helu 7939, claim of Kanahele for *kuleana* at Kalaoa 5th. 36
22. Portion of Hawai‘i Registered Map No. 1449 (prepared by J. S. Emerson, Sept. 1888). 40
23. Portion of Hawai‘i Registered Map No. 1280. 41
24. J. S. Emerson, field notebook map, Book 253:53 (State Survey Division). 45
25. J. S. Emerson, field notebook map, Book 253:69 (State Survey Division). 46
26. J. S. Emerson, field notebook map, Book 253:73 (State Survey Division). 47
27. J. S. Emerson, field notebook map, Book 254:77 (State Survey Division). 48
28. 1899 Grant Map No. 4536 showing *makai* portion of ‘O‘oma 2nd to John A. Maguire. 51
29. Hawai‘i Registered Map No. 2123 (prepared by S. M. Kanakanui and G.F. Wright, May 1902) showing the current study area outlined in red. 54
30. Portion of the 1924 U.S.G.S. Keāhole Point quadrangle showing the current project areas in red. 54
31. Portion of the 1959 U.S.G.S. Keāhole Point quadrangle. 55
32. January 17, 1965 aerial photograph showing the Kekaha lands in the vicinity of the current project areas. 56
33. Oblique aerial view of the completed Keāhole Airport facility taken on October 6, 1971. 57
34. Map of the initial 322-acre NELH site (traced by G.H. Kurosaki April 1984). 57
35. March 27, 1977 aerial photograph showing the completed NELH access road. 58
36. Oblique aerial view of the initial NELH facilities under construction in 1980. 58
37. Map of the expanded NELH and HOST Park site (prepared on September 12, 2000). 59
38. Previous archaeological studies conducted in the vicinity of the current project area. 61
39. Barrera’s (1985a) site location map showing the Hale Wawaloli portion of the current project area outlined in red. 65
40. Barrera’s (1989) site location map. 67
41. Site location map. 72
42. Site 10208 Feature 1 plan view from Cordy (1975). 73
43. Plan view of Site 10208 (D15-15) from Clark (1984:17). 75
44. Site 10208 plan view. 76

# FIGURES

**Page**

45. Bulldozing along eastern side of Site 10208 where Features 4 through 10 were formerly located, view to the south. ..... 77
46. Site 10208 Feature 1, view to the east. ..... 77
47. Site 10208 Feature 1, view to the west. ..... 78
48. Site 10208 Feature 1, view to the southeast. ..... 78
49. Site 10208 Feature 2, view to the south. ..... 79
50. Site 10208 Feature 3, view to the southwest. ..... 79
51. U.S.G.S. Keahole survey pole located within the Site 10208 complex, view to the south. ..... 80
52. Top view of U.S.G.S. Keahole survey pole foundation at Site 10208, view to the south. ..... 80
53. U.S.G.S. Keahole benchmark within the Site 10208 complex. ..... 81
54. Concentration of coral in the northern portion of Site 10208, view to the northeast. ..... 81
55. Possible basalt salt pan mapped by Clark (1984) adjacent to Feature 2 of Site 10208. ..... 82
56. Recent petroglyph at Site 10208, appears to read" T. ASINSU." ..... 82
57. Recent spray paint graffiti at Site 10208. ..... 83
58. Site T-1 plan view. ..... 84
59. Overview of Site T-1 showing the large crack (lower right) and bulldozer push (upper left), view to the east. ..... 85
60. Site T-1 Feature A, view to the north. ..... 85
61. Site T-1 Feature B, view to the southwest. ..... 86
62. Site T-1 Feature C, view to the southwest. ..... 86
63. Site T-2 plan view. ..... 88
64. Site T-2 Feature A, view to the east. ..... 89
65. Site T-2 Feature A with bulldozer push in background, view to the west. ..... 89
66. Waterworn cobble observed at Site T-2 Feature A, view to the south. ..... 90
67. Site T-2 Feature B, view to the northeast. ..... 90
68. Site T-2 Feature C, view to the northeast. ..... 91
69. Site T-2 Feature D, view to the south. ..... 91
70. Waterworn cobble located near Site T-2 Feature D, overview to the east. ..... 92
71. Site T-2 Feature E, view to the west. ..... 92
72. Site T-2 Feature F, view to the west. ..... 93
73. Site T-2 Feature G, view to the north. ..... 93
74. Site T-2 Feature G, view to the south. ..... 94

# TABLES

**Page**

1. Distribution of Kalaoa and ‘O‘oma during the *Māhele ‘Āina* of 1848 (Soehren 2005). ..... 34
2. Archaeological studies conducted in the coastal portions of ‘O‘oma and Kalaoa *ahupua‘a* ..... 60
3. Archaeological sites recorded during the current study. ..... 71
4. Site significance and treatment recommendations. ..... 95

# 1. INTRODUCTION

At the request of Stantec, on behalf of WRNS Studio and the Natural Energy Laboratory of Hawai‘i Authority (NELHA), ASM Affiliates (ASM) conducted an Archaeological Inventory Survey (AIS) in support of the planning and design of a new Innovation Center and Hale Wawaloli Welcome Center within the NELHA Hawai‘i Ocean Science and Technology (HOST) Park at Keahole Point in ‘O‘oma 1st, Kalaoa 4th-5th *ahupua‘a*, North Kona District, Island of Hawai‘i (Figures 1 and 2). The project area for the AIS encompasses Tax Map Keys (TMK): (3) 7-3-043:051 and 100 in their entirety, as well as portions of TMKs: (3) 7-3-043:042, 088, and 101 (Figures 3 and 4). The proposed Innovation Center is an addition to the existing NELHA Research Village and is intended to become a world-leading focal-point for state-of-the art research and development of ocean or blue economy technologies. Hale Wawaloli Welcome Center is an addition to the existing Wawaloli Beach Park facilities and is intended to be the public viewport on the science, engineering, and business activities at the HOST Park, as well as a *ho’okupu* (gift) to the people of West Hawai‘i. The immediate purpose of this AIS is to provide information regarding the type, location, potential significance, and recommended treatments of the cultural resources contained within the project area in order to assist in project planning and design, and to inform the preparation of an Environmental Assessment (EA) currently being prepared for the project. Ultimately the AIS is intended to satisfy the requirements of the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) with respect to the Hawai‘i Revised Statutes (HRS) §6E-8 review of this proposed State project, and fulfill the requirements of the County of Hawai‘i Planning Department and the DLNR with respect to permit approvals for land-altering and development activities.

The current study was performed in compliance with Hawai‘i Administrative Rules (HAR) §13–275, and in accordance with the Rules Governing Minimal Standards for Archaeological Inventory Surveys and Reports as contained in HAR §13–276. This report contains background information outlining the project area’s physical and cultural contexts, a presentation of previous archaeological work in the immediate vicinity of the property, and current survey expectations based on that previous work. Also presented is an explanation of the survey methods, descriptions of the resources encountered, interpretation and evaluation of those resources, treatment recommendations for the documented sites, and a determination of project effect.

## THE PROPOSED PROJECT

NELHA plans to construct and operate a new Innovation Center as well as a separate new “Hale Wawaloli” visitor center for the HOST Park. The Innovation Center is intended as an expansion of the existing Research Village (Phase 1 in the 2011 NELHA Master Plan). The current research facility is essentially at full capacity and the expansion will provide for program growth for the foreseeable future. Hale Wawaloli will be an addition to the existing Wawaloli Beach Park facilities.

The Innovation Center would be developed in two phases, the first of which (“Phase 2”) would begin construction in Fall 2023, and “Phase 2A” would be built approximately 10 years later (Figure 5). Phase 2 would include approximately 20,000 square feet of facilities under roof including offices, conference spaces, laboratories and wet-room research space with flowing seawater, a “maker-space” workshop, meeting nooks, and outside covered workspaces as well as support areas for maintenance and storage (Figure 6). Phase 2 would also include approximately 48,200 square feet of graded outdoor space for research tankage with access to sea water, fresh water, and electricity, vehicular and pedestrian accessible routes, parking areas (50 stalls), security, and environmentally appropriate landscaping. Phase 2A would include approximately 30,000 square feet of facilities under roof, 88 additional parking stalls, as well as approximately 66,400 square feet of graded outdoor space within a fenced area for tenant research activities and tankage. Road and drainage improvements would be constructed in Phase 2, and a septic wastewater system built in compliance with State Department of Health regulations.

Hale Wawaloli would serve as the visitor education center (Figure 7). Its development would include approximately 2,250 square feet and include an outdoor covered pavilion, an open amphitheater spaces for community gatherings and public events, and three fully enclosed spaces (for office and storage uses). It would be accessible from the existing parking area at the Wawaloli beach park and include environmentally appropriate landscaping.

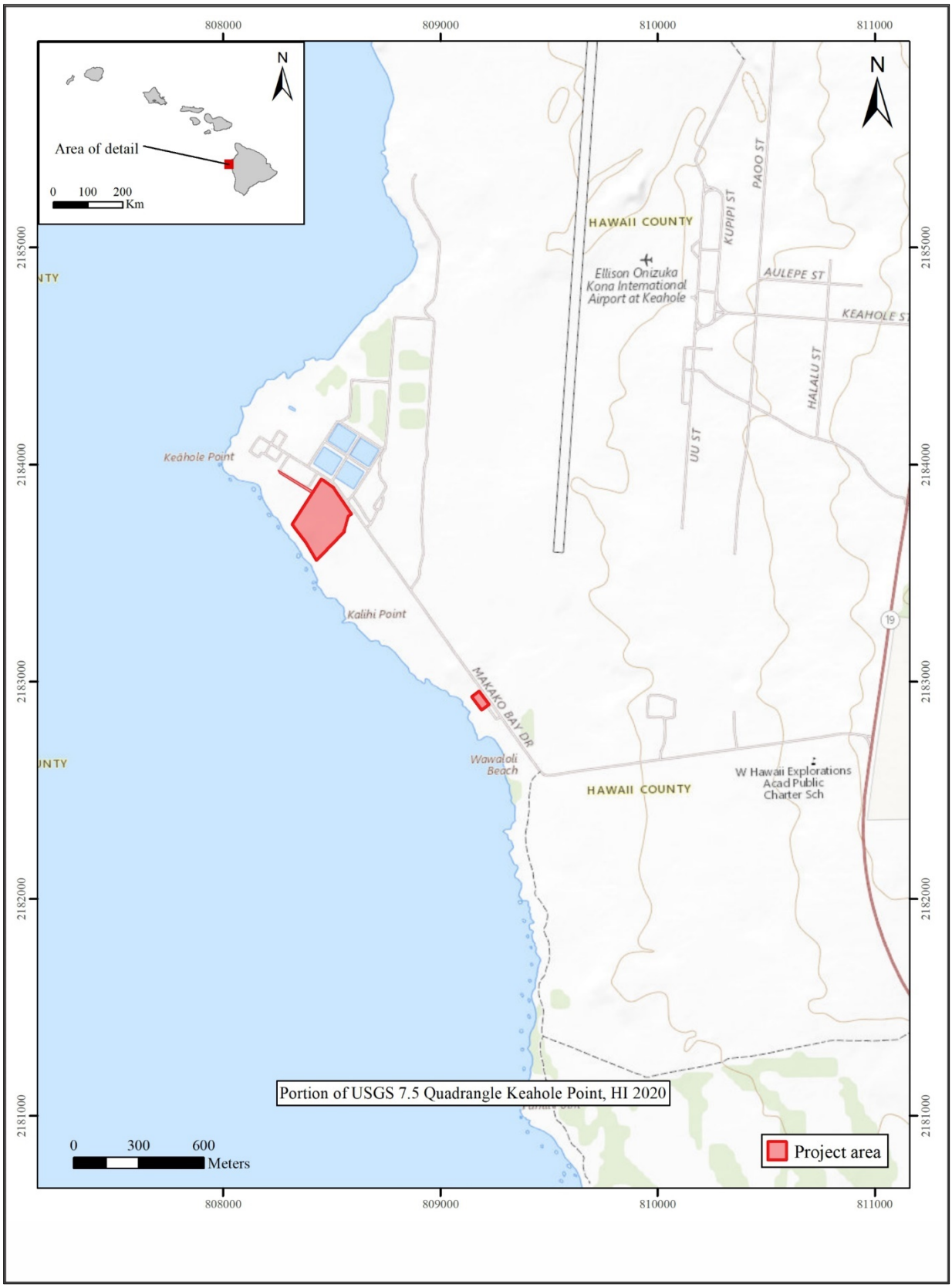



Figure 1. Project area location.

Figure 2. Aerial photograph showing the project area outlined in red.

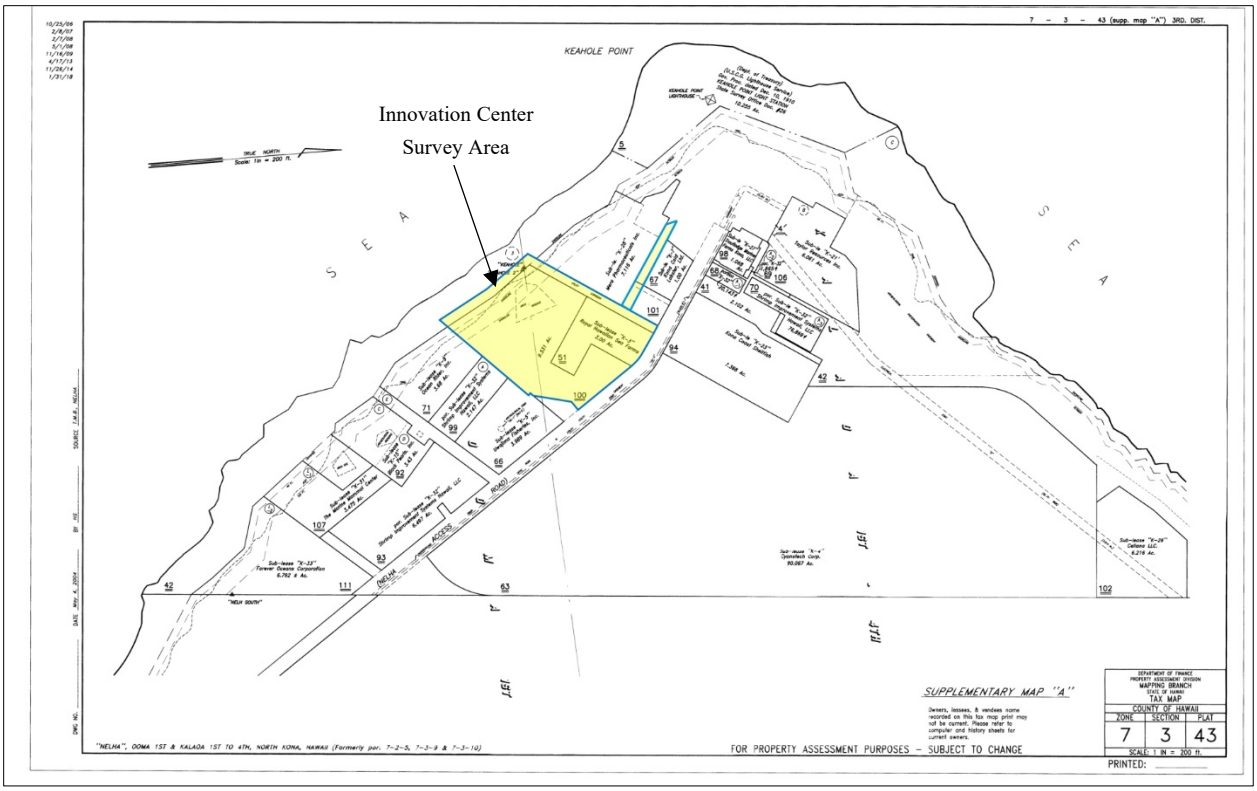



Figure 3. Tax Map Key (TMK): (3) 7-3-043 showing the Innovation Center survey area (Parcels 042 por., 051, 100, and 101 por.).

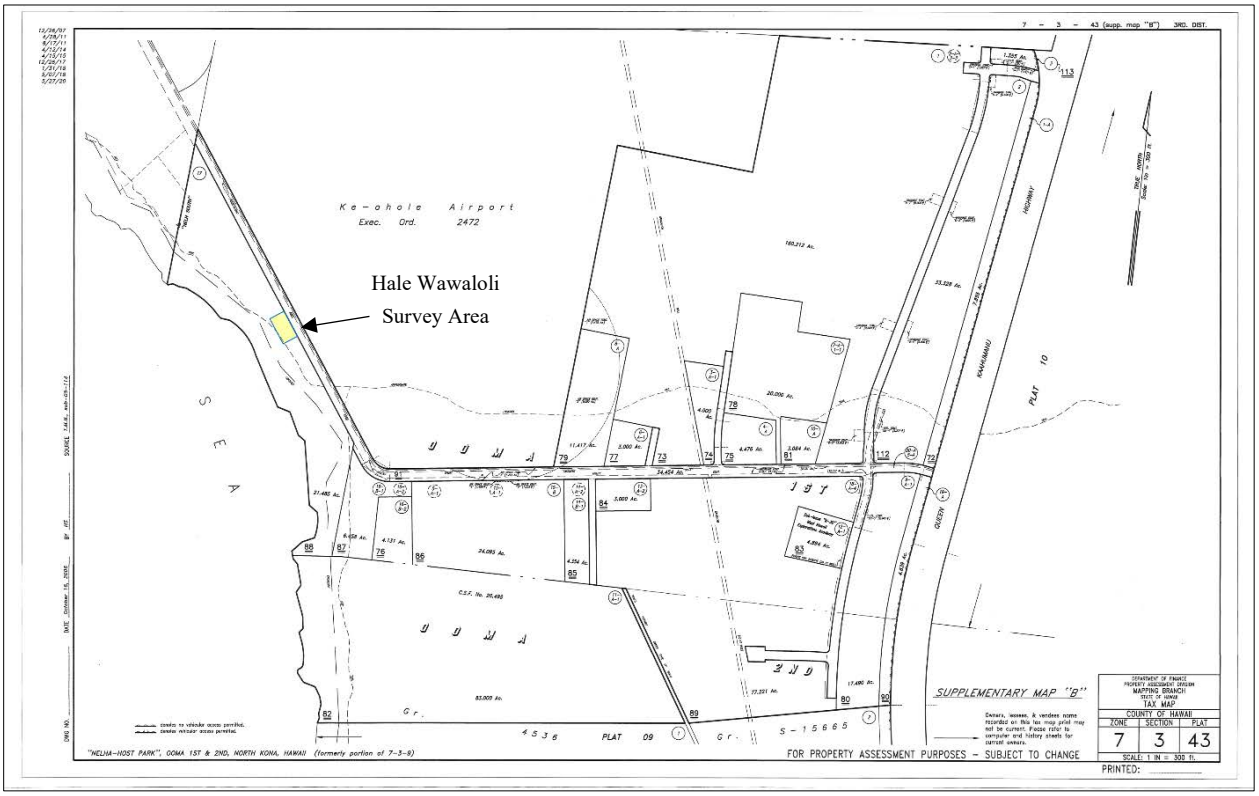



Figure 4. Tax Map Key (TMK): (3) 7-3-043 showing the Hale Wawaloli survey area (portion of Parcel 088).

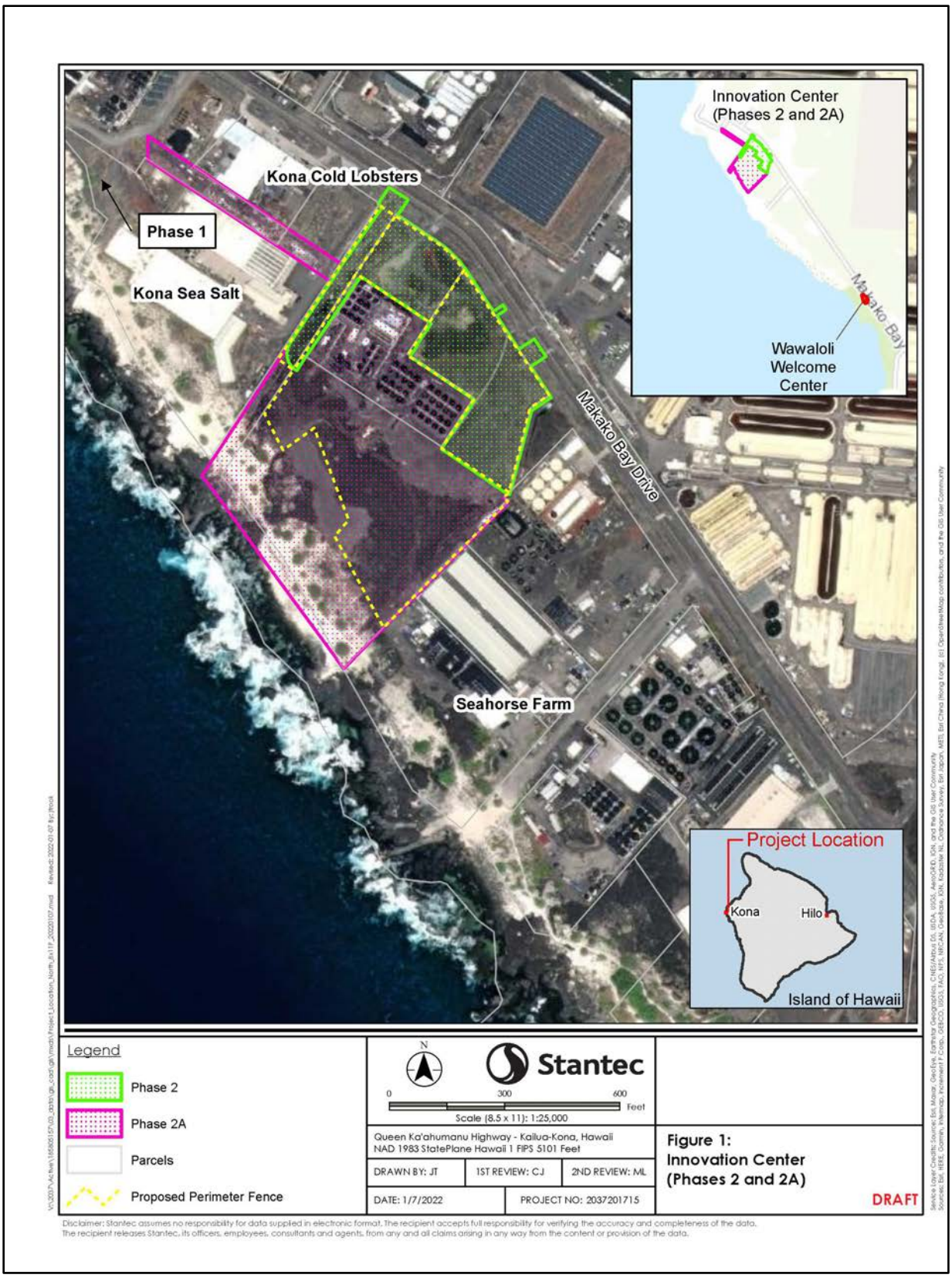



Figure 5. Innovation Center survey area showing the Phase 2 and Phase 2A of the development plan.

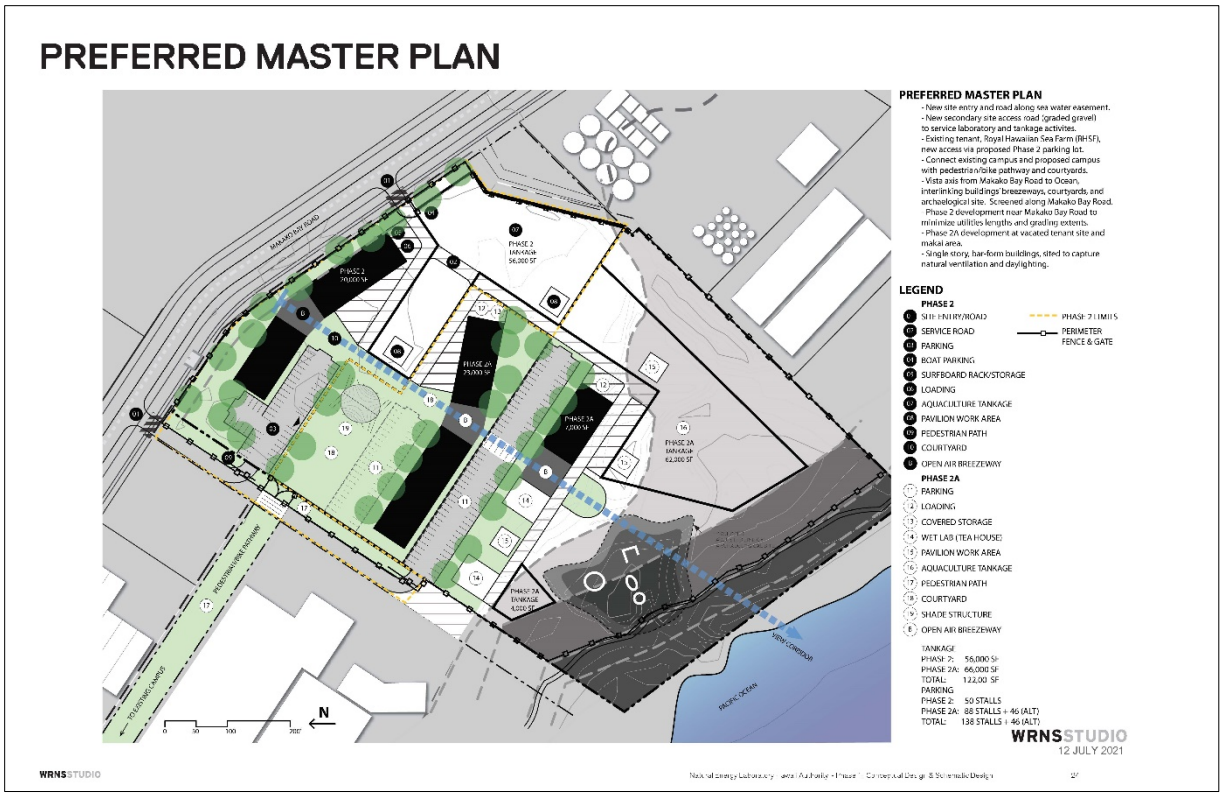



Figure 6. Proposed development plan for the new Innovation Center within the NELHA Hawai‘i Ocean Science and Technology (HOST) Park.

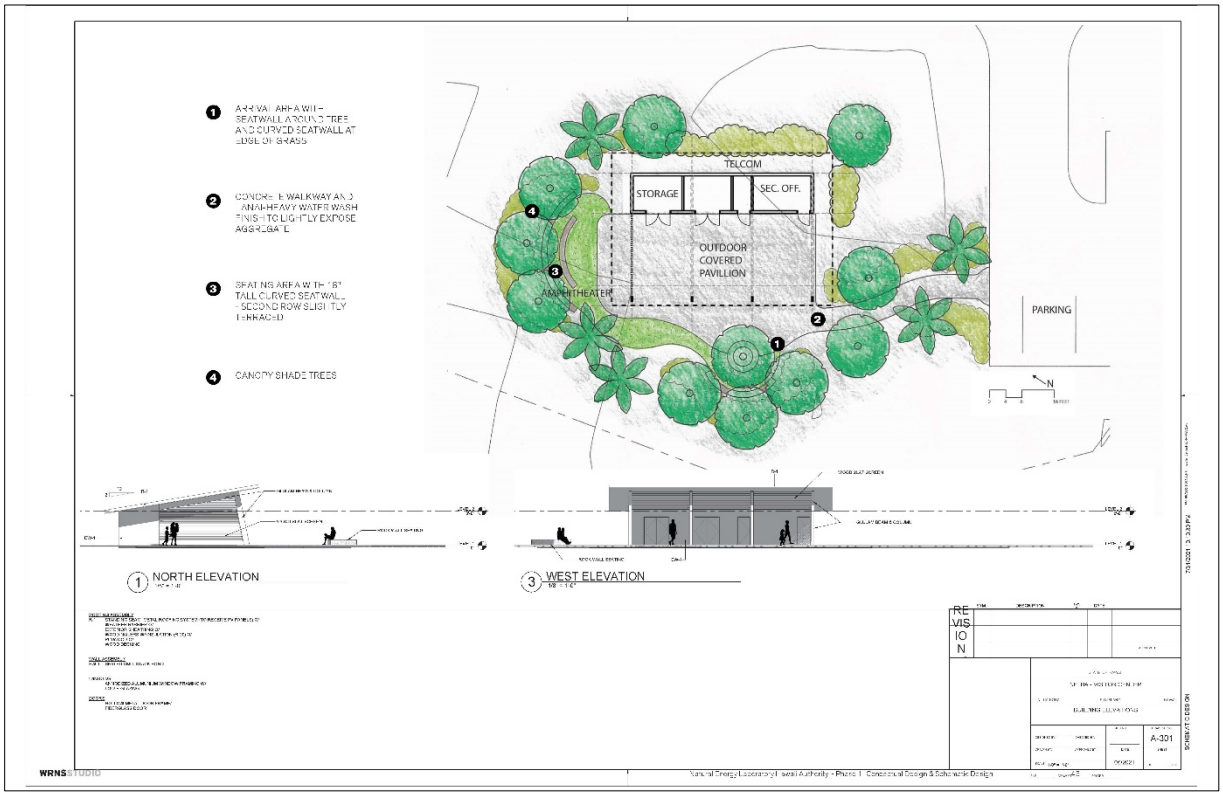



Figure 7. Proposed development plan for the Hale Wawaloli Welcome Center within the NELHA Hawai‘i Ocean Science and Technology (HOST) Park.

## PROJECT AREA DESCRIPTION

The current project area consists of two noncontiguous survey areas totaling roughly 14.3 acres located within the NELHA HOST Park at Keahole Point, ʻOʻoma 1st and Kalaoa 4th-5th *ahupuaʻa*, North Kona District, Island of Hawaiʻi (see Figures 1, and 2). The larger of the two survey areas, totaling roughly 13.5 acres for the proposed development of the Innovation Center, includes TMKs: (3) 7-3-043:100 and 051 in their entirety (totaling 12.5 acres) as well as an 0.5-acre portion of TMK: (3) 7-3-043:042 located to the west of Parcel 100 and a 0.5-acre portion of TMKs: (3) 7-3-043:042 and 101 that extends north from Parcel 051 (see Figure 3). Parcels 051 and 101 are currently developed and are sub-leased by Royal Hawaiian Sea Forms (Figure 8) and Mera Pharmaceuticals, Inc., respectively. The Innovation Center portion of the project area is bounded to the southwest by an undeveloped coastal parcel that fronts the NELHA facility, to the northwest by the developed Mera Pharmaceuticals, Inc. parcel and a parcel subleased to Kona Cold Lobster, Ltd., to the northeast by Makako Bay Drive, and the southeast by three developed parcels (Ocean Rider, Inc., Shrimp Improvement Systems Hawaiʻi, LLC, and Uwajima Fisheries, Inc.; Figure 9). The eastern two-thirds of the Innovation Center survey area has been subject to prior grading and is partially developed (Figure 11). Only the southwestern portion of Parcel 100 (and the adjacent portion of Parcel 042) has not been subject to prior land disturbance (Figures 12 and 13).

The smaller of the two survey areas, for the proposed development of the Hale Wawaloli Welcome Center, is located roughly 0.6 miles south of the Innovation Center survey area and includes a roughly 0.8-acre portion of TMK: (3) 7-3-043:088 (see Figure 4). This portion of the project area is bounded to the northwest and southwest by undeveloped lands, to the northeast by Makako Bay Drive, and to the southeast by the parking lot of the existing Wawaloli Beach Park facility (Figure 10). The area proposed for the Hale Wawaloli Welcome Center, with the exception of a small area in the northwestern corner, has been subject to prior land disturbance (Figure 14).

Located within the Kekaha region of North Kona, at elevations of 1 to 10 meters (3 to 30 feet) above sea level, the principle environmental features of the project area are a hot, dry climate, with extensive lava fields and little to no soil accumulation. The lower seaward slopes of the Kekaha region receive an average of only 333 millimeters (13 inches) of rain per year and have a mean annual temperature of 70 to 76 degrees Fahrenheit (Giambelluca et al. 2014). The terrain in this area is characterized by weathered *pāhoehoe* flows (mapped as Qh2 in Figure 15) that emanated from Hualālai Volcano between 1,500 and 3,000 years ago (Wolfe and Morris 1996). Soils are described as lava flows and beaches (mapped as 12 and 20 on Figure 16) on 0 to 20 percent slopes (Soil Survey Staff 2020). Consequently, the vegetation within the project area is sparse and consists primarily of fountain grass (*Pennisetum setaceum*), beach heliotrope (*Heliotropium foertherianum*), and *naupaka* (*Scaevola taccada*).

Figure 8. Existing development on TMK: (3) 7-3-043:051, view to the northeast.

Figure 9. Developed parcels to the south of the proposed Innovation Center, view to the southwest.

Figure 10. A portion of Parcel 088 slated for the proposed Hale Wawaloli Welcome Center with the existing Wawaloli Beach Park amenities in the background, view to the southeast.

Figure 11. Eastern portion of the proposed area for the Innovation Center showing extensive bulldozing, view to the east.

Figure 12. Western edge of Parcel 100 showing the bulldozed area adjacent to the western boundary of the parcel, view to the south.

Figure 13. The narrow strip of intact *pāhoehoe* bedrock adjacent to bulldozed area within Parcel 100, view to the southeast.

Figure 14. Area for the proposed Hale Wawaloli Welcome Center on Parcel 088 (por.) showing extent of bulldozing, view to the southeast.

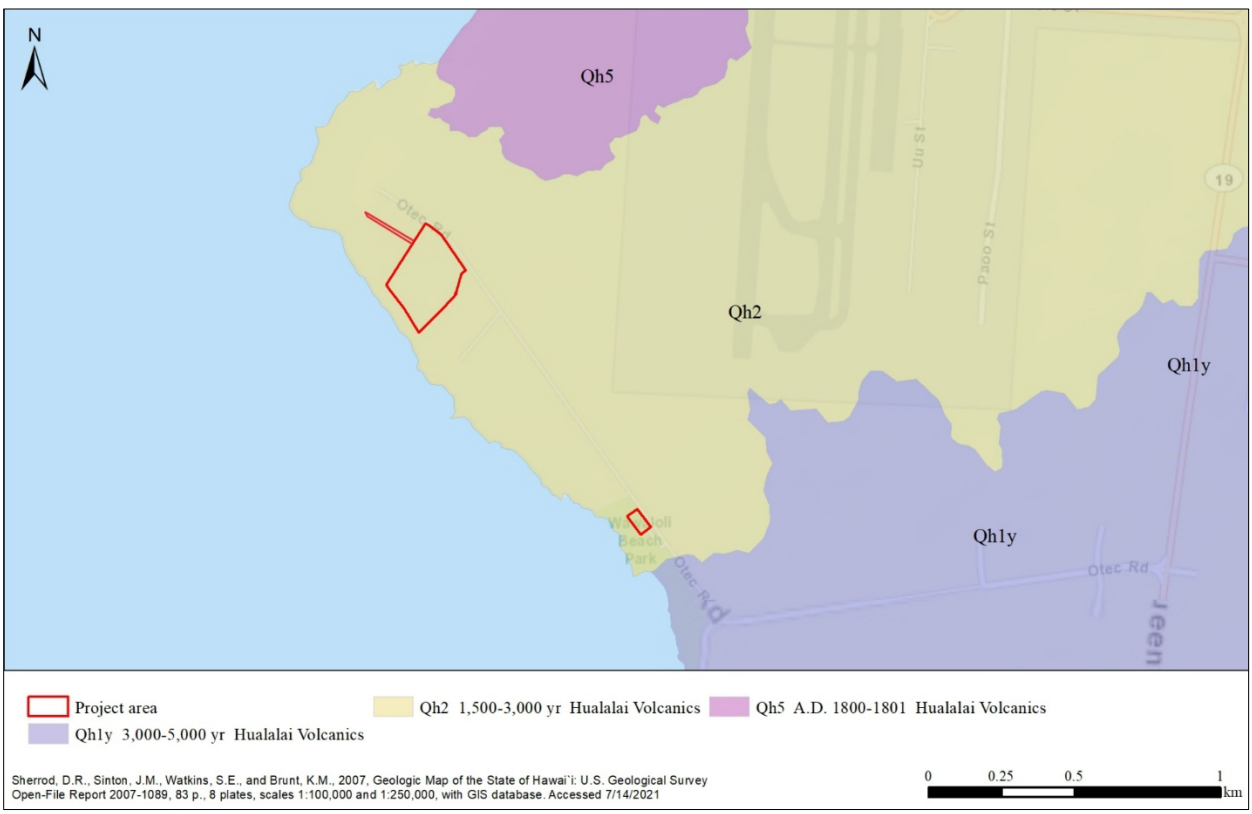



Figure 15. Geology within the project areas.

Figure 16. Soils within the project areas.

# 2. BACKGROUND

To generate a set of expectations regarding the nature of archaeological resources that might be encountered within the current study area, and to establish an environment within which to assess the significance of any such resources, a general culture-historical context for the North Kona region that includes specific information regarding the known history of Kalaoa 4th-5th and ‘O‘oma 1st *ahupua‘a* and the project area is presented. This is followed by a discussion of relevant prior archaeological studies conducted in the vicinity of the project area.

## CULTURE-HISTORICAL CONTEXT

While the physical study area for the current project is limited to two areas roughly totaling 13.8-acres along the coast of ‘O‘oma 1st and Kalaoa 4th-5th *ahupua‘a*, in an effort to provide a comprehensive and holistic understanding of the project area, this section of the report examines the wider Keahole Point region and the study area *ahupua‘a* within the context of the larger Kekaha region of North Kona. Much of the following discussion of culture-historical context for the Kekaha region is summarized from the comprehensive background sections presented in cultural impact studies prepared for nearby projects by Rechtman and Maly (2003) and Rechtman (2006). Additional information and emphasis have been added in some sections to elucidate and highlight people, places, and events associated specifically with the current project area. This comprehensive background information facilitates a more complete understanding of the potential significance of the resources that exist within the current project area.

### Natural and Cultural Resources in a Hawaiian Context

In Hawaiian society, natural and cultural resources are one and the same. Native traditions describe the formation (the literal birth) of the Hawaiian Islands and the presence of life on and around them in the context of genealogical accounts. All forms in the natural environment, from the skies and mountain peaks, to the watered valleys and lava plains, and to the shoreline and ocean depths were believed to be embodiments of Hawaiian deities. One Hawaiian genealogical account, records that Wākea (the expanse of the sky–father) and Papa-hānau-moku (Papa—Earth-mother who gave birth to the islands)—also called Haumea-nui-hānau-wā-wā (Great Haumea—Woman-earth born time and time again)—and various gods and creative forces of nature, gave birth to the islands. Hawai‘i, the largest of the

islands, was the first-born of these island children. As the Hawaiian genealogical account continues, we find that these same god-beings, or creative forces of nature who gave birth to the islands, were also the parents of the first man (Hāloa), and from this ancestor, all Hawaiian people are descended (c.f. Beckwith 1970; Malo 1951; Pukui and Korn 1973). It was in this context of kinship, that the ancient Hawaiians addressed their environment, and it is the basis of the Hawaiian system of land use.

## A Generalized model of Hawaiian Prehistory

While the question of the timing of the first settlement of Hawai‘i by Polynesians remains unanswered, several theories have been offered that derive from various sources of information (i.e., genealogical, oral-historical, mythological, radiometric). However, none of these theories is today universally accepted (Kirch 2011). What is more widely accepted is the answer to the question of where Hawaiian populations came from and the transformations they went through on their way to establish a uniquely Hawaiian culture. The initial settlement in Hawai‘i is believed to have originated from the southern Marquesas Islands (Emory in Tatar 1982). During these early times, Hawai‘i’s inhabitants were primarily engaged in subsistence-level agriculture and fishing (Handy et al. 1991). This was a period of great exploitation and environmental modification when early Hawaiian farmers developed new subsistence strategies by adapting their familiar patterns and traditional tools to their new environment (Kirch 1985; Pogue 1978). Their ancient and ingrained philosophy of life tied them to their environment and kept order; which was further assured by the conical clan principle of genealogical seniority (Kirch 1984). According to Fornander (1880), the Hawaiians brought from their homeland certain universal Polynesian customs and belief: the major gods Kāne, Kū, and Lono; the *kapu* (taboo) system of law and order; cities of refuge; the *‘aumakua* (family or person gods) concept; and the concept of *mana* (divine power).

The earliest inhabitants of the region emphasized the use of natural caves and overhangs, along with the construction of small, simple surface features for habitation purposes, but as populations increased and expanded, so did the occurrence of more permanent habitation structures in both the coastal and upland areas (Jensen 1994). A network of coastal and inland trails, over which the exchange of goods occurred, connected the coastal and upland population centers and resource areas (Hommon 1976). Over a period of a few centuries, the areas with the richest natural resources became populated and perhaps even crowded, and there was increasing separation of the chiefly class from the common people. As populations increased so did societal conflict, which resulted in hostility and war between neighboring groups (Kirch 1985). Soon, large areas of Hawai‘i were controlled by a few powerful chiefs.

As time passed, a uniquely Hawaiian culture developed. The portable artifacts found in archaeological sites of this next period reflect an evolution of the traditional tools and distinctly Hawaiian inventions. The adze (*ko‘i*) evolved from the typical Polynesian variations of plano-convex, trapezoidal, and reverse-triangular cross-section to a very standard Hawaiian rectangular quadrangular tanged adze. The two-piece fishhook and the octopus-lure breadloaf sinker are Hawaiian inventions of this period, as are *‘ulu maika* stones and *lei niho palaoa* (ivory pendant necklace). The latter was a status item worn by those of high rank, indicating a trend toward greater status differentiation (Kirch 1985). As the population continued to expand so did social stratification, which was accompanied by major socioeconomic changes and intensive land modification. Most of the ecologically favorable zones of the windward and coastal regions of all major islands were settled and the more marginal leeward areas were being developed. During this expansion period, additional migrations to Hawai‘i occurred from Tahiti in the Society Islands. Rosendahl (1972) has proposed that settlement at this time was related to the seasonal, recurrent occupation in which coastal sites were occupied in the summer to exploit marine resources, and upland sites were occupied during the winter months, with a focus on agriculture. An increasing reliance on agricultural products may have caused a shift in social networks as well; as Hommon (1976) argues, kinship links between coastal settlements disintegrated as those links within the *mauka-makai* (mountain-sea) settlements expanded to accommodate the exchange of agricultural products for marine resources. This shift is believed to have resulted in the establishment of the *ahupua‘a* system sometime during the A.D. 1400s (Kirch 1985), which added another component to an already well-stratified society. The implications of this model include a shift in residential patterns from seasonal, temporary occupation, to the permanent dispersed occupation of both coastal and upland areas.

The *ahupua‘a* became the equivalent of a local community, with its own social, economic, and political significance, which added another component to a then well-stratified society. *Ahupua‘a* were ruled by *ali‘i ‘ai ahupua‘a* or chiefs who controlled the *ahupua‘a* resources; who, for the most part, had complete autonomy over this generally economically self-supporting piece of land. *Ahupua‘a* lands were in turn, managed by an appointed *konohiki* or lesser chief-landlord. The *ali‘i-‘ai-ahupua‘a*, in turn, answered to an *ali‘i ‘ai moku* (chief who claimed the abundance of the entire district). Thus, *ahupua‘a* resources supported not only the *maka‘āinana* (commoners) and *‘ohana* (families) who lived on the land but also contributed to the support of the royal community of regional and/or

island kingdoms. *Ahupuaʻa* are land divisions that typically incorporated all of the eco-zones from the mountains to the sea and for several hundred yards beyond the shore, assuring a diverse subsistence resource base (Hommon 1986). Although the *ahupuaʻa* land division typically incorporated all of the eco-zones, their size and shape varied greatly. This form of district subdividing was integral to Hawaiian life and was the product of resource management planning that was strictly adhered to. In this system, the land provided fruits and vegetables and some meat for the diet, and the ocean provided a wealth of protein resources (Rechtman and Maly 2003). In communities with long-term royal residents, divisions of labor (with specialists in various occupations on land and in the procurement of marine resources) were also strictly enforced.

By the 17th century, large areas of Hawaiʻi Island were controlled by a few powerful *aliʻi ʻai moku*. There is island-wide evidence to suggest that growing conflicts between independent chiefdoms were resolved through warfare, culminating in a unified political structure at the district level. It has been suggested that the unification of the island resulted in a partial abandonment of portions of leeward Hawaiʻi, with people moving to more favorable agricultural areas (Barrera 1971; Schilt and Sinoto 1980). ʻUmi a Līloa, a renowned *aliʻi* of the Pili line, is often credited with uniting the Island of Hawaiʻi under one rule during the Precontact Period (Cordy 1994). ʻUmi-a-Līloa is also credited with formalizing the land division system on Hawaiʻi Island and separating the various classes of chiefs, priests, and laborers (Beamer 2014; Cordy 2000; Kamakau 1992). Upon the death of ʻUmi-a-Līloa, Hawaiʻi Island came under the control of his eldest son Keliʻiokāloa-A-ʻUmi (Cordy 2000), whose reign is marked by his mistreatment of the lesser chiefs and commoners. His reign was short-lived and by the early 18th century Hawaiʻi Island fell under the control of Alapaʻinui, who assembled a robust army and assigned his closest potential usurpers (his nephews Keawemaʻuhili, Kalaniʻōpuʻu, and Keōua) as generals in his militia. The prodigious ʻĪ clan, spread across the districts of Kaʻū, Puna, Hilo, and portion of Hāmākua was also a powerful force and threat to Alapaʻi campaign (Cordy 2000). As Alapaʻi gathered his forces to strike back at Kekaulike, the *aliʻi nui* of Maui, the high ranking *aliʻi wahine* (chiefess) Kekuʻiapoiwa made her way to Kokoiki, Kohala and gave birth to Paiʻea, the birth name of Kamehameha (ibid.). Kamehameha was reared in the traditions and customs of the ancient chiefs and trained under some of the most skilled warriors of that time including Kekūhaupiʻo. Upon Alapaʻi's death, his eldest son Keaweʻōpala was named heir to the kingdom. By the middle of the 18th century, the young and determined Kamehameha directed his efforts toward consolidating Hawaiʻi Island under his rule. To accomplish this monumental task, Kamehameha continued his training under his more experienced kin, namely Kalaniʻōpuʻu, who was the *aliʻi nui* of Hawaiʻi Island (ʻĪʻī 1959). During Kalaniʻōpuʻū's reign, the first foreign vessels arrived in Hawaiian waters captained by British explorer, James Cook. Cook first landed at Waimea, Kauaʻi in 1778 and in 1779, he anchored just off the shores of Kealakekua Bay, Kona. Aboard these ships were innovative technologies and diseases unknown to the inhabitants of these islands. Items such as metal, nails, guns, canons, and the large foreign vessels themselves stirred the interest of the *aliʻi* and *makaʻāinana* alike. Acquisition of these technological advancements came through barter. This resulted in the *aliʻi* gaining possession of such items that ultimately set traditional Hawaiian warfare in new trajectory; one that would be forged by none other than Kamehameha. Wars occurred regularly between intra-island and inter-island polities during this period. It was during this time of warfare that Kamehameha, who would eventually rise to power and unite all the Hawaiian Islands under one rule (Kamakau 1992).

### ʻOʻoma 1st and Kalaoa 4th-5th *ahupuaʻa* and the Greater North Kona District

The project area is located within the *ahupuaʻa* of ʻOʻoma 1st and Kaloa 4th-5th, in the district of Kona, one of six major *moku-o-loko* within the island. The district of Kona itself, extends from the shore across the entire volcanic mountain of Hualālai, and continues to the summit of Mauna Loa, where Kona is joined by the districts of Kaʻū, Hilo, and Hāmākua. One traditional reference to the northern and southern-most coastal boundaries of Kona tells us of the district's extent:

> *Mai Ke-ahu-a-Lono i ke ʻā o Kani-kū, a hōʻea i ka ʻūlei kolo o Manukā i Kaulanamauna e pili aku i Kaʻū!*—From Keahualono [the Kona-Kohala boundary] on the rocky flats of Kanikū, to Kaulanamauna next to the crawling (tangled growth of) ʻūlei bushes at Manukā, where Kona clings to Kaʻū! (*Kaʻao Hoʻoniua Puʻuwai no Ka-Miki in Ka Hōkū o Hawaiʻi*, September 13, 1917; Translated by Kepā Maly)

Kona, like other large districts on Hawaiʻi, was further divided into *ʻokana* or *kalana* (regions of land smaller than the *moku-o-loko*, yet comprising a number of smaller units of land). In the region now known as Kona ʻakau (North Kona), there are several ancient regions (*kalana*) as well. The southern portion of North Kona was known as "Kona kai ʻōpua" (interpretively translated as: Kona of the distant horizon clouds above the ocean), and included the area extending from Lanihau (the present-day vicinity of Kailua Town) to Puʻuohau (now known as Red Hill). The northern-most portion of North Kona was called "Kekaha" (descriptive of an arid coastal place). Native residents of

the region affectionately referred to their home as *Kekaha-wai-ʻole o nā Kona* (Waterless Kekaha of the Kona District), or simply as the *āina kaha*. It is within this region of Kekaha, that the lands of ʻOʻoma and Kalaoa are found.

The *ahupuaʻa* of ʻOʻoma (historically, ʻOʻoma 1st and 2nd) and Kalaoa (historically, Kalaoa 1st – 5th) are two of some twenty ancient *ahupuaʻa* within the *ʻokana* of Kekaha-wai-ʻole. The place name ʻOʻoma can be literally translated as concave. The place name Kalaoa can be literally translated as "the choker (as a stick for catching eels)" (Pukui et al. 1974:75). To date, no tradition explaining the source of the place names has been located. A few place names within ʻOʻoma were discussed in traditional accounts, thus we have some indication of the histories associated with that land.

While there are only limited native accounts that have been recorded about ʻOʻoma, we do know that the land was so esteemed, that during the youth of Kauikeaouli (later known as Kamehameha III), the young prince—son of Kamehameha I and his sacred wife Keōpūolani—was taken to be raised near the shore of ʻOʻoma under the care of his stewards from infancy until he was five years old (Kamakau 1961:263-264). This is a significant part of the history of this land, as great consideration went into all aspects of the young king's upbringing (see ʻĪʻī 1959 and Kamakau 1961).

## The Environmental Setting of ʻOʻoma and Kalaoa

The *ahupuaʻa* of ʻOʻoma and Kalaoa cross several environmental zones that are generally called *wao* in the Hawaiian language. These environmental zones include the near-shore fisheries and shoreline strand (*kahakai*) and the *kula kai/kula uka* (shoreward/inland plains). These regional zones were greatly desired as places of residence by the natives of the land.

While the *kula* region is now likened to a volcanic desert, native and historic accounts describe or reference groves of native hardwood shrubs and trees such as *ʻūlei* (*Osteomeles anthyllidifolia*), *ēlama* (*Diospyros ferrea*), *uhiuhi* (*Caesalpina kavaiensis*), and *ohe* (*Reynoldsia sandwicensis*) extending across the land and growing some distance shoreward. The few rare and endangered plants found in the region, along with small remnant communities of native dryland forest (Char 1991) give an indication that there was a significant diversity of plants growing upon the *kula* lands prior to the introduction of ungulates.

The lower *kula* lands receive only about 10 to 20 inches of rainfall annually, and it is because of their dryness, the larger region of which ʻOʻoma and Kalaoa are a part, is known as "Kekaha." While on the surface, there appears to be little or no potable water to be found, the very lava flows which cover the land contain many underground streams that are channeled through subterranean lava tubes which feed the springs, fishponds and anchialine ponds on the *kula kai* (coastal flats). Also in this region, on the flat lands, about a half-mile from the shore, is the famed *Alanui Aupuni* (Government Trail), built in 1847, at the order of Kamehameha III. This trail or government roadway was built to meet the needs of changing transportation in the Hawaiian Kingdom, and in many places it overlays the older near shore *ala loa* (ancient foot trail that encircled the island).

Continuing into the *kula uka* (inland slopes), the environment changes as elevation increases. This zone is called the *wao kanaka* (region of man) and *wao nahele* (forest region). Rainfall increases to 30 or 40 inches annually, and taller forest growth occurred. This region provided native residents with shelter for residential and agricultural uses, and a wide range of natural resources that were of importance for religious, domestic, and economic purposes. In ʻOʻoma and Kalaoa, this region is generally between the 1,200 to 2,200 foot elevation, and is crossed by the present-day Māmalahoa Highway. The highway is situated not far below the ancient *ala loa*, or foot trail, also known as Ke-alaʻehu, and was part of a regional trail system passing through Kona from Kaʻū and Kohala.

The ancient Hawaiians saw (as do many Hawaiians today) all things within their environment as being interrelated. That which was in the uplands shared a relationship with that which was in the lowlands, coastal region, and even in the sea. This relationship and identity with place worked in reverse as well, and the *ahupuaʻa* as a land unit was the thread that bound all things together in Hawaiian life. In an early account written by Kihe (in *Ka Hōkū o Hawaiʻi*, 1914-1917), with contributions by John Wise and Steven Desha Sr., the significance of the dry season in Kekaha and the custom of the people departing from the uplands for the coastal region is further described:

> *…ʻOia ka wā e neʻe ana ka lā iā Kona, hele a maloʻo ka ʻāina i ka ʻai kupakupa ʻia e ka lā, a o nā kānaka, nā liʻi o Kona, pūheʻe aku la a noho i kahakai kāhi o ka wai e ola ai nā kānaka* – It was during the season, when the sun moved over Kona, drying and devouring the land, that the chiefs and people fled from the uplands to dwell along the shore where water could be found to give life to the people. (*Ka Hōkū o Hawaiʻi*, April 5, 1917 translated by Kepā Maly)

It appears that the practice of traveling between upland and coastal communities in the ʻOʻoma and Kalaoa *ahupuaʻa* greatly decreased by the middle nineteenth century. Indeed, the only claimant for *kuleana* land in ʻOʻoma,

during the *Māhele ʻĀina* of 1848—when native tenants were allowed to lay claim to lands on which they lived and cultivated—noted that he was the only resident in ʻOʻoma at the time (see *Helu* 9162 to Kahelekahi, in this study). This is perhaps explained by the fact that at time of the *Māhele* there was a significant decline in the Hawaiian population, and changes in Hawaiian land tenure led to the relocation of many individuals from various lands.

## Native Traditions and Historical Accounts of ʻOʻoma, Kalaoa and the Kekaha Region

This section of the study presents *moʻolelo*—native traditions and historical accounts (some translated from the original Hawaiian by Kepā Maly)—of the Kekaha region that span several centuries. There are very few accounts that have been found to date, that specifically mention ʻOʻoma and Kalaoa. Thus, narratives that describe neighboring lands within the Kekaha region help provide an understanding of the history of these *ahupuaʻa*, describing features and the use of resources that were encountered on the land.

It may be that the reason there are so few accounts for ʻOʻoma, and Kalaoa is that those *ahupuaʻa* may have been considered marginal settlement areas, occupied only after the better situated lands of Kekaha—those lands with the sheltered bays, and where fresh water could be easily obtained—were populated. As the island population grew, so too did the need to expand to more remote or marginal lands. This thought is found in some of the native traditions and early historic accounts below. However, as people populated the Kekaha lands, they came to value its fisheries—those of the deep sea, near shore, and inland fishponds.

*Punia: A Tale of Sharks and Ghosts of Kekaha*

The native account of Punia (also written Puniaiki – cf. Kamakau 1964), is perhaps among the earliest accounts of the Kekaha area, and in it is found a native explanation for the late settlement of Kekaha. The following narratives are paraphrased from Fornander's *Hawaiian Antiquities and Folklore* (Fornander 1959):

> Punia was born in the district of Kohala, and was one of the children of Hina. One day, Punia desired to get lobster for his mother to eat, but she warned him of Kaiʻaleʻale and his hordes of sharks who guarded the caves in which lobster were found. These sharks were greatly feared by all who lived along, and fished the shores of Kohala for many people had been killed by the sharks. Heeding his mother's warning, Punia observed the habits of the sharks and devised a plan by which to kill each of the sharks. Setting his plan in motion, Punia brought about the deaths of all the subordinate sharks, leaving only Kaiʻaleʻale behind. Punia tricked Kaiʻaleʻale into swallowing him whole. Once inside Kaiʻaleʻale, Punia rubbed two sticks together to make a fire to cook the sweet potatoes he had brought with him. He also scraped the insides of Kaiʻaleʻale, causing great pain to the shark. In his weakened state, Kaiʻaleʻale swam along the coast of Kekaha, and finally beached himself at Alula, near the point of Maliu in the land of Kealakehe. The people of Alula, cut open the shark and Punia was released.
>
> At that time Alula was the only place in all of Kekaha where people could live, for all the rest of the area was inhabited by ghosts. When Punia was released from the shark, he began walking along the trail, to return to Kohala. While on this walk, he saw several ghosts with nets all busy tying stones for sinkers to the bottom of the nets, and Punia called out in a chant trying to deceive the ghosts and save himself:

| | |
|---|---|
| *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 koʻu 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, 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 koʻu makuakane, koe au.* | Since you are dead, father, I am the only one left. |

> Hearing Punia's wailing, the ghosts said among themselves, "Our nets will be of some use now, since here comes a man who is acquainted with this place and we will not be letting down our nets in the wrong place." They then called out to Punia, "Come here." When Punia went to the ghosts, he explained to them, the reason for his lamenting; "I am crying because of my father, this is the place where we used to fish. When I saw the lava rocks, I thought of him." Thinking to trick Punia and learn where all the kuʻuna (net fishing grounds) were, the ghosts told Punia that they would work under him. Punia went into the ocean, and one-by-one and two-by-two, he called the ghosts

> into the water with him, instructing them to dive below the surface. As each ghost dove into the water, Punia twisted the net entangling the ghosts. This was done until all but one of the ghosts had been killed. That ghost fled and Kekaha became safe for human habitation. (Fornander 1959:9-17)

One of the earliest datable accounts that describes the importance of the Kekaha region fisheries comes from the mid-sixteenth century, following ‘Umi-a-Līloa’s unification of the island of Hawai‘i under his rule. Writing in the 1860s, native historian, Samuel Mānaiakalani Kamakau (1961) told readers about the reign of ‘Umi, and his visits to Kekaha:

> ‘Umi-a-Liloa did two things with his own hands, farming and fishing...and farming was done on all the lands. Much of this was done in Kona. He was noted for his skill in fishing and was called Pu‘ipu‘i a ka lawai‘a (a stalwart fisherman). Aku fishing was his favorite occupation, and it often took him to the beaches (Ke-kaha) from Kalahuipua‘a to Makaula[1]. He also fished for ‘ahi and kala. He was accompanied by famed fishermen such as Pae, Kahuna, and all of the chiefs of his kingdom. He set apart fishing, farming and other practices… (Kamakau 1961:19-20)

In his accounts of events at the end of ‘Umi’s life, Kamakau (1961) references Kekaha once again. He records that Ko‘i, one of the faithful supporters and a foster son of ‘Umi, sailed to Kekaha, where he killed a man who resembled ‘Umi. Ko‘i then took the body and sailed to Maka‘eo in the *ahupua‘a* of Keahuolu. Landing at Maka‘eo in the night, Ko‘i took the body to the cave where ‘Umi’s body lay. Replacing ‘Umi’s body with that of the other man, Ko‘i then crossed the lava beds, returning to his canoe at Maka‘eo. From there, ‘Umi’s body was taken to its’ final resting place… (Kamakau 1961:32-33).

As a child in ca. 1812, Hawaiian historian John Papa I‘i passed along the shores of Kekaha in a sailing ship, as a part of the procession by which Kamehameha I returned to Kailua-Kona from his residency on O‘ahu. In his narratives, I‘i described the shiny lava flows and fishing canoe fleets of the “Kaha” (Kekaha) lands:

> The ship arrived outside of Kaelehuluhulu, where the fleet for aku fishing had been since the early morning hours. The sustenance of those lands was fish.
>
> When the sun was rather high, the boy [I‘i] exclaimed, “How beautiful that flowing water is!” Those who recognized it, however, said, “That is not water, but pahoehoe. When the sun strikes it, it glistens, and you mistake it for water…”
>
> Soon the fishing canoes from Kawaihae, the Kaha lands, and Ooma drew close to the ship to trade for the pa‘i‘ai (hard poi) carried on board, and shortly a great quantity of aku lay silvery-hued on the deck. The fishes were cut into pieces and mashed; and all those aboard fell to and ate, the women by themselves.
>
> 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… (‘Ī‘ī 1959:109-110)

*Ka-Lani-Kau-i-ke-Aouli (Kamehameha III)*

In ca. 1813, Ka-lani Kau-i-ke-aouli, who grew up to become Kamehameha III, was born. S.M. Kamakau (1961) tells us that the baby appeared to be still-born, but that shortly after birth, he was revived. Upon the revival of the baby, he was given to the care of Ka-iki-o-‘ewa, who with Keawe-a-mahi and family, raised the child in seclusion at ‘O‘oma for the first five years of the young king’s life. Kauikeaouli apparently held some interest in the land of ‘O‘oma 2nd through the *Māhele ‘Āina*, as he originally claimed ‘O‘oma 2nd as his personal property, but later gave it up to the Kingdom (see records of *Māhele ‘Āina* in this study).

Kamakau provides us with the following description of Kauikeaouli’s birth and early life at ‘O‘oma:

> Ka-lani-kau-i-ke-aouli was the second son of Ke-opu-o-lani by Kamehameha, and she called him Kiwala‘o after her own father. She was the daughter of Kiwala‘o and Ke-ku‘i-apo-iwa Liliha, both children of Ka-Iola Pupuka-o-Hono-ka-wai-lani, and hence she [Ke-opu-o- lani] was a *ni‘aupi‘o* and a *naha* chiefess, and the *ni‘aupi‘o* rank descended to her children and could not be lost by them. While she was carrying the child [Kau-i-ke-aouli] several of the chiefs begged to have the bringing up of the child, but she refused until her *kahu*, Ka-lua-i-konahale, known as Kua-kini, came with the same request. She bade him be at her side when the child was born lest someone else get

[1] Kalāhuipua‘a is situated in the district of Kohala, bounding the northern side of Pu‘uanahulu in Kekaha. Maka‘ula is situated a few *ahupua‘a* north of ‘O‘oma.

possession of it. He was living this side of Keauhou in North Kona, and Ke-opu-o-lani lived on the opposite side.

On the night of the birth the chiefs gathered about the mother. Early in the morning the child was born but as it appeared to be stillborn Kua-kini did not want to take it. Then came Ka-iki-o-ʻewa from some miles away, close to Kuamoʻo, and brought with him his prophet who said, "The child will not die, he will live." This man, Ka-malo-ʻihi or Ka-pihe by name, came from the Napua line of kahunas descended from Makua-kau-mana whose god was Ka-ʻonohi-o-ka-la (similar to the child of God). The child was well cleaned and laid upon a consecrated place and the seer (*kaula*) took a fan (*peʻahi*), fanned the child, prayed, and sprinkled it with water, at the same time reciting a prayer addressed to the child of God, something like that used by the Roman Catholics—

*"He is standing up, he is taking a step, he walks"*
(*Kulia-la, kaʻina-la, hele ia la*).

Or another—

| | |
|---|---|
| *Huila ka lani i ke Akua,* | The heavens lighten with the god, |
| *Lapalapa ka honua i ke keiki* | The earth burns with the child, |
| *E ke keiki e, hooua i ka punohu lani,* | O son, pour down the rain that brings the rainbow, |
| *Aia i ka lani ka Haku e,* | There in heaven is the Lord. |
| *O kuʻu ʻuhane e kahe mau,* | Life flows through my spirit, |
| *I laʻa i kou kanawai.* | Dedicated to your law. |

The child began to move, then to make sounds, and at last it came to life. The seer gave the boy the name of "The red trail" (Ke-aweawe-ʻula) signifying the roadway by which the god descends from the heavens.

Ka-iki-o-ʻewa became the boy's guardian and took him to rear in an out-of-the-way place at ʻOʻoma, Kekaha. Here Keawe-a-mahi, the lesser chiefs, the younger brothers and sisters of Ka-iki-o-ʻewa, and their friends were permitted to carry the child about and hold him on their laps (*uha*). Ka-pololu was the chief who attended him; Koʻi-pepeleleu and Ulu-nui's mother [were] the nurses who suckled him. Later Ka-ʻai-kane gave him her breast after she had given birth to Ke-kahu-puʻu. Here at ʻOʻoma he was brought up until his fifth year, chiefly occupied with his toy boats rigged like warships and with little brass cannon loaded with real powder mounted on [their] decks. The firing off of these cannon amused him immensely. He excelled in foot races. On one occasion when the bigger boys had joined in the sport, a [rascal] boy named Ka-hoa thought to play a practical joke by smearing with mud the stake set up to be grasped by the one who first reached the goal. He expected one of the larger boys to be the winner, but it was the little prince who first caught the stick and had his hands smeared. "You will be burnt alive for dirtying up the prince. We are going to tell Ka-pololu on you!" the boys threatened; but the prince objected, saying, "Anyone who tells on him shall never eat with me again or play with me and I will never give him anything again." Kau-i-ke-aouli was a splendid little fellow. He loved his playmates and never once did them any hurt, and he was kind and obedient to his teachers… (Kamakau 1961:263-264)

*"Kaao Hooniua Puuwai no Ka-Miki" (The Heart stirring Story of Ka-Miki)*

It is not until the early twentieth century, that we find a few detailed native accounts which tell of traditional features and residents of ʻOʻoma, Kalaoa, and the vicinity. The writings of John Whalley Hermosa Isaac Kihe, a native son of Kekaha, in Hawaiian language newspapers (translated by Kepā Maly from the original Hawaiian texts), share the history of the land and sense the depth of attachment that native residents felt for ʻOʻoma, Kalaoa, and the larger Kekaha-wai-ʻole-o-nā-Kona.

Kihe (who also wrote under the name of Ka-ʻohu-haʻaheo-i-nā-kuahiwi-ʻekolu) was born in 1853, his parents were native residents of Honokōhau and Kaloko (his grandfather, Kuapāhoa, was a famed *kahuna* of the Kekaha lands). During his life, Kihe taught at various schools in the Kekaha region; served as legal counsel to native residents applying for homestead lands in ʻOʻoma and vicinity; worked as a translator on the Hawaiian Antiquities collections of A. Fornander; and was a prolific writer himself. In the later years of his life, Kihe lived at Puʻu Anahulu and Kalaoa, and he is fondly remembered by elder *kamaʻāina* of the Kekaha region. Kihe, who died in 1929, was also one of the primary informants to Eliza Maguire, who translated some of the writings of Kihe, publishing them in abbreviated form in her book "Kona Legends" (1926).

Writers today have varying opinions and theories pertaining to the history of Kekaha, residency patterns, and practices of the people who called Kekaha-wai-ʻole-o-nā-Kona home. For the most part, our interpretations are limited by the fragmented nature of the physical remains and historical records, and by a lack of familiarity with the diverse qualities of the land. As a result, most of us only see the shadows of what once was, and it is difficult at times, to comprehend how anyone could have carried out a satisfactory existence in such a rugged land.

Kihe and his co-authors provide readers with several references to places and events in the history of ʻOʻoma, Kalaoa, and neighboring lands. Through the narratives, we learn of place name origins, areas of ceremonial significance, how resources were managed and accessed, and the practices of those native families who made this area their home.

One example of the rich materials recorded by native writers, is found in "*Kaʻao Hoʻoniua Puʻuwai no Ka-Miki*" (The Heart Stirring Story of Ka-Miki). This tradition is a long and complex account, that was published over a period of four years (1914-1917) in the weekly Hawaiian-language newspaper *Ka Hōkū o Hawaiʻi*. The narratives were primarily recorded for the paper by Hawaiian historians John Wise and J.W.H.I. Kihe.

While "*Ka-Miki*" is not an ancient account, the authors used a mixture of local stories, tales, and family traditions in association with place names to tie together fragments of site-specific histories that had been handed down over the generations. Also, while the personification of individuals and their associated place names may not be entirely "ancient," such place name-person accounts are common throughout Hawaiian (and Polynesian) traditions. The English translations below are a synopsis of the Hawaiian texts, with emphasis upon the main events and areas being discussed. Diacritical marks and hyphenation have been placed to help with pronunciation of certain words.

This *moʻolelo* (tradition) is set in the 1300s (by association with the chief Pili-a-Kaʻaiaea), and is an account of two supernatural brothers, Ka-Miki (The quick, or adept, one) and Ma-Kaʻiole (Rat [squinting] eyes). The narratives describe the birth of the brothers, their upbringing, and their journey around the island of Hawaiʻi along the ancient *ala loa* and *ala hele* (trails and paths) that encircled the island. During their journey, the brothers competed alongside the trails they traveled, and in famed *kahua* (contest fields) and royal courts, against *ʻōlohe* (experts skilled in fighting or in other competitions, such as running, fishing, debating, or solving riddles, that were practiced by the ancient Hawaiians). They also challenged priests whose dishonorable conduct offended the gods of ancient Hawaiʻi. Ka-Miki and Ma-Kaʻiole were empowered by their ancestress Ka-uluhe-nui-hihi-kolo-i-uka (The great entangled growth of uluhe fern which spreads across the uplands), who was one of the myriad of body forms of the goddess Haumea, the earth-mother, creative force of nature who was also called Papa or Hina. Among her many nature-form attributes were manifestations that caused her to be called upon as a goddess of priests and competitors (people, places named for them, and other place names are marked below with underlining):

> …Kūmua was the husband of Ka-uluhe-nui-hihi-kolo-i-uka. The place that is named for Kūmua is in the uplands of Kohanaiki, an elevated rise from where one can look towards the lowlands. The shore and deep sea are all clearly visible from this place. The reason that Kūmua dwelt there was so that he could see the children and grandchildren of he and his wife.
>
> Wailoa, a daughter, was the mother of Kapaʻihilani, also called Kapaʻihi. There is a place in the uplands of Kohanaiki, below Kūmua, to the northwest, a hidden water hole, that is called Kapaʻihi. Wailoa is a pond there on the shore of Kohanaiki. Because Wailoa married Kahunakalehu, a native of the area, she lived and worked there. Thus the name of that pond is Wailoa, and it remains so to this day.
>
> Pipipiʻapoʻo was another daughter of Kūmua and Ka-uluhe-nui-hihi-kolo-i-uka. She married Haleolono, one who cultivated sweet potatoes upon the *ʻilima* covered flat lands of Nānāwale, also called Nāhiʻahu (Nāwahʻiahu), as it has been called from before and up to the present time. Cultivating the land was the skill of this youth Haleolono, and because he was so good at it, he was able to marry the beauty, Pipipiʻapoʻo.
>
> Pipipiʻapoʻo's skill was that of weaving pandanus mats, and there are growing many pandanus trees there, even now. The grove of pandanus trees and a nearby cave, is called Pipipiʻapoʻo to this day, and you may ask the natives of Kohanaiki to point it out to you.
>
> Kapukalua was a son of Kūmua and Kaʻuluhe. He was an expert at *aku* lure fishing, and all other methods of fishing of those days gone by. He married Kauhiʻonohua a beauty with skin as soft as the blossoms of the *hīnano*, found in the pandanus grove of ʻOʻoma. This girl was pleasingly beautiful, and because of her fame, Kapukalua, the exceptionally skilled son of the sea spray of ʻApoʻula, secured her as his wife. Here, we shall stop speaking of the elders of Ka-Miki… [January 8, 1914]

The tradition continues, recounting the training of the brothers, and preparations of their *hālau ali‘i* (royal compound) at Kohanaiki. At the dedication ceremonies it was revealed that one of the *kahuna* of the Kaha lands, had taken up the habit of killing people, and that he had also thought to take the lives of Ka-Miki and Ma-Ka‘iole. We revisit the story here, and learn the name of a priest of ‘O‘oma and Kohanaiki—

> …The sun broke forth and the voices of the roosters and the *‘elepaio* of the forests were heard resonating and rising upon the mountain slopes. The day became clear, with no clouds to be seen, it was calm. So too, the ocean was calm and the shore of La‘i a ‘Ehu (Kona) was calm. The flowers of the upland forest reddened and unfolded, and nodded gently in the *kēhau* breezes.
>
> The priests gathered together to discuss these events and prepared to apologize to the children of the chief, asking for their forgiveness. They selected ‘Elepaio, Pūhili, Kalua‘ōlapa, and Kalua-‘ōlapa-uwila to go before the brothers for this purpose.
>
> ‘Elepaio was the high priest of Honokōhau. The place where he dwelt bears the name ‘Elepaio [an *‘ili* on the boundary of Honokōhau nui & iki]. It is in the great grove of *‘ulu (kaulu ‘ulu)* on the boundary between Honokōhau-nui and Honokōhau-iki… [April 23, 1914]
>
> Pūhili 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 high priest of Hale‘ōhi‘u and Kamāhoe, that is the waterless land of Kalaoa (Kalaoa wai ‘ole). The place where he lived was in the uplands of Maulukua on the plain covered with *‘ilima* growth. This place bears his name to this day.
>
> Kalua-‘ōlapa-uwila was the high priest of Kealakehe and Ke‘ohu‘olu (Keahuolu), and it was he who built the *heiau* named Kalua-‘ōlapa-uwila, which is there along the shore of Kealakehe, next to the road that goes to Kailua. The nature of this priest was that of a shark and a man. The shark form was named Kaiwi, and there is a stone form of the shark that can be seen near the *heiau* to this day.
>
> These priests all went to the door of the house and presented the offerings of the black pig, the red fish, the black *‘awa*, the white rooster, the *malo* (loin clothes), and all things that had been required of their class of priests. They also offered their prayers and asked forgiveness for their misspoken words. They then called for their prayers to be freed and the *kapu* ended… [April 30, 1914]

*Ka Punawai o Wawaloli (The Pond of Wawaloli)*

Through the 1920s, up to the time of his death in 1929, J.W.H.I. Kihe continued to submit traditional accounts and commentary on the changing times to the paper, *Ka Hōkū o Hawai‘i*. In 1923, Kihe penned a series of articles, some of which formed the basis of Eliza Maguire's *Kona Legend*s (1926). One of the accounts, "*Ka Punawai o Wawaloli*" (The Pond of Wawaloli), describes that the pond of Wawaloli, on the shore of ‘O‘oma, was named for a supernatural ocean being, who could take the form of the *loli* (sea cucumber) and of a handsome young man. Through this account it is learned that people regularly traveled between the uplands and shore of ‘O‘oma; the *kula* lands were covered with *‘ilima* growth; and that a variety of fish, seaweeds, and shellfish were harvested along the shore. Also, the main figures in the tradition are memorialized as places on the lands of ‘O‘oma, Kalaoa, and neighboring *ahupua‘a*. These individuals and places include Kalua‘ōlapa (a hill on the boundary of Hāmanamana and Haleohi‘u), Wawaloli (a bay between ‘O‘oma and Kalaoa), Ho‘ohila (on the boundary of Kaū and Pu‘ukala), Pāpa‘apo‘o (a cave site in Hāmanamana), Kamakaoiki and Malumaluiki (locations unknown). The following narratives were translated by Kepā Maly from the original Hawaiian texts published in *Ka Hōkū o Hawai‘i* (September 23rd, October 4th & 11th, 1923):

> The place of this pond (Wawaloli) is set there on the shore of ‘O‘oma near Kalaoa. It is a little pond, and is there to this day. It is very close to the sandy shore, and further towards the shore there is also a pond in which one can swim. There is a tradition of this pond, that is held dearly in the hearts of the elders of this community.
>
> Wawaloli is the name of a *loli* (sea cucumber) that possessed dual body forms (*kino pāpālua*), that of a *loli*, and that of a man!
>
> Above there on the *‘ilima* covered flat lands, there lived a man by the name of Kalua‘ōlapa and his wife, Kamakaoiki, and their beautiful daughter, Malumaluiki.
>
> One day the young maiden told her mother that she was going down to the shore to gather *limu* (seaweeds), *‘ōpihi* (limpets), and *pupu* (shellfish). Her mother consented, and so the maiden traveled to the shore. Upon reaching the shore, Malumaluiki desired to drink some water, so she visited the

pond and while she was drinking she saw a reflection in the rippling of the water, standing over her. She turned around and saw that there was a handsome young man there, with a smile upon his face. He said… [September 27, 1923] "…Pardon me for startling you here as we meet at this pond, in the afternoon heat which glistens off of the pāhoehoe."

She responded, "What is the mistake of our meeting, you are a stranger, and I am a stranger, and so we have met at this pond." The youth, filled with desire for the beautiful young maiden, answered "I am not a stranger here along this shore, indeed, I am very familiar with this place for this is my home. And when I saw you coming here, I came to meet you."

These two strangers, having thus met, then began to lay out their nets to catch *kala*, *uhu*, and *pālani*, the native fish of this land. And in this way, the beauty of the plains of Kalaoa was caught in the net of the young man who dwelt in the sea spray of ʻOʻoma.

These two strangers of the long day also fished for *hīnālea*, and then for *kawele ʻā*. It was during this time, that their lines became entangled like those of the fishermen of Wailua (a poetic reference to those who become entangled in a love affair).

The desire for the *limu*, *ʻōpihi*, and *pūpū* was completely forgotten, and the fishing poles bent as the lines were pulled back in the sea spray. The handsome youth was moistened in the rains that fell, striking the land and the beloved shore of the land. The sun drew near, entering the edge of the sea and was taken by Lehua Island. Only then did these two fishers of the long day take up their nets.

Before the young maiden began her return to the uplands, she told the youth, "Tell me your name." He answered her, "The name by which I am known is Wawa. But my name, when I go and dwell in the pond here, is Loli. And when you return, you may call to me with the chant:

| | |
|---|---|
| *E Loli nui kīkewekewe*[2] | Oh great Loli moving back and forth |
| *I ka hana ana kīkewekewe* | Doing your work moving back and forth |
| *I kuʻu piko kīkewekewe* | You are in my mind moving back and forth |
| *A ka makua kīkewekewe* | The parents moving back and forth |
| *I hana ai kīkewekewe* | Are at their work moving back and forth |
| *E piʻi mai ʻoe kīkewekewe* | Won't you arise moving back and forth |
| *Ka kaua puni kīkewekewe* | To that which we two desire moving back and forth |
| *Puni kauoha kīkewekewe* | Your command is desired moving back and forth |

Having finished their conversation, the maiden then went to the uplands. It was dark, and the *kukui* lamps had been lit in the house. Malumaluiki's parents asked her, "Where are your limu, *ʻōpihi* and *pūpū*?" She replied, "It is proper that you have asked me, for when I went to the shore it was filled with people who took all there was? Thus I was left with nothing, not even a fragment of *limu* or anything else. So I have returned up here."

Well, the family meal had been made ready, so they all sat to eat together. But after a short while the maiden stood up. Her parents inquired of this, and she said she was no longer hungry, and that her feet were sore from traveling the long path. So the maiden went to sleep. She did not sleep well though, and felt a heat in her bosom, as she was filled with desire, thus she had no sleep that night.

With the arrival of the first light of day, the Malumaluiki went once again down to the shore. Upon arriving at the place of the pond, she entered the water and called out as described above. Then, a *loli* appeared and turned into the handsome young man. They two then returned to their fishing for the *kala*, *uhu* and *pālani*, the native fish the land.

So it was that the two lovers met regularly there on the shore of ʻOʻoma. Now Malumaluiki's parents became suspicious because of the actions of the daughter, and her regular trips to the shore. So they determined that they should secretly follow her and spy on her.

One day, the father followed her to the shore, where he saw his daughter sit down by the side of the pond. He then heard her call out —

| | |
|---|---|
| *E Loli nui kīkewekewe* | Oh great Loli moving back and forth |

[2]"Kīkewekewe" is translated by Eliza Maguire (1926) as "charmer." Kepā Maly was unfamiliar with this meaning of the word. It is most commonly used in the refrain of a song, and is here translated as "moving back and forth," as the word is used in the spoken language. Kewe also means concave, similar to the place name ʻOʻoma.

| | |
|---|---|
| *I ka hana ana kīkewekewe* | Doing your work moving back and forth |
| *I ku'u piko kīkewekewe* | You are the center of my life moving back and forth |
| *Piko maika'i kīkewekewe* | It is good moving back and forth |
| *A ka makua kīkewekewe* | The parents moving back and forth |
| *I hana ai kīkewekewe* | Are at their work moving back and forth |
| *E pi'i mai 'oe kīkewekewe* | Won't you arise moving back and forth |
| *Ka kaua puni kīkewekewe* | To that which we two desire moving back and forth |
| *Puni kauoha kīkewekewe* | Your command is desired moving back and forth |

[October 4, 1923]

"O Loli, here is your desire, the one you command, Malumaluiki, who's eyes see nothing else."

Her father then saw a *loli* coming up from the pond, and when it was up, it turned into the youth. He watched the two for a while, unknown to them, and saw that his daughter and the youth of the two body forms (*kino pāpālua*), took their pleasure in one another.

The father returned to the uplands and told all of this to her mother, who upon hearing it, was filled with great anger, because of the deceitfulness of her daughter. But then she learned that the man with whom her daughter slept was of dual body forms. Kamakaoiki then told Kalua'ōlapa that he should "Go down and capture the *loli*, and beat it to death," to which he agreed.

One day, Kalua'ōlapa went down early, and hid, unseen by the two lovers. Malumaluiki arrived at the pond and called out, and he then memorized the lines spoken by his daughter. When she left, returning to the uplands, he then went to the pond and looked closely at it. He then saw a small circular opening near the top of the water in the pond. He then understood that that was where the *loli* came up from. He then slept that night and in the early morning, he went to the pond and set his net in the water. He then began to call out as his daughter had done with the above words.

When he finished the chant, the *loli* began to rise up through the hole, and was ensnared in the net. Kalua'ōlapa then carried him up onto the *kula*, walking to the uplands. On his way, he saw his daughter coming down, and he hid until she passed him by.

When the daughter arrived at the pond, she called out in the chant as she always did. She called and called until the sun was overhead, but the *loli* did not appear in the pond, nor did he come forward in his human form. Thus, she thought that he had perhaps died, and she began to wail and mourn for the loss of her lover. Finally as evening came, the beautiful maiden stood, and ascended the *kula* to her home.

Now, let us look back to the Kalua'ōlapa. He went up to his house and showed the *loli* to his wife. Seeing the *loli*, she told her husband, "Take it to the *kahuna*, Pāpa'apo'o who lives on the *kula* of Ho'ohila." So he went to the *kahuna* and explained everything that had occurred to him, and showed him the *loli* in his net. Seeing this and hearing of all that had happened, Pāpa'apo'o told the father to build an *imu* in which to *kālua* the great *loli* that moves back and forth (*loli kīkewekewe*). He said, "When the *loli* is killed, then your daughter will be well, so too will be the other daughters of the families of the land." Thus, the *imu* was lit and the supernatural *loli* cooked.

When the daughter returned to her home, her eyes were all swollen from crying. Her mother asked her, "What is this, that your eyes are puffy from crying, my daughter?" She didn't answer, she just kneeled down, giving no response. At that time, her father returned to the house and saw his daughter kneeling down, and he said "Your man, with whom you have been making love at the beach has been taken by the *kahuna* Pāpa'apo'o. He has been cooked in the *imu* that you may live, that all of the girls who this *loli* has loved may live."

That pond is still there on the shore, and the place with the small round opening is still on the side of that pond to this day. It is something to remember those things of days gone by, something that should not be forgotten by those of today and in time to come. [October 11, 1923]

*Ka Loko o Paaiea (The fishpond of Pā'aiea)*

The tradition of *Ka loko o Paaiea* (The fishpond of Pā'aiea) was written by J.W.H.I. Kihe, and printed in *Ka Hōkū o Hawai'i* in 1914 and 1924. The narratives describe traditional life and practices in various *ahupua'a* of Kekaha, and specifically describes the ancient fishpond Pā'aiea. The following excerpts from Kihe's *mo'olelo*, include references to Wawaloli, on the shore of 'O'oma and Kalaoa. Pā'aiea, was destroyed by the Hualālai lava flows of 1801, reportedly as a result of the pond overseer's refusal to give the goddess Pele—traveling in human form—any fish from the pond:

> Pāʻaiea was a great fishpond, something like the ponds of Wainānāliʻi and Kīholo, in ancient times. At that time the high chiefs lived on the land, and these ponds were filled with fat *awa*, *ʻanae*, *āhole*, and all kinds of fish that swam inside. It is this pond that was filled by the lava flows and turned into *pāhoehoe*, that is written of here. At that time, at Hoʻonā, there was a *Konohiki* (overseer), Kepaʻalani, who was in charge of the houses (*hale papaʻa*) in which the valuables of the King [Kamehameha I] were kept. He was in charge of the King's food supplies, the fish, the *hālau* (long houses) in which the fishing canoes were kept, the fishing nets and all things. It was from there that the King's fishermen and the retainers were provisioned. The houses of the pond guardians and *Konohiki* were situated at Kaʻelehuluhulu and Hoʻonā.
>
> In the correct and true story of this pond, we see that its boundaries extended from Kaʻelehuluhulu on the north, and on the south, to the place called Wawaloli (between ʻOʻoma and Kalaoa). The pond was more than three miles long and one and a half miles wide, and today, within these boundaries, one can still see many water holes.
>
> While traveling in the form of an old woman, Pele visited the Kekaha region of Kona, bedecked in garlands of the *koʻokoʻolau* (*Bidens* spp.). Upon reaching Pāʻaiea at Hoʻonā, Pele inquired if she might perhaps have an *ʻamaʻama*, young *āholehole*, or a few *ʻōpae* (shrimp) to take home with her. Kepaʻalani, refused, "they are *kapu*, for the King." Pele then stood and walked along the *kuapā* (ocean side wall) of Pāʼaiea till she reached Kaʻelehuluhulu. There, some fishermen had returned from *aku* fishing, and were carrying their canoes up onto the shore…
>
> …Now because Kepaʻalani was stingy with the fishes of the pond Pāʻaiea, and refused to give any fish to Pele, the fishpond Pāʻaiea and the houses of the King were all destroyed by the lava flow. In ancient times, the canoe fleets would enter the pond and travel from Kaʻelehuluhulu to Hoʻonā, at Uaʻuʻālohi, and then return to the sea and go to Kailua and the other places of Kona. Those who traveled in this manner would sail gently across the pond pushed forward by the ʻ*Eka* wind, and thus avoid the strong currents which pushed out from the point of Keāhole
>
> It was at Hoʻonā that Kepaʻalani dwelt, that is where the houses in which the chiefs valuables (*hale papaʻa*) were kept. It was also one of the canoe landings of the place. Today, it is where the light house of America is situated. Pelekāne (in Puʻukala) is where the houses of Kamehameha were located, near a stone mound that is partially covered by the *pāhoehoe* of Pele. If this fishpond had not been covered by the lava flows, it would surely be a thing of great wealth to the government today… [J.W.H.I. Kihe in *Ka Hoku o Hawaii*; compiled and translated by Kepā Maly, from the narratives written February 5-26, 1914 and May 1-15, 1924].

*Na Hoʻomanao o ka Manawa (The Recollections of a Native Son)*

Later in 1924, Kihe described the changes which had occurred in the Kekaha region since his youth. In the following article, titled *Na Hoʻomanao o ka Manawa* (in *Ka Hōkū o Hawaiʻi* June 5th & 12th 1924), Kihe wrote about the villages that were once inhabited throughout Kekaha, identifying families, practices, and schools of the historic period (ca. 1860-1924). In the two part series (translated by Kepā Maly), he also shared his personal feelings about the changes that had occurred, including the demise of the families and the abandonment of the coastal lands of Kekaha.

> There has arisen in the mind of the author, some questions and thoughts about the nature, condition, living, traveling, and various things that bring pleasure and joy. Thinking about the various families and the many homes with their children, going to play and strengthening their bodies.
>
> In the year 1870, when I was a young man at the age of 17 years old, I went to serve as the substitute teacher at the school of Honokōhau. I was teaching under William G. Kanakaʻole who had suffered an illness (*maʻi-lolo*, a stroke).
>
> In those days at the Hawaiian Government Schools, the teachers were all Hawaiian and taught in the Hawaiian language. In those days, the students were all Hawaiian as well, and the books were in Hawaiian. The students were all Hawaiian… There were many, many Hawaiian students in the schools, no Japanese, Portuguese, or people of other nationalities. Everyone was Hawaiian or part Hawaiian, and there were only a few part Hawaiians.
>
> The schools included the school house at Kīholo where Joseph W. Keala taught, and later J.K. Kaʻailuwale taught there. At the school of Makalawena, J. Kaʻelemakule Sr., who now resides in Kailua, was the teacher. At the Kalaoa School, J. U. Keaweʻake was the teacher. There were also others here, including myself for four years, J. Kainuku, and J.H. Olohia who was the last one to

teach in the Hawaiian language. At Kaloko, Miss Kaʻaimahuʻi was the last teacher before the Kaloko school was combined as one with the Honokōhau school where W.G. Kanakaʻole was the teacher. I taught there for two years as well... [Kihe includes additional descriptions on the schools of Kona]

It was when they stopped teaching in Hawaiian, and began instructing in English, that significant changes took place among our children. Some of them became puffed up and stopped listening to their parents. The children spoke gibberish (English) and the parents couldn't understand (*nā keiki namu*). Before that time, the Hawaiians weren't marrying too many people of other races. The children and their parents dwelt together in peace with the children and parents speaking together… [June 5, 1924]

…Now perhaps there are some who will not agree with what I am saying, but these are my true thoughts. Things which I have seen with my own eyes, and know to be true…In the year 1870 when I was substitute teaching at Honokōhau for W.G. Kanakaʻole, I taught more than 80 students. There were both boys and girls, and this school had the highest enrollment of students studying in Hawaiian at that time [in Kekaha]. And the students then were all knowledgeable, all knew how to read and write.

Now 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 (*ʻāpana*) land sections of Kekaha.

From the lands of Honokōhau, Kaloko, Kohanaiki, the lands of ʻOʻoma, Kalaoa, Haleʻohiʻu, Makaʻula, Kaū, Puʻukala-ʻŌhiki, Awalua, the lands of Kaulana, Mahaiʻula, Makalawena, Awakeʻe, the lands of Kūkiʻo, Kaʻūpūlehu, Kīholo, Keawaiki, Kapalaoa, Puʻuanahulu, and Puʻuwaʻawaʻa. 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. Haʻau, remains. He is the only native child (*keiki kupa)* besides this author, who remains.

At Kohanaiki, there were many people on this land between 1870 and 1878. These were happy years with the families there. In those years Kaiakoili was the *haku ʻāina* (land overseer)...

Now the land is desolate, there are no people, the houses are quiet. Only the houses remain standing, places simply to be counted. I dwelt here with the families of these homes. Indeed it was here that I dwelt with my *kahu hānai* (guardian), the one who raised me. All these families were closely related to me by blood. On my fathers' side, I was tied to the families of Kaloko [J.W.H.I. Kihe's father was Kihe, his grandfather was Kuapāhoa, a noted *kahuna* of Kaloko]. I am a native of these lands.

The lands of ʻOʻoma, and Kalaoa, and all the way to Kaulana and Mahaiʻula were also places of many people in those days, but today there are no people. At Mahaiʻula is where the great fishermen of that day dwelt. Among the fishermen were Poʻokoʻai mā, Pāʻaoʻao senior, Kaʻao mā, Kaiʻa mā, Kaʻāʻīkaula mā, Pāhia mā, and John Kaʻelemakule Sr., who now dwells at Kailua.

Kaʻelemakule moved from this place [Mahaiʻula] to Kailua where he prospered, but his family is buried there along that beloved shore (*kapakai aloha*). He is the only one who remains alive today… At Makalawena, there were many people, men, women, and their children. It was here that some of the great fishermen of those days lived as well. There were many people, and now, they are all gone, lost for all time.

Those who have passed away are Kahaʻialiʻi mā, Mamaʻe mā, Kapehe mā, Kauaionuʻuanu mā, Hopulāʻau mā, Kaihemakawalu mā, Kaomi, Keoni Aihaole mā, and Pahukula mā. They are all gone, there only remains the son-in-law of Kauaionuʻuanu, J.H. Mahikō, and Jack Punihaole, along with their children, living in the place where Kauaionuʻuanu and Ahu once lived.

> At Kūkiʻo, not one person remains alive on that land, all are gone, only the *ʻaʻā* remains. It is the same at Kaʻūpūlehu, the old people are all gone, and it is all quiet… [June 12, 1924]

*Ko Keoni Kaelemakule Moolelo Ponoi – Kakau ponoi ia mai no e ia (The True Story of John Kaʻelemakule – Actually written by him[3])*

In the period between 1928 and 1930, John Kaʻelemakule Sr., who was a native of Kekaha, living at Mahaiʻula, Kaulana and Kohanaiki, wrote a series of articles that were published in serial form in *Ka Hōkū o Hawaiʻi*. The story is a rich account of life in Kekaha between 1854 and 1900. Kaʻelemakule's texts introduce us to the native residents of Kekaha, and include descriptions of the practices and customs of the families who resided there. In the following excerpts from Kaʻelemakule's narratives (translated by Kepā Maly), we find reference once again to ʻOʻoma, Kalaoa, and neighboring lands, and the practices associated with procuring water in this region:

> "*Kekaha Wai Ole o na Kona*" (Waterless Kekaha of Kona)
>
> …We have seen the name "Kekaha wai ole o nā Kona" since the early part of my story in *Ka Hōkū o Hawaiʻi*, and we have also seen it in the beautiful tradition of Mākālei. An account of the boy who dwelt in the uplands of Kekaha *wai ʻole*, that was told by Ka-ʻohu-haʻaheo-i-nā-kuahiwi-ʻekolu [the penname used by J.W.H.I. Kihe]. I think that certain people may want to know the reason and meaning of this name. So it is perhaps a good thing for me to explain how it came about. The source of it is that in this land of Kekaha even in the uplands, between Kaulana in the north and ʻOʻoma in the south, there was no water found even in the ancient times. For a little while, I lived in the uplands of Kaulana, and I saw that this land of Kekaha was indeed waterless.
>
> The water for bathing, washing one's hands or feet, was the water of the banana stump (*wai pūmaʻia*). The *pūmaiʻa* was grated and squeezed into balls to get the juice. The problem with this water is that it makes one itchy, and one does not really get clean. 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… [September 17, 1929:3]
>
> …The *kūpuna* 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 (Kaneikawaiola) 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 ʻole believed, and there were people who were *kiaʻi* (guardians) who watched over and cleaned the caves, the house of Kāne… [September 24, 1929:3]
>
> When the *kapu* of the water cave had been broken, the priest was called to perform a ceremony and make offerings. The offerings were a small black pig; a white fish, and *āholehole*; young taro leaves; and *awa*. When the offering was prepared, the priest would chant to Kane:
>
> | | |
> |---|---|
> | *E Kane i uka, e Kane i kai,* | O Kane in the uplands, O Kāne at the shore, |
> | *E Kane i ka wai, eia ka puaa,* | O Kane in the water, here is the pig, |
> | *Eia ka awa, eia ka luau,* | Here is the *ʻawa*, here are the taro greens, |
> | *Eia ka ia kea.* | Here is the white fish. |
>
> Then all those people of the uplands and coast joined together in this offering, saying:
>
> | | |
> |---|---|
> | *He mohai noi keia ia oe e Kane,* | This is a request offering to you o Kāne, |

[3] This account was published in serial form in the Hawaiian newspaper *Ka Hōkū o Hawaiʻi*, from May 29, 1928 to March 18, 1930. The translated excerpts in this section include narratives that describe Mahaiʻula and nearby lands in Kekaha with references to families, customs, practices, ceremonial observances, and sites identified in text. The larger narratives also include further detailed accounts of Kaʻelemakule's life, and business ventures. A portion of the narratives pertaining to fishing customs (November 13, 1928 to March 12, 1929), and canoeing practices (March 19 to May 21, 1929) were translated by M. Kawena Pukui, and may be viewed in the Bishop Museum-Hawaiian Ethnological Notes (BPBM Archives).

| | |
|---|---|
| *E kala i ka hewa o ke kanaka i hana ai,* | Forgive the transgression done by man, |
| *A e hoomaemae i ka hale wai,* | Clean the water house (source), |
| *A e hoonui mai i ka wai o ka hale,* | Cause the water to increase in the house, |
| *I ola na kanaka,* | That the people may live, |
| *Na ohua o keia aina wai ole.* | Those who are dependent on this waterless land. |
| *Amama.* | It is finished… |

[October 1, 1929:3; Kepā Maly, translator]

It is not surprising today, when we hear of caves in which cultural materials are found. Along trails, near residences, and in once remote areas, a wide range of uses occurred. Caves in the Kekaha lands were used to store items, keep planting shoots cool and fresh for the next season, to hide or take shelter in, to catch water, and for burial.

## Land Tenure in ‘O‘oma, Kalaoa, and Vicinity

Through the traditions and early historical accounts cited above, we see that there are descriptions of early residences and practices of the native families on the lands of ‘O‘oma, Kalaoa, and within greater Kekaha. Importantly, we find chiefly associations with the land of ‘O‘oma 2nd, as documented by the residency of the chiefs Kaikio‘ewa, Keaweamahi, their families and retainers, while they were serving as the guardians of the young king, Kauikeaouli (Kamehameha III in ca. 1813-1818; Kamakau 1961 and Gov. Kapeau, 1847 in this study). Among the earliest government records documenting residency are those of the *Māhele ‘Āina* (Land Division), Interior and Taxation Departments, Roads and Public Works, and the Government Survey Division.

This section of the study describes land tenure (residency and land use) and identifies families associated with ‘O‘oma, Kalaoa, and its neighboring lands. The documentation is presented chronologically within the following subsections, The *Māhele ‘Āina* (1848): Disposition of ‘O‘oma and Kalaoa, Land Grants in ‘O‘oma, Kalaoa, and Vicinity (1855-1864), Summary of Land Tenure Described in Grant Records, The Government Homesteading Program in Kekaha, Field Surveys of J.S. Emerson (1882-1889), The Kalaoa-‘O‘oma Homesteads, and Twentieth Century Land Tenure in the Vicinity of the Current Study Area. A review of the records below reveals that none of the claims by native tenants made during the *Māhele*, nor any of the purchases of Royal Patent Grants, included lands that are a part of the current study area.

*The Māhele ‘Āina (1848): Disposition of ‘O‘oma and Kalaoa*

In Precontact Hawai‘i, all land, ocean, and natural resources were held in trust by the high chiefs (*ali‘i ‘ai ahupua‘a* or *ali‘i ‘ai moku*). The use of land, fisheries and other resources were given to the *hoa‘āina* (native tenants) at the prerogative of the *ali‘i* and their representatives or land agents (*konohiki*), who were considered lesser chiefs. By 1845, the Hawaiian system of land tenure was being radically altered, and the foundation for implementing the *Māhele ‘Āina* was set in place, a system of fee-simple right of ownership.

As the *Māhele* evolved, it defined the land interests of Kauikeaouli (King Kamehameha III), some 252 high-ranking *Ali‘i* and *Konohiki*, and the Government. As a result of the *Māhele*, all land in the Kingdom of Hawai‘i came to be placed in one of three categories: (1) Crown Lands (for the occupant of the throne); (2) Government Lands; and (3) *Konohiki* Lands (cf. Indices of Awards 1929). The “Enabling” or “*Kuleana Act*” of the *Māhele* (December 21, 1849) further defined the frame work by which *hoa‘āina* (native tenants) could apply for, and be granted fee-simple interest in “*Kuleana*” lands (cf. Kamakau in *Ke Au Okoa* July 8 & 15, 1869; 1961:403-403). The *Kuleana Act* also reconfirmed the rights of *hoa‘āina* to access, subsistence and collection of resources necessary to their life upon the land in their given *ahupua‘a* (“Enabling Act”[4], August 6, 1850 – HSA DLNR 2-4).

In the *Buke Kakau Paa no ka Mahele Aina* (Land Division Book), between Kamehameha III and his supporters, we learn that by the time of the *Māhele ‘Āina*, ‘O‘oma was divided into two *ahupua‘a*, ‘O‘oma 1st and 2nd; and Kalaoa into five *ahupua‘a*, Kalaoa 1st through 5th. During the *Māhele*, Kalaoa 1st–5th and ‘O‘oma 2nd were held by Kamehameha III, and then subsequently assigned to the Government land inventory on March 8, 1848. All but Kalaoa 5th, which is not listed in the *Māhele* Book[5], were returned to Kamehameha III by the various *Konohiki* (Table 1) in lieu of commutation fees on other lands (Soehren 2005). Kalaoa 1st was returned by Keaweamahi (*Buke Māhele*, February 2, 1848:73), the wife of Kaikio‘ewa, the guardian of the Kauikeaouli (Kamehameha III) at ‘O‘oma; Kalaoa 2nd was returned by Kinimaka (*Buke Māhele*, February 9, 1848:128), the husband of the high chiefess Kaniu and the *hanai* father of the young King Kalākaua; Kalaoa 3rd was returned by Hewahewa (*Buke Māhele*, February 14,

[4] See also *“Kanawai Hoopai Karaima no ko Hawaii Pae Aina”* (Penal Code) 1850.

[5] Kalaoa 4th and 5th both may have originally belonged to Leleiohoku (Native Register Vol. 8:514, 516).

1848:168), the *kahuna nui* (high priest) of Kamehameha I and II; Kalaoa 4th was returned by William Pitt Leleiohoku (*Buke Māhele*, January 28, 1848:25), the adopted son of Governor George Kuakini (he had received Kaukai's lands upon his death in 1844) and husband of Ruth Ke'elikōlani; and 'O'oma 2nd was returned by the *kahuna* Kekaha (*Buke Māhele*, February 14, 1848:158). 'O'oma 1st, on the other hand, was claimed by, and awarded to, Moses Kekūāiwa (brother of Kamehameha IV and V, and Victoria Kamāmalu), one of the children of Kīna'u and M. Kekūanao'a, thus, a grandson of Kamehameha I (Buke Māhele 1848, January 27, 1848:13-14). Moses Kekūāiwa died on November 24, 1848, and his father, Mataio Kekūanao'a, administrator of the estate, relinquished in commutation, his rights to 'O'oma 1st, giving the land over to the Government land inventory (Foreign Testimony Volume 3:408).

In 2000, Kumu Pono Associates digitized the entire collection of handwritten records from the *Māhele 'Āina*. Most of the records are in the Hawaiian language. An extensive review of all the records identifies only one native tenant who filed a claim of residency and land use in 'O'oma during the *Māhele*. The claim—*Helu* 9162, by Kahelekahi—was not awarded, and except for an entry in Native Register Volume 8 (Figure 17), there is no further record of the claim. Below, is a copy of the original Hawaiian text from the Native Register. The account is of particular interest as Kahelekahi reported that in 1848, he was the only resident in 'O'oma:

> ***Kahelekahi – Helu 9162***
> ***Kailua, Hawaii February 9, 1848***
> Greetings to all of you commissioner who quiet land titles, I hereby tell you of my claim for land. I have an entire ahupuaa situated there in Kona, its name is Ooma 2. It is an old land gotten by me from Koomoa, and held to this time. For 15 years, I have been the only one residing on this land, there are no other people, only me. I am the only one, there is no one living here to help from one year to the next year. Kamehameha III is the one above, who has this land, and W.P. Leleiohoku is below him, and I am the one man dwelling there. The survey of the length and width of this land is not accurately completed. That is what I have to tell you.
>
> Done by me, Kahelekahi
>
> [Native Register Vol. 8:543; translated by Kepā Maly]

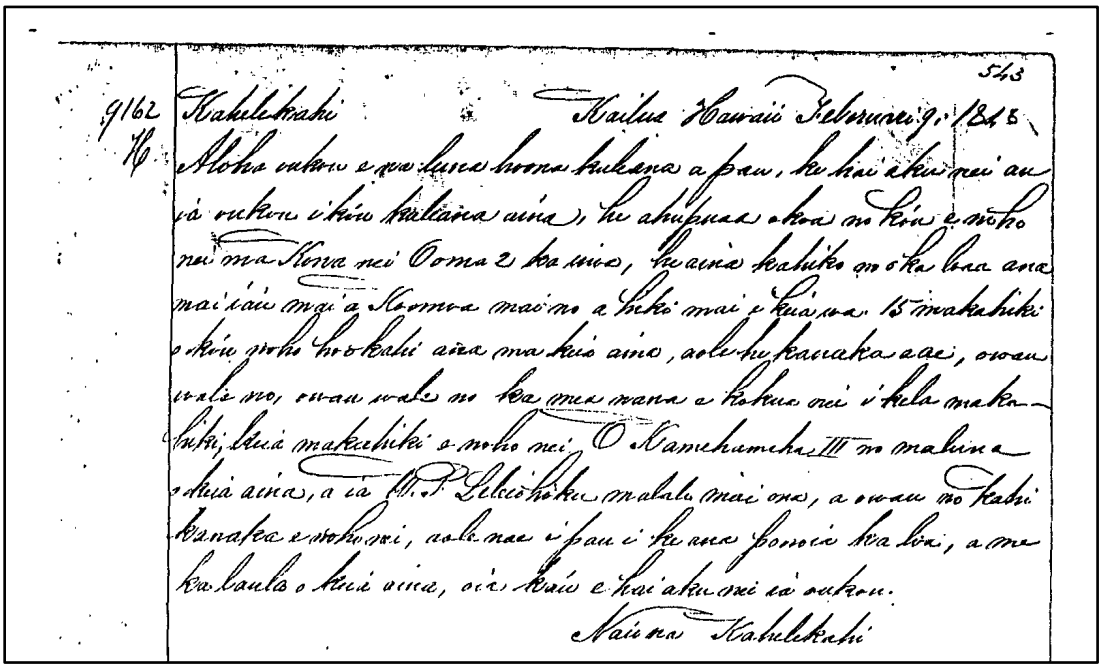


Figure 17. Copy of Native Register Vol. 8:543 Helu 9162, claim of Kahelekahi for *kuleana* at 'O'oma.

**Table 1. Distribution of Kalaoa and ‘O‘oma during the *Māhele ‘Āina* of 1848 (Soehren 2005).**

| *Ahupua‘a* | *Returned by* | *Retained by* | *Kuleana* |
|---|---|---|---|
| Kalaoa 1st | Keaweamahi | Government | - |
| Kalaoa 2nd | Kinimaka | Government | - |
| Kalaoa 3rd | Hewahewa | Government | - |
| Kalaoa 4th | Leileiohiku | Government | - |
| Kalaoa 5th | - | Government | 2 |
| ‘O‘oma 1st* | Kekuaiwa | Government | - |
| ‘O‘oma 2nd | Kekaha | Government | - |

***Land surrendered to Government in lieu of commutation fee subsequent to the *Māhele* of 1848.**

In Kalaoa 5th two *kuleana* claims were awarded – LCAw. 7899 to Kupuoe and LCAw. 7937 to Kukaaui – both of which were located next to one another in the *mauka* portion of the *ahupua‘a* (a third *kuleana* was claimed but not awarded). Kupuoe’s and Kukaaui’s awards in Kalaoa 5th (Figures 18 and 19) are as follows:

> ***Kupuoe (Kupuae) – Helu 7899***
> ***Kailua, Hawaii Jan. 2, 1849***
> Kanahele sworn [the whole ili claim is an error] He has seen the house lot and the place Kupuoe had cultivated. There are 12 partially cultivated kihapais in Kaweo ili of Kalaoa 5 ahupuaa. It has not been enclosed completely, one house is for Kupuoe. In Kalaoa 4, 8 kihapais have been cultivated. Kupuoe’s land is from Kaainoa in 1843, no one has objected to him. Kukaanio sworn they [Kanahele and Kukaanio] both have known in the same way.
>
> [Native Testimony 4:540; translated by Kepā Maly]

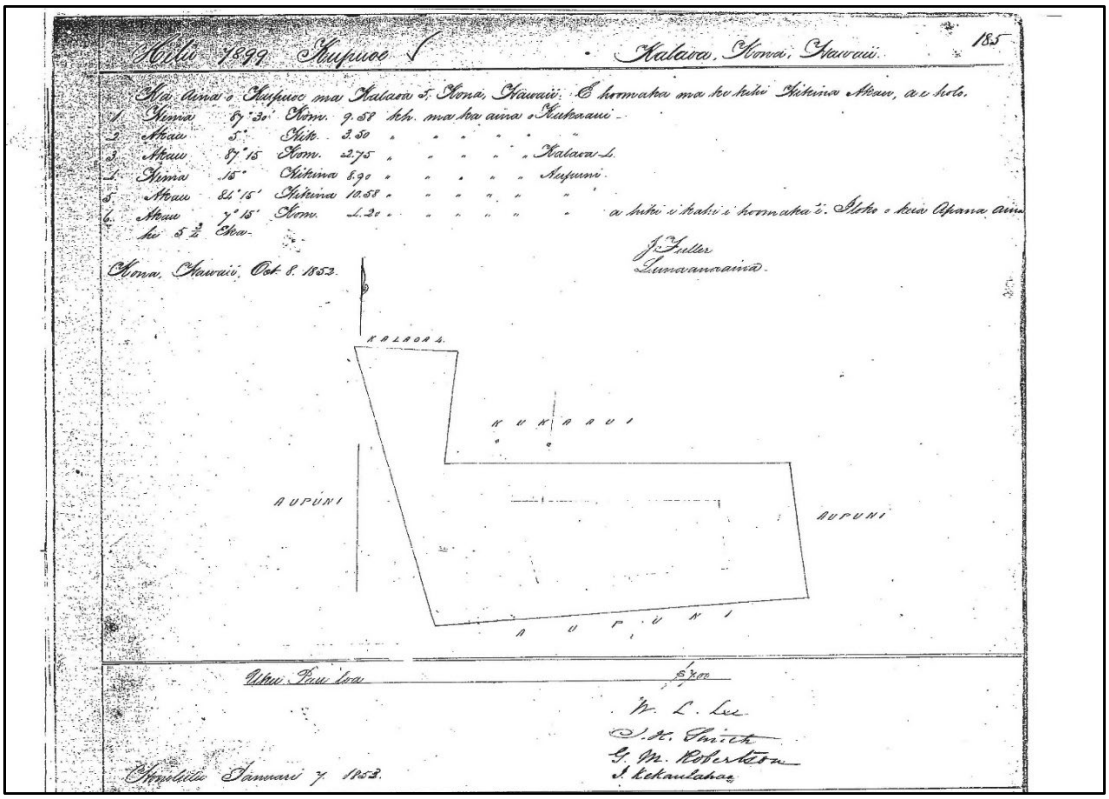



Figure 18. LCAw. 7899 awarded to Kupuoe (*Māhele* Book Vol. 7:185).

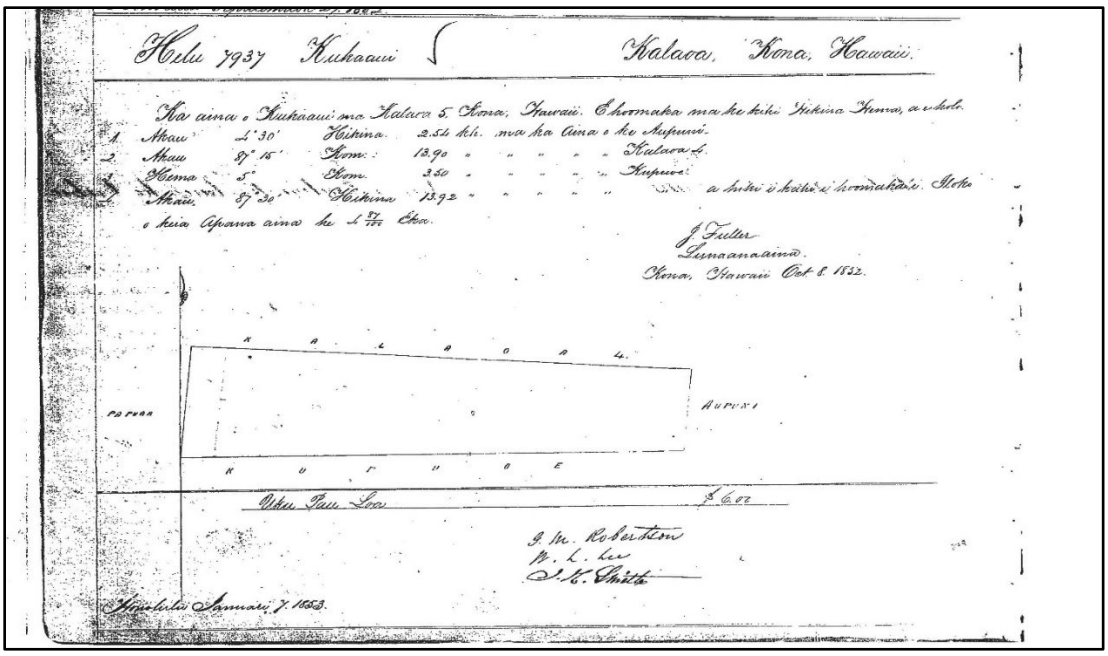

Helu 7937 Kukaaui Kalaoa, Kona, Hawaii.

Figure 19. LCAw. 7937 awarded to Kukaaui (*Māhele* Book Vol. 7:184).

***Kukaaui (Kukaani/Kukaanio) – Helu 7937***

Greetings to all of you Land Commissioners: I hereby petition for my ili in the ahupua'a [possessed by] Leleiohoku, in Kailua, Hawaii, which is as follows: it is an entire ill in the comer of Kalaoa 5 - its name is Kahuku. It is bounded on the north by Kahuku, on the east by Kapulehu [Kaʻūpūlehu], on the south by Kawao, on the west by Kihalau. That is it, for your information, the commissioners to quiet land titles.

KUKAAUI

[Native Register 8:453-454; translated by Kepā Maly]

Kanahele sworn He has seen the place Kukaani had cultivated. It is an error that he had included the whole ili in his claim. The Kahuku ili of Kalaoa 5 ahupuaa, 9 Kihapais are at Kalaoa [Kalaoa] 4, 8 have been partially cultivated. He does not know the boundaries and is expecting the surveyor to establish boundaries upon his arrival.

Land is from Kaluaonaona [Kalimaonaona] in 1848, no one has objected to Kukaani. Kupuoe sworn they both have known alike in the things mentioned about this land.

[Native Testimony 4:539-540; translated by Kepā Maly]

The unawarded *kuleana* in Kalaoa 5th was claimed by Kanahele under two separate numbers (LCAws. 7926 and 7939), and was apparently also in the more *mauka* portion of the *ahupuaʻa*. The original Hawaiian text from the Native Register for both claims are presented below (Figures 20 and 21) followed by translations.

***Kanahele – Helu 7926***

Greetings to the Land Commissioners: I hereby petition for my house lot at Kalaoa 5 on Hawaii, in the ahupuaʻa of Leleiohoku in Kailua. It is 528 feet by 396 feet. That is the size of my house lot, for your information, O Land Commissioners.

KANAHELE

[Native Register Vol. 8:514; translated by *Waihona ʻAina*]

***Kanahele – Helu 7939***

Greetings to the Land Commissioners: I hereby petition for my ʻili of land in the middle of the ahupuaʻa of Kalaoa 5, of Leleiohoku, in Kailua, Hawaii. My land is as follows: On the north is Haleolono, on the east is Kalulu, on the south is Kaholo Two, on the west is Keahole. That is it.

KANAHELE [Native Register Vol. 8:516; translated by *Waihona ʻAina*]

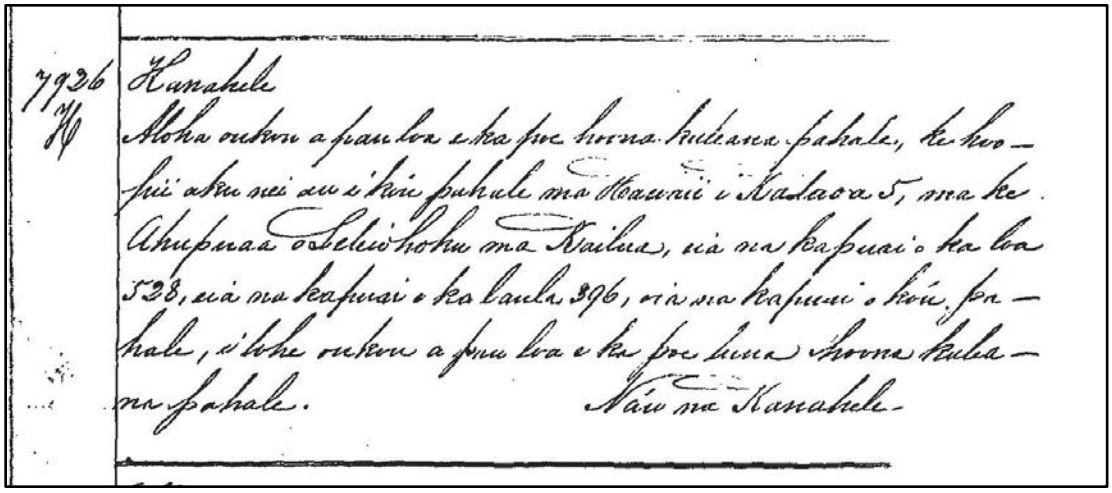

7926 H
Kanahele
Aloha oukou a pau loa e ka poe hoona kuleana pahale, ke hoo-
pii aku nei au i koi pahale ma Hawaii i Kalaoa 5, ma ke
Ahupuaa o Lelehoku ma Kailua, eia na kapuai o ka loa
528, eia na kapuai o ka laula 396, eia na kapuai o koi pa-
hale, i loke oukou a pau loa e ka poe huna hoona kula-
na pahale. Naiu na Kanahele-

Figure 20. Copy of Native Register Vol. 8:514 Helu 7926, claim of Kanahele for *kuleana* at Kalaoa 5th.

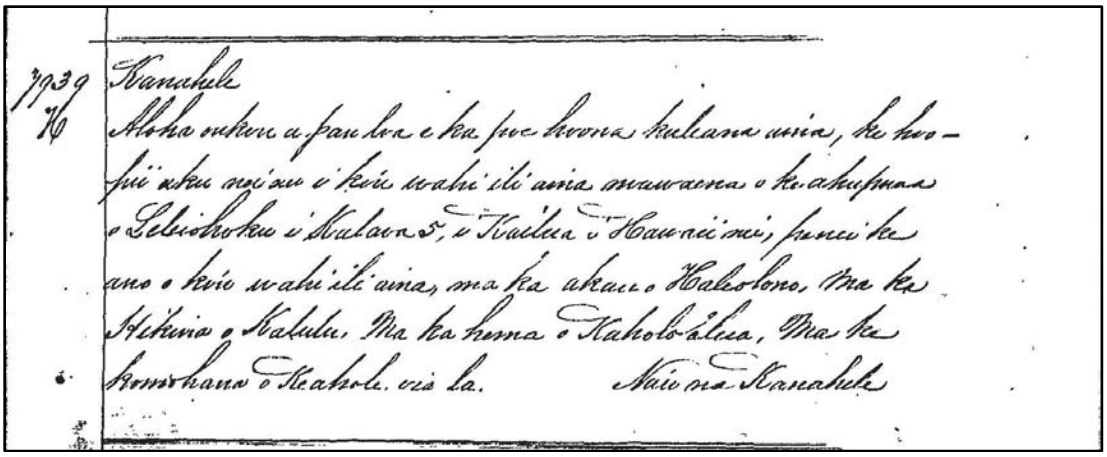

7939 H
Kanahele
Aloha oukou a pau loa e ka poe hoona kuleana aina, ke hoo-
pii aku nei au i koi wahi ili aina mawaena o ke ahupuaa
o Lelehoku i Kalaoa 5, o Kailua o Hawaii nei, pueu ke
ano o koi wahi ili aina, ma ka akau o Halekolono, ma ka
Hikina o Kalulu, Ma ka hema o Kaholo-ilua, Ma ke
Komohana o Keahole. eia la. Naiu na Kanahele

Figure 21. Copy of Native Register Vol. 8:516 Helu 7939, claim of Kanahele for *kuleana* at Kalaoa 5th.

Four other individuals (John Nawahie, Paina, Kalei, and Kaikeleaukai) also claimed *kuleana* in the neighboring Kalaoa *ahupua'a*, but none of these were awarded. Two of these claimants (Paina and Kaikeleaukai) and both of the *kuleana* recipients in Kalaoa 5th were listed as residents of Kalaoa *ahupua'a* in 1849, as was Halekahi who claimed land in 'O'oma, when S. Haanio, Tax Assessor of North Kona, submitted a report to the Board of Education regarding those individuals who were subject to the Tuesday Tax Laws (*Poalua*), to be worked as a part of the School Tax requirements of the time. At the time of Haanio's report, three individual families were identified as residents of 'O'oma and sixteen collectively in the Kalaoa *ahupua'a*. Residents in the neighboring land of Kohanaiki were also listed. The residents of this are in 1849 were:

> Kalaoa: 1. Kila, 2. Piena, 3. Nakuala, 4. Kupono, 5. Loa, 6. Kaeha, 7. Keliipuipui, 8. Kapuolokai, 9. Kaainoa, 10. Paina, 11. Kalimaonaona, 12. Kaikeleaukai, 13. Kanahele, 14. Kukaani, 15. Kupuai, and 16. Helekahi
>
> Ooma: 1. Kalua, 2. Kamaka and 3. Mamali
>
> Kohanaiki: 1. Hulikoa, 2. Kaoeno, 3. Honolii and 4. Awa [HSA – Series 262, Hawaii 1849].

Unfortunately, there is no indication of where people were living at the time. Based on traditional patterns of residency in the region, it is likely that they had primary residences in the uplands, near sheltered *māla 'ai* (agricultural fields), and kept near shore residences for seasonal fishing, collection of salt, and other resources of the coastal zone. Of the names given for 'O'oma and Kalaoa, descendants of some of these family lines are known to still be residing in the Kekaha region.

*Land Grants in ʻOʻoma, Kalaoa 5th, and Vicinity (1855-1864)*

In conjunction with the *Māhele*, the King also authorized the issuance of Royal Patent Grants to applicants for tracts of land, larger than those generally available through the Land Commission. The process for applications was set forth by the "Enabling Act" of August 6, 1850, which set aside portions of government lands for grants.

> Section 4. Resolved that a certain portion of the Government lands in each Island shall be set apart, and placed in the hands of special agents to be disposed of in lots of from one to fifty acres in fee simple to such natives as may not be otherwise furnished with sufficient lands at a minimum price of fifty cents per acre. [HSA – "Enabling Act" Series DLNR 2-4]

The Kingdoms' policy of providing land grants to native tenants was further clarified in a communication from Interior Department Clerk, A. G. Thurston, on behalf of Keoni Ana (John Young), Minister of the Interior; to J. Fuller, Government Land Agent-Kona:

> *February 23, 1852*
> …His Highness the Minister of the Interior instructs me to inform you that he has and does hereby appoint you to be Land Agent for the District of Kona, Hawaii. You will entertain no application for the purchase of any lands, without first receiving some part, say a fourth or fifth of the price; then the terms of sale being agreed upon between yourself and the applicant you will survey the land, and send the survey, with your report upon the same to this office, for the Approval of the Board of Finance, when your sales have been approved you will collect the balance due of the price; upon the receipt of which at this office, the Patent will be forwarded to you.
>
> Natives who have no claims before the Land Commission have no Legal rights in the soil.
>
> They are therefore to be allowed the first chance to purchase their homesteads. Those who neglect or refuse to do this, must remain dependent upon the mercy of whoever purchases the land: as those natives now are who having no kuleanas are living on lands already Patented, or belonging to Konohikis.
>
> Where lands have been granted, but not yet Patented, the natives living on the land are to have the option of buying their homesteads, and then the grant be located, provided this can be done so as not to interfere with them.
>
> No Fish Ponds are to be sold, neither any landing places.
>
> As a general thing you will charge the natives but 50 cents pr. acre, not exceeding 50 acres to any one individual.
>
> Whenever about to survey land adjoining that of private individuals, notice must be given them or their agents to be present and point out their boundaries…
>
> [Interior Department Letter Book 3:210-211]

Between 1855 and 1864, at least six applications were made for land in the *ahupuaʻa* of ʻOʻoma and Kalaoa 5th, and four of them were patented. The applications were made by:

| Grant | Applicant | Land | Acreage Book and Year |
|---|---|---|---|
| 1590 Kauhini | Hamanamana, Kalaoa and Ooma 1 | 1,816 | 8:1855 (canceled) |
| 1599 J. Hall | Ooma 2 | 101.33 | 8:1855 (canceled) |
| 1600 Kaakau | Ooma 2 | 58.5 | 8:1855 |
| 1609 Kama | Kalaoa 5 | 45 | 8:1855 |
| 2027 Kameheu | Ooma 2 | 101.33 | 11:1856 (same area as Grant 1599) |
| 2031 Koanui | Ooma 1 | 24.5 | 11:1856 |
| 2972 Kaakau & Kama | Kalaoa 5 & Ooma 1 | 515 | 14:1864 |

["Index of all Grants Issued…Previous to March 31, 1886;" 1887]

The grants to Kaʻakau and Kameheu were patented by 1859, as recorded in the following letter:

> *April 8, 1859*
> *S. Spencer, Interior Department Clerk;*
> *to Lot Kamehameha, Minister of the Interior;*

Lands in Puaa and Ooma 2 in Kona, Hawaii which were sold by the Government Agent:

| | |
|---|---|
| Royal Patent 1600, Kaakau 58 50/100 acres in Ooma | $29.25 |
| Royal Patent 2027, Kameheu, 101 33/100 acres in Ooma | $38.00 |

[HSA – Interior Department, Lands]

In the years following issuance of the first Royal Patents, native tenants and others continued to express interest in the lands of ‘O‘oma and Kalaoa *ahupua‘a*. Applications were made to either lease or purchase portions of the remaining government lands. In 1865, Government Surveyor and Land Agent, S.C. Wiltse, wrote to the Minister of the Interior, describing the condition and status of the lands remaining to the government.

*September 5, 1865*
*S.C. Wiltse, Government Surveyor and Land Agent;*
*to F.W. Hutchinson, Minister of the Interior.*
Kona Hawaii. Government Lands in this District not Sold;
also those Sold and Not Patented:

…”Kalaoa 5th”

Not in the Mahele book but believed to be Gov’t. land. This land above the Govt. Road has been sold and Patented. Below the road I have surveyed 515 acres which was sold by Sheldon to “Kaakau” & “Kama” who payed him $165.00. As no valuation was made of this land per acre by Sheldon I afterwards valued it myself as follows, 300 Ac. at 50 cts. per acre, 215 at 25 cts. per Ac. The balance due according to this valuation including Patent was $42.75 which was payed to me in March 1864 and forwarded by me to your office. The survey of this land is in your office. If the payments made are satisfactory, these men would be very glad to get their Patent.

<u>This is a piece of 3rd rate land, used only as goat pasture, no improvements on it.</u> <u>Makai of this survey is about 400 Ac. remaining to the Govt., but of very little value.</u>

“Ooma 1st & 2nd”

The best part of these lands have been sold, there remains to the Govt. the forest part, 2 or 300 Ac., and the makai part some 1500 Ac., about 500 of which is 3rd rate land, the balance rocks.

“Kohanaiki”

The forest part of this land is all that remains to the Gov’t., this is extensive, extending to the mauka side of the forest. It may contain 1500 to 2000 Ac.

The makai part of this land containing 220 Ac. has been sold both by Sheldon and myself. In April 1863 I was surveying in Kona when “Nahuina” (who lives on the adjoining land of “Kaloko”) applied to me to survey the makai part of the Gov’t. land Kohanaiki which he wished to purchase. I inquired whether he had applied to Sheldon for this lands (Sheldon was then in Honolulu) he told me that he had not, but would do so immediately, if it was necessary he would go to Honolulu for that purpose. I told him that I was then writing to Sheldon and I would make the application for him which I did, but never got an answer. I wrote several times to him about that time, for information about Gov’t. lands, but he declined to answer my letters.

On the 30th of May following, I surveyed said piece of land for “Nahuina.” When I was making this survey “Kapena” (who bought this land from Sheldon) was present, and afterwards went to Honolulu and payed Sheldon for this land.

“Nahuina” had the money then to pay for this land, and I told him to keep it until he knew who he was paying it to. I was perfectly satisfied then that Sheldon’s transaction as Gov’t. land Agt. was not honest. Mr. Sheldon had then been away from Kona nearly three months, he had previous to this resigned his office as Judge and taken up his residence permanently in Honolulu. Afterwards when requested by Mr. S. Spencer to act as land Agt. for Kona, “Nahuina” payed me for this land at 25 cents per Acre. Its only value is for a place for a residence on the beach.

I have been thus particular in giving you the history of this affair, so that you might be able to decide which of the parties were intitled to said land… [HSA – Interior Department, Lands]

Historical records document that the primary use of the *kula* – lowlands in the Kekaha region, was for goat ranching, with limited cattle ranching. Throughout the 1800s, most of the cattle ranching occurred on the *mauka* slopes nearer the old upper government road.

*Summary of Land Tenure Described in Grant Records*

Grant No.'s 1600 (for Kaakau) and 2031 (for Koanui) are situated on the *mauka* side of the Alanui Aupuni (the Upper Government Road, near present-day Māmalahoa Highway) in 'O'oma 1st and 2nd *ahupua'a*.

Grant No. 1599 (surveyed for Kauhini), was situated across the *kula* lands from O'oma 1st in the south, to Hāmanamana, in the north. Communications from the 1880s, indicate that the parcel was never patented, though Kauhini had lived in 'O'oma 1st, through the time of his death (before 1888). J.S. Emerson's Register Map No. 1449 (Figure 22), identifies a Triangulation Station in 'O'oma 1st as "Kauhini." At almost the same time that Kauhini's grant was surveyed, other grants in Kalaoa and 'O'oma covering a portion of the area described under Kauhini's grant were patented, including one to Kakau and Kama in Kalaoa 5th (Royal Patent Grant No. 2972). In 1888, this confusing situation was brought to the government's attention in a letter from more than 70 native residents of 'O'oma and the larger Kekaha region, when the Minister of the Interior was developing homestead lots for applicants (see communications below).

Grant No. 2027 (for Kameheu), situated in 'O'oma 2nd, extends from the *makai* edge of the Upper Government Road, to a short distance below the historic Homestead Road between Kaloko and Kalaoa, at about 900 feet above sea level (see Figure 22).

'O'oma grantee Kaakau (Grant No. 1600), also held an interest in Grant No. 2972 in the land of Kalaoa 5th and 'O'oma 1st, which he shared with his relative, Kama. Historic survey records (in Register Maps and Survey Field Books) do identify "Kama's house" near the Wawaloli pond (Register Map No. 1449) in 'O'oma 1st. The same house is later identified as "Keoki Mao's House" (Register Map No. 1280; Figure 23). Kama also received Grant 1609 in Kalaoa 5.

In 1888, government surveyor J.S. Emerson identified Kama as a resident in 'O'oma, near the *mauka* government road (see communication below). This Kama is identified in oral history interviews as being an elder of the Kamaka line, from whom the often-mentioned Palakiko Kamaka and others descend. A temporary beach shelter—in the vicinity of "Kama's House" marked near the shore of 'O'oma 1st on Register Maps 1449 and 1280 (see Figures 22 and 23)—remained in use by family members at least until the outbreak of World War II.

While no formal awards or grants of land appear to have been made for the near shore *kula* or beach lands, it is logical to assume that families living in the uplands of the 'O'oma, Kalaoa, and Kohanaiki *ahupua'a*, made regular visits to the near shore lands. The practice of continued travel between upland residences and near-shore shelters, is also described by *kūpuna* Peter K. Park, and Elizabeth Lee, who was born and raised in the *mauka* section of 'O'oma, and by other *kūpuna* from neighboring lands (Rechtman and Maly 2003).

No records indicating that the above Royal Patent Grantees had applied for coastal parcels as a part of their original claims were found by (Rechtman and Maly 2003). A further review of the *Māhele* records was also made to determine if any of the grant applicants had been *Māhele* claimants (as is sometimes the case). Their names did not appear in the Register or Testimony volumes for the area.

*The Government Homesteading Program in Kekaha*

Following the *Māhele* and Grant programs of the middle 1800s, it was found that many native tenants still remained on lands for which they had no title. In 1884, the Hawaiian Kingdom initiated a program to create Homestead lots on Government lands—a primary goal being to get more Hawaiian tenants in possession of fee-simple property (Homestead Act of 1884). The Homestead Act allowed applicants to apply for lots of up to 20 acres in size, and required that they own no other land.

On Hawai'i, several lands in the Kekaha region of North Kona, were selected and a surveying program was authorized to subdivide the lands. Initially, those lands extended from Kohanaiki to Kūki'o. Because it was the intent of the Homestead Act to provide residents with land upon which they could cultivate crops or graze animals, most of the lots were situated near the *mauka* road (near the present-day Māmalahoa Highway) that ran between Kailua and 'Akāhipu'u.

Early in the process, native residents of Kekaha began writing letters to the Minister of the Interior, observing that 20 acre parcels were insufficient "to live on in every respect." They noted that because of the rocky nature of the land, goats were the only animals that they could raise, and thus, try to make their living (cf. State Archives–Land File, December 26, 1888, and Land Matters Document No. 255; and communications below).

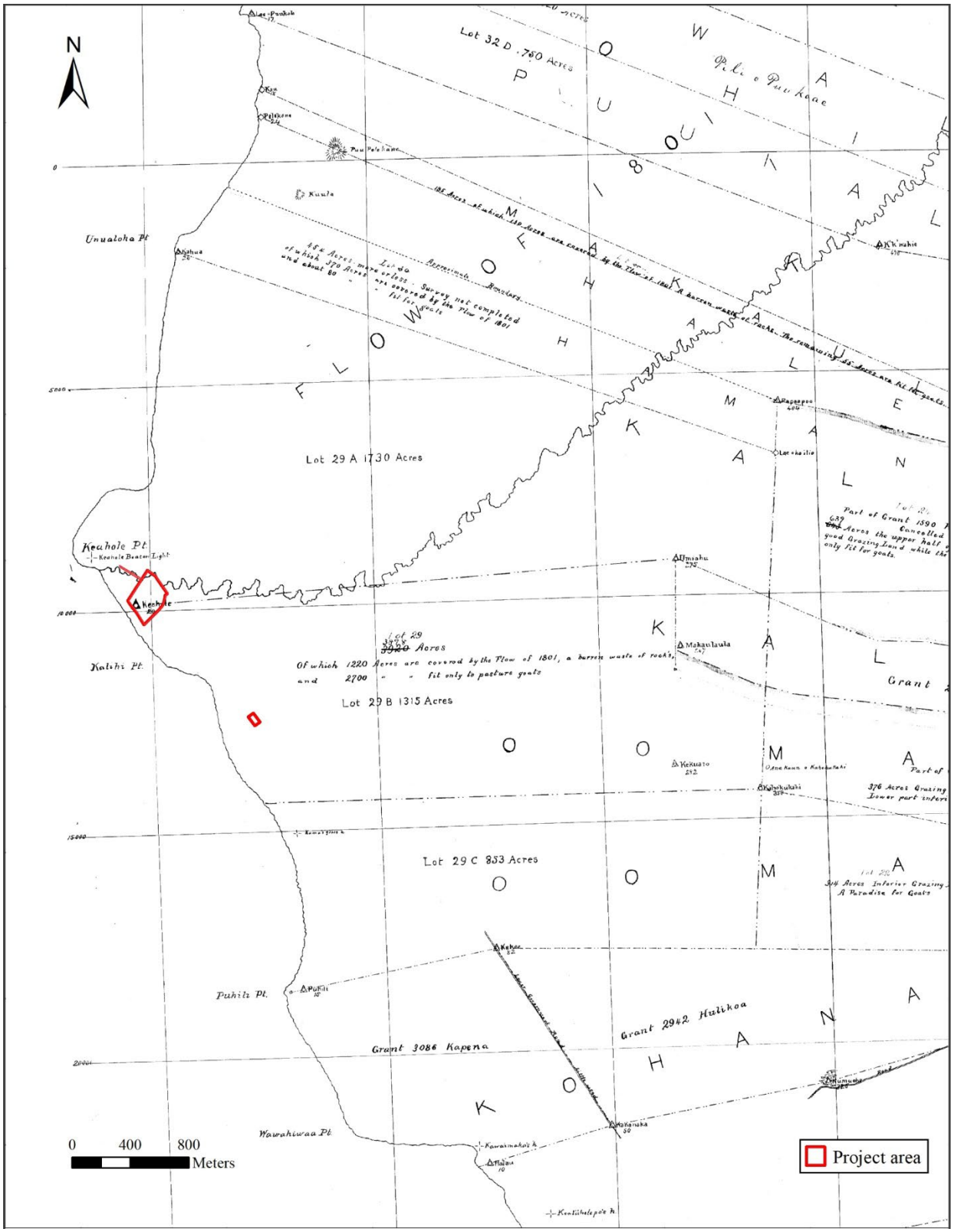



Figure 22. Portion of Hawai‘i Registered Map No. 1449 (prepared by J. S. Emerson, Sept. 1888).

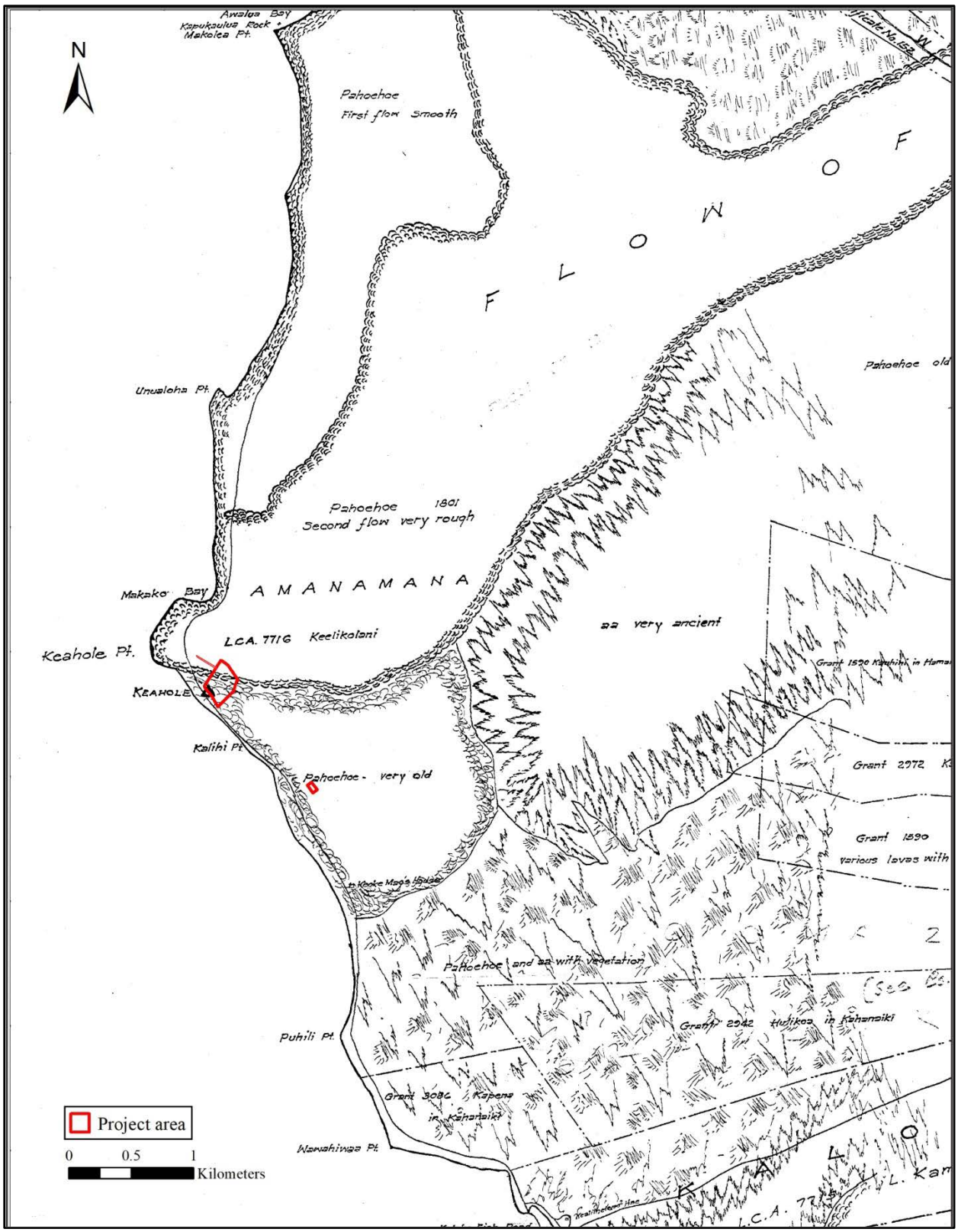



Figure 23. Portion of Hawai‘i Registered Map No. 1280.

During the first years of the Homestead Program, all of the remaining government lands in the Kekaha region, from Kohanaiki to Kūkiʻo 2nd, had been leased to King David Kalākaua for grazing purposes. The following lease was issued, with the notation that should portions of the land be desired for Homesteading purposes, the King would relinquish his lease:

> *August 2nd 1886*
> *General Lease 364*
> *Between His Majesty Kalakaua;*
> *and Walter M. Gibson, Minister of the Interior*
> [Lease of unencumbered government lands between Kealakehe to Kukio 2nd]:
>
> …Oma [Ooma] No. 1 & 2 – yearly rent Ten dollars…
>
> Each and every of the above mentioned lands are let subject to the express condition that at any time during the term of this lease, the Minister of the Interior may at his discretion peaceably enter upon, take possession, and dispose of such piece or pieces of land included in the lands hereby demised, as may be required for the purposes of carrying out the terms and intent of the Homestead Laws now in force, or that may be hereafter be enacted during the term of this lease… [State Land Division Lease Files]

By 1889, the demand for homestead lots in the Kekaha lands was so great that King Kalākaua gave up his interest in the lands:

> *January 22, 1889*
>
> *J.W. Robertson, Acting Chamberlain;*
>
> *to J.A. Hassinger, Chief Clerk, Interior Department*
>
> [Regarding termination of Lease No. 364 for lands from Kukio to Kohanaiki]:
>
> …I have the honor to acknowledge the receipt of your communication, of the 17th, instant, informing me that you are directed, by His Excellency the Minister of the Interior, to say, that he desires to take possession of the lands, described in Government Lease No. 364, for Homestead purposes, and requests the surrender of the lease.
>
> His Majesty the King, is willing, for the purpose of assisting in carrying out the Homestead Act, to accede to the terms of the lease, so far as to give up only such portions of the lands, as are suitable to be apportioned off for Homestead purposes.
>
> It has come to the knowledge of His Majesty, that several of the applicants for portions of the above lands, are already in possession of lands elsewhere, and living in comfortable homes. They are not poor people, nor are they entitled to the privilege of obtaining lands under the Homestead Act, but are desirous of obtaining more of such property, for the purpose of selling or leasing to the Chinese, which class is beginning to outnumber the natives in nearly every district…
>
> His Majesty is desirous of retaining the balance of lands, that may be left after the apportionment has been completed; and also desires to lease remnants of other Government lands in that section of the Island…
>
> Reply attached – Dated January 22, 1889:
>
> The lands of Kohanaiki and Kalaoa and Makaula have been divided up into Homestead lots, and taken up.
>
> Lands marked * are in Emerson's List of lands to be sold. Emerson's List attached.
>
> His Majesty has paid rent to Aug. 22, 1889. Another rent is due in adv. from this date…
>
> | | |
> |---|---|
> | * Kukio 2 | * Maniniowali |
> | * Mahaiula | * Kaulana |
> | * Awalua | Puukala |
> | + Makaula | + Kalaoa 1, 2, 3, 4 & 5 |
> | * Ooma 1 & 2 | + Kohanaiki |
>
> Lease cancelled by order – Minister of Int. August 2, 1889 [HSA – Interior Department, Lands]

One of the significant issues that arose with the development of homesteads in the Kekaha region, involved the lands of ‘O‘oma, Kalaoa, and Hāmanamana, which had been surveyed for Kauhini in 1855, under Grant No. 1590. The grant was apparently never patented, and questions regarding the government’s authority to divide portions of the ‘O‘oma-Kalaoa-Hāmanamana lands into Homestead lots were raised. Adding to the confusion, in 1888, John A. Maguire was also making his move from Kohala to Kona, and in the process of establishing his Huehue Ranch. One of the lands he reportedly purchased was covered under the unperfected Grant No. 1590. Thus, homestead applicants and program managers met with a wide range of challenges during the program’s history.

*Field Surveys of J.S. Emerson (1882-1889)*

Among the most interesting historic Government records of the study area—in the later nineteenth century—are the communications and field notebooks of Kingdom Surveyor, Joseph S. Emerson. Born on O‘ahu, J.S. Emerson (like his brother, Nathaniel Emerson, a compiler of Hawaiian history) had the ability to converse in Hawaiian, and he was greatly interested in Hawaiian beliefs, traditions, and customs. As a result of this interest, his letters and field notebooks record more than coordinates for developing maps. While in the field, Emerson also sought out knowledgeable native residents of the lands he surveyed, as guides. Thus, while he was in the field he also recorded their traditions of place names, residences, trails, and various features of the cultural and natural landscape (including the extent of the forest and areas impacted by grazing). Among the lands that Emerson worked in was the greater Kekaha region of North Kona, including the lands of ‘O‘oma, Kalaoa, and vicinity.

One of the unique facets of the Emerson field notebooks is that his assistant J. Perryman, was also a sketch artist. While in the field, Perryman prepared detailed sketches that help to bring the landscape of the period to life. In a letter to W.D. Alexander, Surveyor General, Emerson described his methods and wrote that he took readings off of:

> …every visible hill, cape, bay, or point of interest in the district, recording its local name, and the name of the *Ahupuaa* in which it is situated. Every item of local historical, mythological or geological interest has been carefully sought & noted. Perryman has embellished the pages of the field book with twenty four neatly executed views & sketches from the various trig stations we have occupied… [Emerson to Alexander, May 21, 1882; HSA – DAGS 6, Box 1]

Discussing the field books, Emerson also wrote to Alexander, reporting “I must compliment my comrade, Perryman, for his very artistic sketches in the field book of the grand mountain scenery…” (HSA – HGS DAGS 6, Box 1; Apr. 5, 1882). Later he noted, “Perryman is just laying himself out in the matter of topography. His sketches deserve the highest praise…” (ibid. May 5, 1882). Field book sketches and the Register Maps that resulted from the fieldwork provide a glimpse of the country side of more than 100 years ago.

*Field Notebooks and Correspondence from the Kekaha Region*

The following documentation is excerpted from the field notebooks and field communications of J. S. Emerson. Emerson undertook his original surveys of lands in the Kekaha region in 1882-1883 (producing Register Maps No. 1449 and 1280; see Figure 23). Subsequently, in 1888-1889, Emerson returned to Kekaha to survey out the lots to be developed into Homesteads for native residents of ‘O‘oma, Kalaoa and vicinity (see above, The Government Homesteading Program in Kekaha). Through Emerson’s letters and notes taken while surveying, we learn about the people who lived on the land—some of them identified in preceding parts of the study—and about places on the landscape. The numbered sites and place names cited from the field books coincide with sketches prepared by Perryman, which are shown as figures in the current study.

> *J.S. Emerson Field Notebook Vol. 111 Reg. No. 253*
> *West Hawaii Primary Triangulation, Kona District*
> *Akahipuu; May 27, 1882*
> (Figure 24)
>
> *Site # and Comment:*
>
> …6 – Koanui’s frame house. E.G. In Honokohau – nui.
>
> 23 – Kaloko-nui fish pond. Tang. S. end by Nuuanu’s grass house.
>
> 24 – Wall between fish pond of Kaloko nui and iki.
>
> 25 – Kaloko iki fish pond. Tang. N. extremity.
>
> 26 – Kawaimaka’s frame house. In Kohanaiki.
>
> 27 – Lae o Wawahiwaa. Rock cape. In Kohanaiki.
>
> 28 – <u>Keoki Mao’s grass house. In Ooma.</u>

29 – Pahoehoe hill. Between Ooma and Kalaoa 5.

30 – Lae o Keahole. Extremity. In Kalaoa 5.

31 – Lae o Kukaenui. Resting place for boats.

32 – Makolea Bay.

[Notebook 253:53]

While taking sightings from Keāhole, Perryman prepared additional sketches of the landscape. One sketch on page 69 of the field book (Figure 25) depicts the view up the slope of Hualālai. Dated June 4, 1882, the sketch is of importance as it also depicts Kalaoa Village and church; the upper Government road; Kohanaiki Village; and two trails to the coast, one trail to Honokōhau, and the other near the Kaloko-Kohanaiki boundary. Use of these trails continued through the 1950s. The other sketch on page 73 of the field book (dated June 8, 1882) depicts the coastline south from Keāhole, to an area beyond Keauhou (Figure 26). Of interest, we see only the near-shore "Trail" in the foreground, with no trail on the *kula* lands. Then a short distance south, a house is depicted on the shore, in the ʻOʻoma vicinity (identified as the house of Kama or Keoki Mao on Emerson's Register Maps). And a little further beyond (south of) the house, two trails are indicated—presumably the *Alanui Aupuni* on the *kula* lands to ʻOʻoma, and the near shore trail, seen coming in from Honokōhau.

While surveying the uplands on Hualālai in August 1882, Perryman drew a sketch of the Keāhole-Honokōhauiki coastal lands. This sketch (Figure 27) from field Book No. 254 shows the reverse view of Figure 24. Noting again, that the only trail given at that time, was the near shore trail, running out of Honokōhau-Kaloko, Kohanaiki, ʻOʻoma and on to Keāhole.

In his field book notes, on May 1st, 1888, Emerson noted that he had placed the "Pulehu" station on the "ground by ahu, about 4 feet makai of Kama's goat pen, on the iwi aina between Kalaoa 5 and Ooma 1…" (J.S. Emerson Field Book 291:83).

In the same field book on May 19th, 1888, while surveying the area near the boundary of ʻOʻoma 1st and 2nd, at the 325 foot elevation, Emerson cited off of a station named "Kahokukahi." The point is "on the entrance of the cave, Kahokukahi… The above is the vertical entrance of a famous ana kaua, which extends for a long distance to the E. and to the W…" (J.S. Emerson Field Book 291:137). An "ana kaua" would be a place, where during times of war, people could hide and fortify themselves. Emerson's description indicates that the cave runs some distance *mauka* and *makai* of "Kahokukahi."

On May 23, 1888, Emerson surveyed Pūhili, the boundary between Kohanaiki and ʻOʻoma 2nd. He observed, "Large [mark] on solid pahoehoe, on bound. bet. Kohanaiki & Ooma, by the sea, near the end of a cape… Station mark, drill hole in stone, 9 ft. S. of the S. corner of an old "kahua hale" on white sand…" (J.S. Emerson Field Book 291:151).

Returning to his "old camp Ooma," in August 1888, Emerson submitted the following letter to Alexander:

> *August 25th, 1888*
>
> …I have to report that the very intricate and irregular remainder of Gov't. land situated in Kealakehe is cut up into homesteads, ready for the committee to estimate its values. The job has been made unusually long & tedious by the absurd arrangement of the old kuleanas scattered around at random. I have also run out the boundaries of Papaakoko, ready for fencing. Thursday P.M. I made my way through a heavy rain to this place and set up tent in the storm. It rained a good deal every day since and is raining now. In spite of the weather the work of cutting up Ooma 1st goes bravely on. I have a huge umbrella to camp under while it rains. I propose to finish up Ooma 1st & return to Honolulu by the next trip of the *Hall*.
>
> Kailua beach is the great rendezvous for men & asses from all parts of the country when the steamer arrives from Honolulu. It has in consequence become the natural place to tell and hear gossip & news. Here, the sand-lot orator, mounted on a packing box, can address the largest crowd. T.N. Simeona, who stole the church money, keeps the pound and takes care of the court house wanting to make a speech, repaired to the beach last Wednesday morning and is reported to have made a windy harangue to the effect that the King was hewa and that the Ministers were pono! Up to that time he had always been the contemptible too of the King's party and was loud in his denunciation of the Government. I explain this change in his talk by his wish to retain his Gov't. billets & his desire to avoid arrest as a rebel.

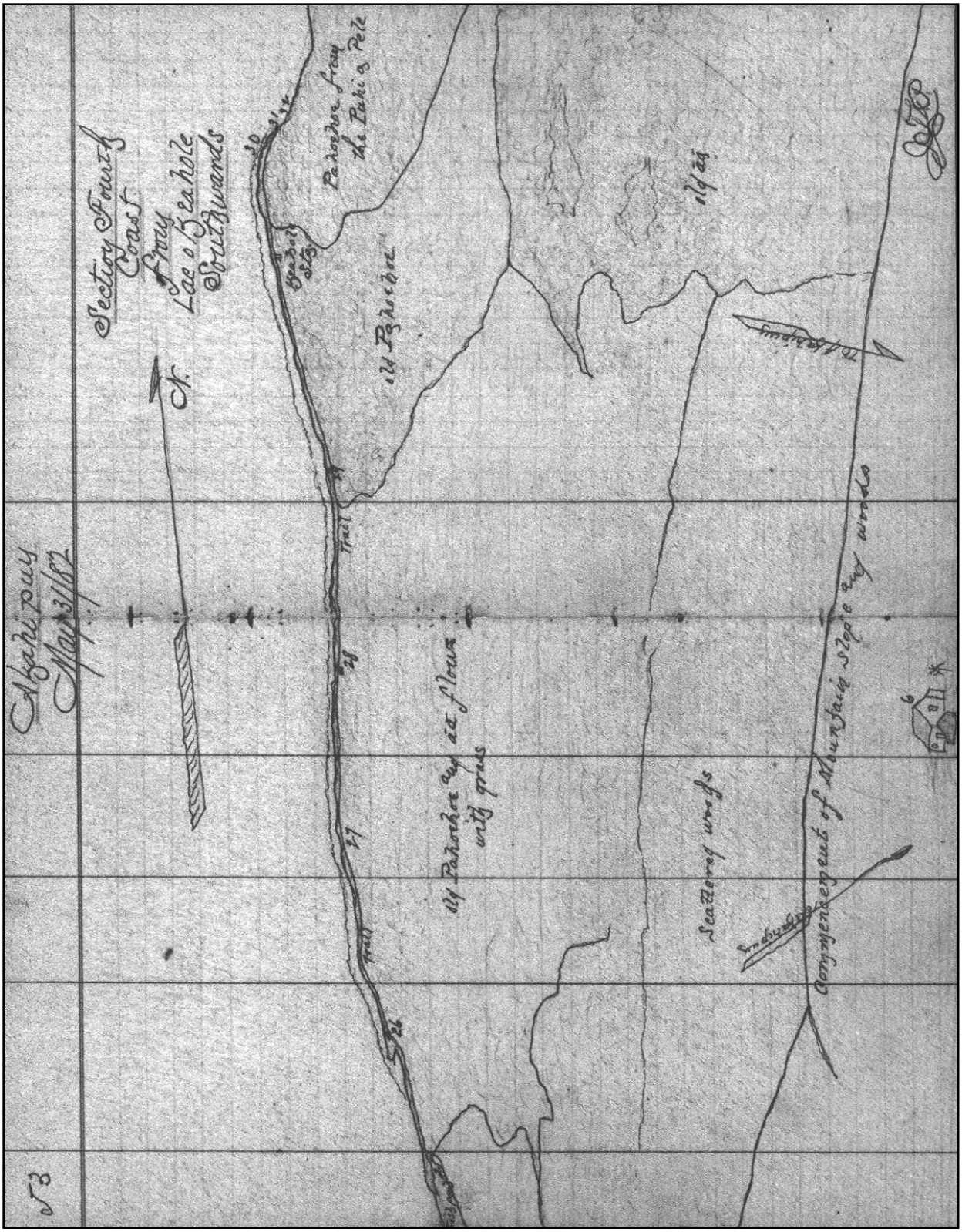



Figure 24. J. S. Emerson, field notebook map, Book 253:53 (State Survey Division).

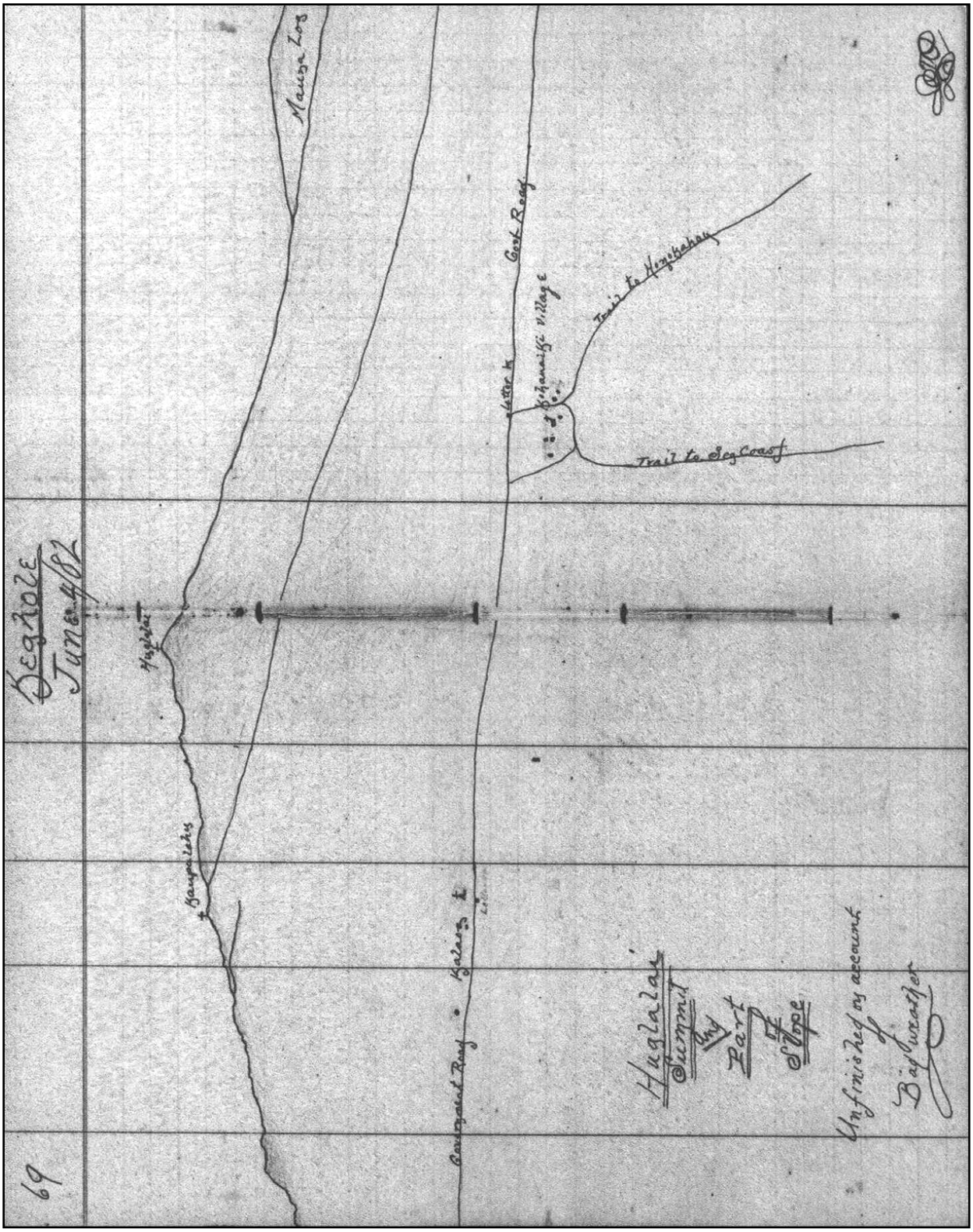



Figure 25. J. S. Emerson, field notebook map, Book 253:69 (State Survey Division).

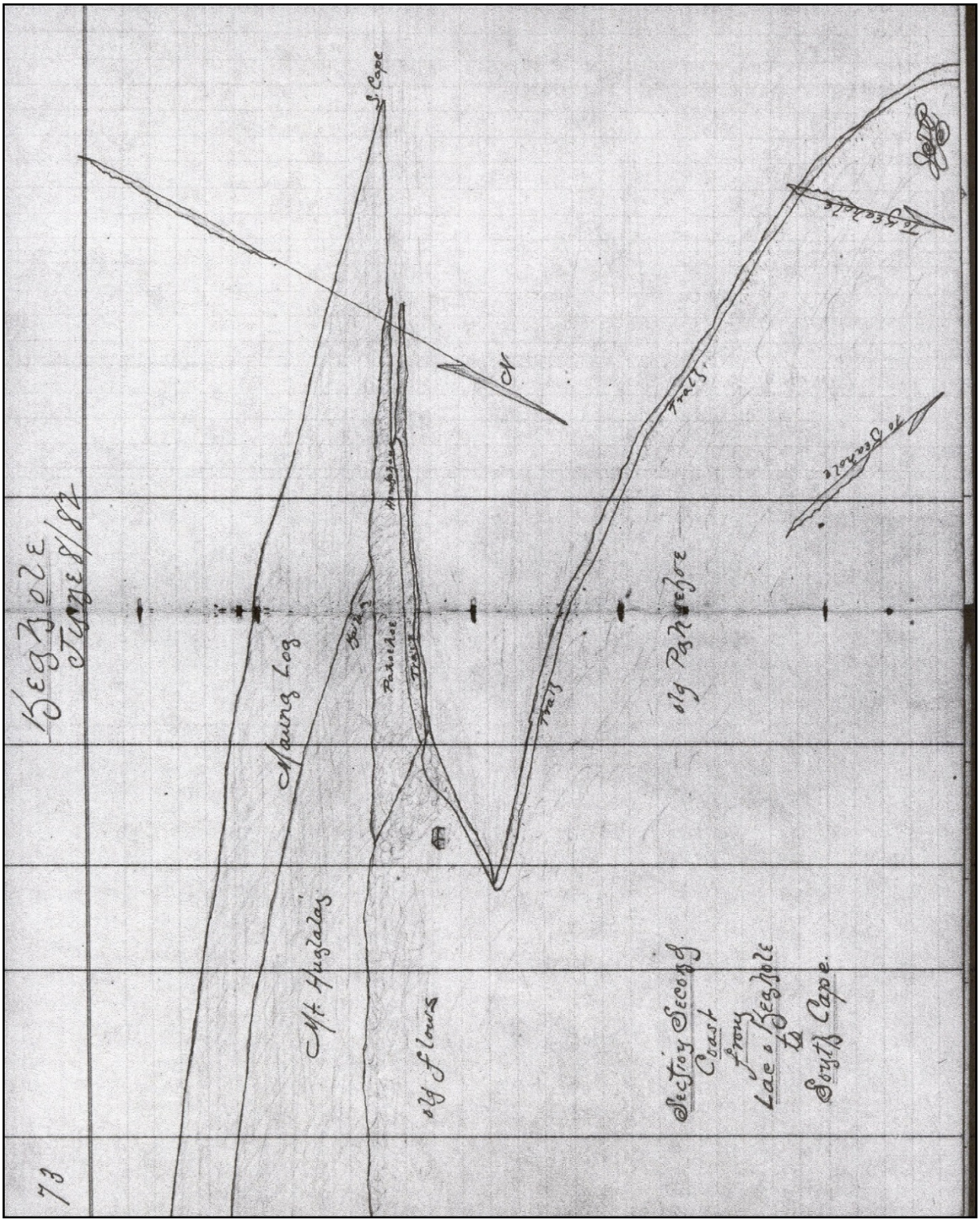



Figure 26. J. S. Emerson, field notebook map, Book 253:73 (State Survey Division).

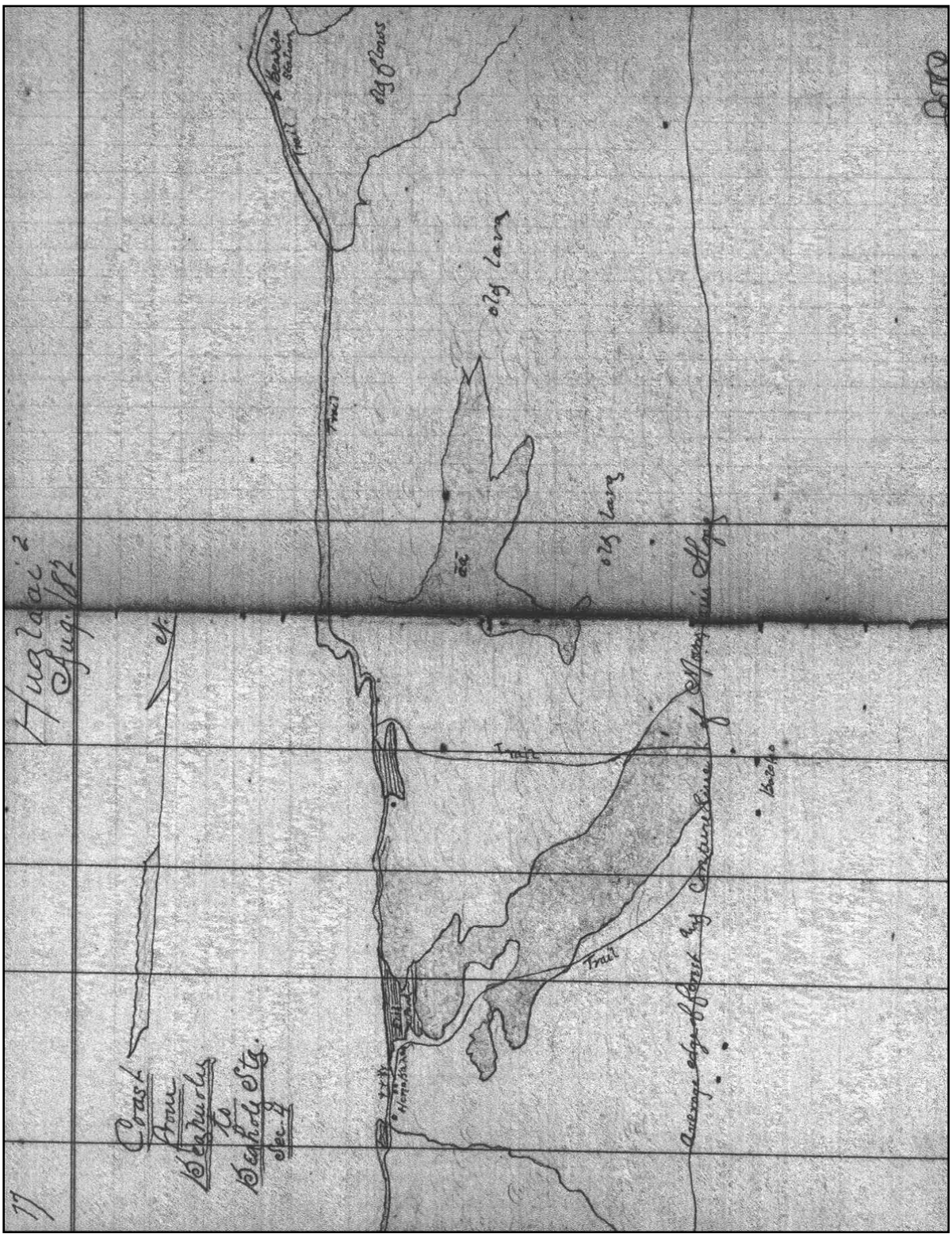



Figure 27. J. S. Emerson, field notebook map, Book 254:77 (State Survey Division).

> A native man told me the other day (Wednesday) that the Cabinet was hewa in two things viz.
>
> 1st They taxed chickens, banana trees and many other things that had not been heretofore taxed.
>
> 2nd They arrested and sent to Molokai many who were not lepers. For these reasons many justified Wilcox for trying to out the ministers.
>
> There is a sturdy old native living at Kaloko named Kealiihelepo, whom I greatly respect. Said he to me "When King Kalakaua returned from his foreign trip he made a speech at Kailua and said that 'in foreign lands the foreign God was losing his power. His former worshippers were deserting him. That the old Hawaiian Gods were still mana and them he would worship.'" But said Kealiihelepo "The King was mistaken. Our old Gods were once mighty, but the coming of the foreigner with his Gods has robbed them of their strength. Therefore the King has made the mistake to oppose the God who is now in power, and Jehovah is opposing him. Hence the King's pilikia."
>
> You are entirely justified in calling Kona "that heathen district."
>
> [HSA – HGS DAGS 6, box 2 Jan.-Apr. 1888]

On October 14th 1888, Emerson wrote to Alexander, briefing him on conversations he was having with J.W.H. Isaac Kihe, his "encyclopedia," "the son of a famous sorcerer." Later, Emerson used many of the notes taken during his conversations with Kihe, to develop his paper on Hawaiian religion (Emerson 1892). J.W.H. Isaac Kihe, was the son of Kihe, who was the son of Kuapahoa, of Kaloko (notes of J.S. Emerson, September 25, 1915; in collection of the Hawaiian Historical Society). While at 'O'oma, Kihe described the various nature forms taken by the deceased, and their role in the spiritual practices. On October 14th Kihe named for him some of the gods called upon by those who practiced the Kahuna Kuni sorcery.

> *Ooma*
> *October 14, 1888*
> *J.S. Emerson; to W.D. Alexander:*
> …I have just been having a chat with a son of a famous sorcerer, with the following for a summary of what he said.
>
> There are four gods worshipped by murders and sorcerers viz:
>
> (1). Kui-a-Lua, the god of the Lua, Mokomoko, Haihai and other forms of violence.
>
> (2). Uli, the god of the Anaana, Kuni, Hoopiopio and Lawe Maunu.
>
> (3). Kalaipahoa, god of the Hoounauna, Hookomokomo and Hooleilei.
>
> (4). Hiiaka-i-ka-poli-o-Pele, the goddess of the Poi uhane, Apo leo, Pahiuhiu and Hoonoho uhane…
>
> [J.S. Emerson, in collection of the Hawaiian Historical Society]

Emerson's 1888-1889 survey and subdivision of the Akahipuu Section of North Kona (between the *ahupua'a* of Kohanaiki and Makaula), originally conceived of as twenty-nine lots extending from the ocean to above the upper Government Road (see Figure 22), was later revised to include fifty-nine homestead lots ranging in size from less than 4 acres to more than 45 acres, all located in the *mauka* portions of the *ahupua'a*. The newly created lots included (by *ahupua'a* from south to north) thirty-three in Kohanaiki (Lots 1-33; the Kohanaiki Homesteads), four in 'O'oma 2nd (Lots 56-59), eight in 'O'oma 1st (Lots 48-55), one in Kalaoa 4th (Lot 47), two in Kalaoa 3rd (Lots 34 and 46), one in Kalaoa 2nd (Lot 35), three in Kalaoa 1st (Lots 36, 38, and 40), six in Hamanamana (Lots 37, 39, 41, and 42-44), and one in Makaula (Lot 45). Emerson did not divide the *mauka* lands of Kalaoa 5th, which already belonged to Kaakau and Kama (Grant Nos. 1609 and 2972). The newly created homestead lots in 'O'oma were soon purchased by native residents of the area, who had long been desirous of obtaining these lands (see above). An 1893 letter from J. Kaelemakule, Land Agent, to J.A. King, Minister of the Interior, lists some of the applicants for the homestead lots in 'O'oma 2nd Ahupua'a:

> *June 22, 1893*
> *J. Kaelemakule, Land Agent; to J.A. King, Minister of the Interior:*
> …I am forwarding you with this, the copy of the agreement of Wm. Harbottle, and some applications as herein below set forth (see Figure 27):
>
> # 107, Kalua (w), for Lot # 59, Map 6, Ooma;
>
> # 108, G.M. Paiwa, for Lot # 56, Map 6, Ooma;
>
> # 109, Namakaokalani, for Lot # 58, Map 6, Ooma;
>
> # 110, Pika Kaninau, for Lot # 57, Map 6, Ooma.
>
> Lot # 57 above set forth, was formerly agreed with D. Kealoha Hoopii, but this applicant left altogether and lived a long time in Kohala, and has done nothing towards the land, and has never signed the agreement to this day. As two years have gone by, I thought it would be better to give the lands to the new applicant… [HSA – Interior Department, Lands]

The four Homestead lots in ‘O‘oma 2nd, located between 700 and 1,100 feet elevation and containing 40.50 to 45 acres each (see Figure 27), were eventually patented (from *makai* to *mauka*) to:

- James Kuhaiki – Right of Purchase Lease # 75, Lot 59
  (Patented to Mrs. Hattie Kinoulu; Grant No. 9468);
- Jno. Kainuku – C.O. No. 33, Lot 58
  (not granted by 1902);
- Holokahiki – C.O. No. 11, Lot 57
  (cancelled; R.P.L. # 59 to Jno. Broad; Grant No. 5912); and
- E.M. Paiwa – Grant No. 4273, Lot 56.

The eight Homestead lots in ‘O‘oma 1st, extending from 1,022 feet elevation to the old Māmalahoa Highway and containing approximately 15 to 25 acres each, were sold between 1895 and 1899 (from *makai* to *mauka*) to:

- S. Kane – Grant No. 3819, Lot 55; 1896
- Loe Kumukahi – Grant No. 3820, Lot 54; 1896
- Papala (w) – Grant No. 3820 B, Lot 53; 1896
- Kaulainamoku – Grant No. 3821, Lot 52; 1896
- L. Kahinu – Grant No. 3805, Lot 51; 1895
- J. Hoolapa – Grant No. 3804, Lot 50; 1895
- J.M. Lilinoe – Grant No. 4343, Lot 49; 1899
- J. Palakiko – Grant No. 3822, Lot 48; 1899

Except for the Homestead parcels and the two lots patented to Koanui and Keone, no other land in ‘O‘oma 1st was sold during this time. The land was retained by the government and portions leased out for grazing (see General Lease No.’s 590 and 604). In ‘O‘oma 2nd, *makai* of the four newly created homestead lots, were two lots consisting of approximately 1,333 acres—the first lot from above the shore to the 1847 *Alanui Aupuni*, containing approximately 302 acres, and the other lot extending *mauka* from the same *Alanui Aupuni*, to about the 700 foot elevation (containing approximately 1,031 acres; Figure 28). In 1899, John A. Maguire, founder of Huehue Ranch applied for a Patent Grant on both of the *makai* lots, but he only secured Grant No. 4536, for the lower parcel of 302 acres, in ‘O‘oma 2nd. Maguire’s Huehue Ranch did hold General Lease No.’s 1001 and 590 for grazing purposes on the remaining government lands—both below and above the *mauka* highway—in ‘O‘oma 2nd.

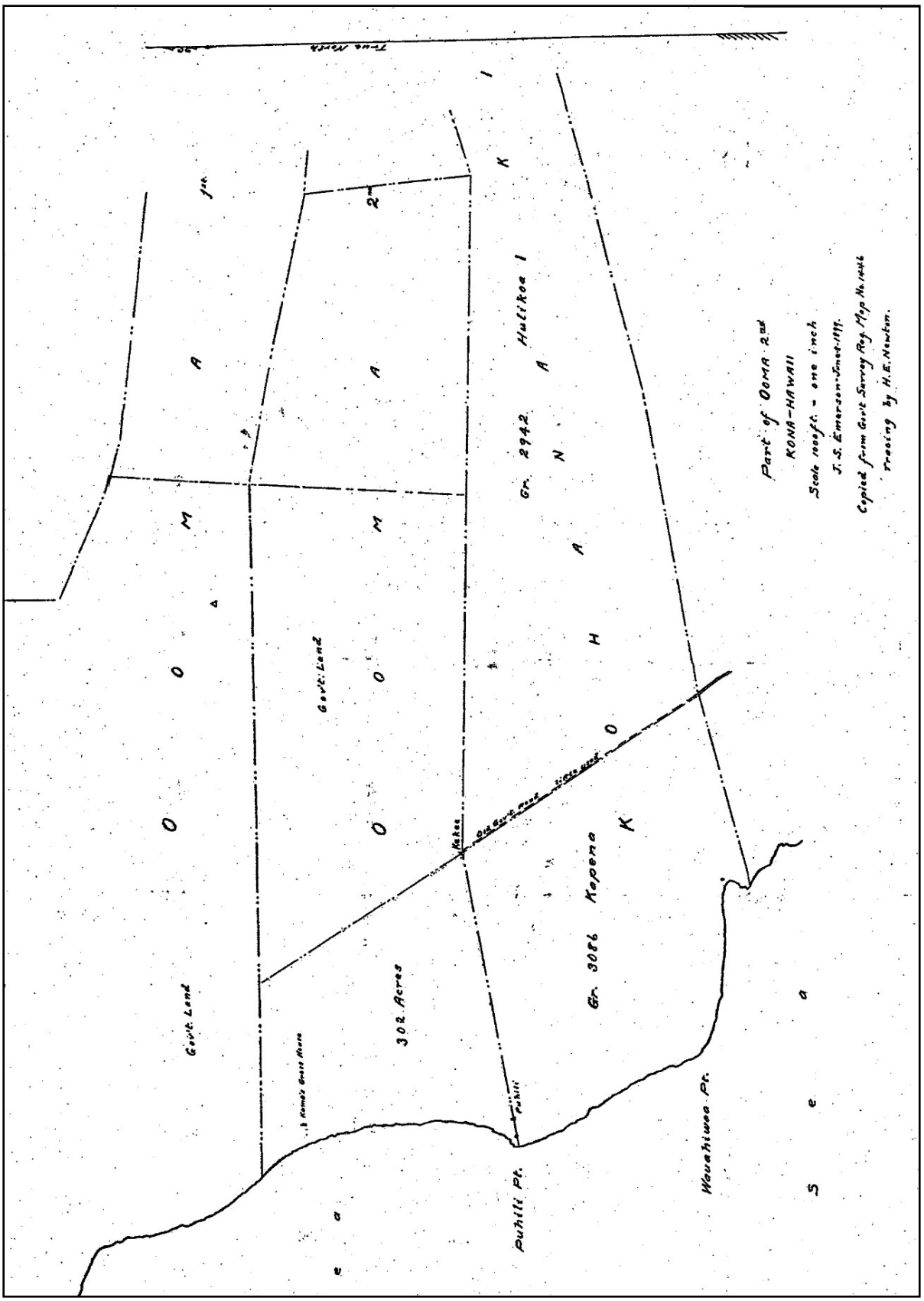



Figure 28. 1899 Grant Map No. 4536 showing *makai* portion of ‘O‘oma 2nd to John A. Maguire.

The notes of survey from Maguire's Grant No. 4536 describes the near shore parcel in 'O'oma 2nd, and it also references one of the prominent cultural-historical features on the boundary between 'O'oma 2nd and Kohanaiki, an "old 'Kahua hale' on white sand…" The "kahua hale" being an old house site. The notes of survey (see Figure 28) read:

> Grant No. 4536
>
> To J.A. Maguire
>
> Purchase Price $351.00
>
> A Portion of Ooma 2nd, N. Kona, Hawaii Applied for by J.C. Lenhart, June 8, 1899.
>
> Beginning at Puhili Gov't. trig. St. on the boundary between Kohanaiki and Ooma marked by a drill hole in stone 9 feet South of the South corner of an old "Kahua hale" on white sand at a point from which
>
> Akahipuu Gov't. trig. Sta. is N 55º 27' 39" E true 32634.7 feet
>
> Keahole Gov't. Trig. Sta. is N 21º 52' 36" W true 9310.5 ft.
>
> Keahuolu Gov't Trig. Sta. is S 22º 24' 36" E true 20,141.8 ft., and running —
>
> 1. S. 79º 26' W. true 298.0 feet along Gr. 3086 Kapena, to a large [mark] on solid pahoehoe by the sea at Puhili Point, thence continuing the same line to the sea shore and along the sea shore to a point whose direct bearing and distance is:
>
> 2. N. 4º 54' W. true 4192.0 feet;
>
> 3. Due east true 2920.0 feet along Ooma 1st;
>
> 4. S. 31º 30' E. true 3920.0 feet along reservation for Gov't. Road 30 feet wide;
>
> 5. S 790º 45' W. true 4387.0 feet along Grant 3086 Kapena, to initial point and including an area of 302 acres.

*The Kalaoa-'O'oma Homesteads*

In March and April of 1902, S. M. Kanakanui and his assistant George F. Wright surveyed and subdivided 1,736 acres of land in the *makai* portions of 'O'oma and Kalaoa into fifteen homestead lots (Lots 1-15) known collectively as the Kalaoa-'O'oma Homesteads (Figure 29). They also surveyed the remaining portions of the boundary of 'O'oma 2nd (the area leased to J. A. Maguire), laid out a road from the homesteads to the *mauka* Government Road, laid out a realigned portion of the *makai* Government Road, and accurately surveyed two miles of coastline. The *Report of the Surveyor of the Territory of Hawai'i for the Year Ending June 30th, 1902* contains the following account of that survey:

> …Mr. Kanakanui's party travelled overland to Ooma, which is situated about five or six miles North of Kailua, North Kona. March 20th. until April 30th. was taken up with the subdividing of 1736 acres of land situated in Ooma I and Kalaoa V, into fifteen homesteads of from 100 to 130 acres each, also with the running out of the boundary of the remaining portion of Ooma II, below the Government Road, a tract of 1031 acres. A 50 foot road, a little over three and one half miles in length and from two to six per cent grade was run through the homesteads to connect with the Government Road. Another road, a little over one and one half miles through the lower section of these lands, was run, and over two miles of coast line was accurately located. (Wall 1902:5)

Following the initial survey of the homesteads the fifteen lots were further subdivided into twenty-five lots (all but Lots 3, 13, 14, and 15 were divided roughly in half and designated as Lots 1A and 1B, 2A and 2B, etc…). The current study area includes portions of Lots 1A and 1B. The road to the *mauka* Government Road laid out by Kanakanui and Wright in 1902 splits the Kalaoa-'O'oma Homesteads in half, and appears to approximate the boundary between Kalaoa 5th (to the north) and O'oma 1st (to the south), while at the same time maintaining the appropriate grade. This road was never built, nor was the *makai* Government road ever realigned, and although there were several applicants for the Kalaoa-'O'oma Homesteads, by ca. 1910 only two of the *mauka*-most lots had been patented (Lots 13 and 15). Applicants for land in 'O'oma 1st and Kalaoa 5th at this time (from *makai* to *mauka*) included:

- H. Greyson – Right of Purchase Lease # 35; Lot 1-B (cancelled);
  Greyson's parcel was just *mauka* of the shore line exclusion in Kalaoa 5th.
- Kanealii – Right of Purchase Lease # 30; Lot 4-B (cancelled);
  Kanealii's parcel was just *mauka* of the shore line exclusion in 'O'oma 1st.

- C. W. Heremona – Right of Purchase Lease # 31; Lot 3-A (cancelled);
Heremona's parcel was along the *makai* edge of the realigned Government Road in O‘oma 1st.
- S. Kupuoa – Right of Purchase Lease # 34; Lot 5 (cancelled);
Kupuoa's parcel was along the *mauka* edge of the realigned Government Road in Kalaoa 5th.
- Wm. Kouhi – Right of Purchase Lease # 32; Lot 9 (cancelled);
Kouhi's parcel was *mauka* of Kupuoa's parcel in Kalaoa 5th.
- J.W. Wahinekapu – Right of Purchase Lease # 29; Lot 11 (cancelled);
Kouhi's parcel was *mauka* edge of Kouhi's parcel in Kalaoa 5th.
- Wm. Keanaaina – Right of Purchase Lease #33; Lot 13 (Patented by Grant No. 5472);
The *makai* end of Wm. Nuuanu Keanaaina's Grant 5472, is situated at approximately 325 feet above sea level in ‘O‘oma 1st.
- J. Maiola – Right of Purchase Lease # 28; Lot 14 (cancelled);
J. Maiola's parcel was situated about 525 feet above sea level in ‘O‘oma 1st.
- K. Kama Jr. – Right of Purchase Lease #27; Lot 15 (Patented by Grant No. 5046);
The *makai* end of K. Kama's Grant No. 5046, is situated at approximately 725 feet above sea level in ‘O‘oma 1st.

With the exception of Lots 13 and 15 (totaling 252.5 acres), the *makai* lands of the Kalaoa-‘O‘oma Homesteads (1,485.5 acres) were never patented and remained in the inventory of Government Lands. By the early twentieth century the coastal lands of Kekaha were only sparsely populated, as most of the residents, with the drastic changes in land tenure that occurred during the second half of the nineteenth century, had either moved away or chosen to reside permanently in the more agriculturally productive uplands (Rechtman and Maly 2003).

*Twentieth Century Land Tenure in the Vicinity of the Current Study Area*

*Kama‘āina* who have participated in oral history interviews (see Rechtman and Maly 2003), describe on-going travel between the uplands and coastal lands of ‘O‘oma, Kalaoa and other *ahupua‘a* in Kekaha throughout the twentieth century. The primary method of travel between 1900 and 1947, was by foot or on horse or donkey, and those who traveled the land, were generally residents of the ‘O‘oma, Kalaoa, Kohanaiki Homesteads and other lands in the immediate vicinity. The 1924 U.S.G.S. Keāhole Point quadrangle (Figure 30) shows a trail/road, labeled "Kauhini Road" descending from the uplands of Kalaoa 4th/5th to Wawaloli (beach/pond) at the shore of ‘O‘oma 1st, just south of the Parcel 088 project area. An upper portion of this road, labeled "Alanui Kauhini" is shown on an 1889 map prepared by J.S. Emerson (see Figure 29). Kauhini Road was likely named for a former resident of the Kalaoa/‘O‘oma area, who had applied for the Grant No. 1599 in the uplands of those *ahupua‘a* in 1855, but who moved away before the grant was patented (see above, Summary of Land Tenure Described in Grant Records). On the 1924 U.S.G.S. map, Kauhini Road is shown crossing the realigned 1847 Government Road and continuing to the near shore *alaloa* (see Figure 30). The near shore trail is depicted along the coast between the *ahupua‘a* of Honokāhau and Kalaoa 4th, where it terminates at the Keāhole Point lighthouse and light keeper's residence.

The lighthouse at Keāhole Point started as a wooden mast beacon constructed sometime after 1906, and in 1910 the Territory of Hawai‘i set aside the land at Keāhole Point for use as a lighthouse reservation (Moore et al. 1999). According to Dean (1991), John Makahi serviced the light from 1909 to 1912 and Samuel Leleo was the light keeper until 1914 when a "new" concrete lighthouse was constructed. Between 1915 and 1919 the light was attended to by Haliaka Kahananui, a resident of Kalaoa *mauka* (Kahananui received Grant No. 3750, Homestead Lot 47, in Kalaoa 4th along the southern edge of Kauhini Road in 1895). Kahananui "was responsible for refilling and lighting the gas light in the lighthouse on a weekly basis," following "a trail to the coast, walking or riding on horseback the 3 miles from her home" (Moore et al. 1999:17). Her service ended when the oil lamps were replaced with battery powered electric lights.

After World War II, retired military vehicles became available to the public, and after that time, the *Alanui Aupuni* and some of the smaller trails along the shore were modified for vehicular traffic. The primary routes of travel through the 1960s, descended from upland Kohanaiki and Kaloko, or came out of Kailua. In the 1950s, Hu‘ehu‘e Ranch bulldozed a Jeep road to the shore at Kaloko. The ranch, and some individuals who went to the shore either as a part of their ranch duties, or for leisure fishing along the coast, used this Jeep road. The 1959 U.S.G.S. Keāhole Point quadrangle (Figure 31) shows that Kauhini Road and the near shore *alaloa* were also converted to "Jeep Trails" by this time. The *Alanui Aupuni* was modified for vehicular travel from Kailua, to at least as far as Honokāhau and Kaloko *ahupua‘a*, and remained in use through the 1970s.

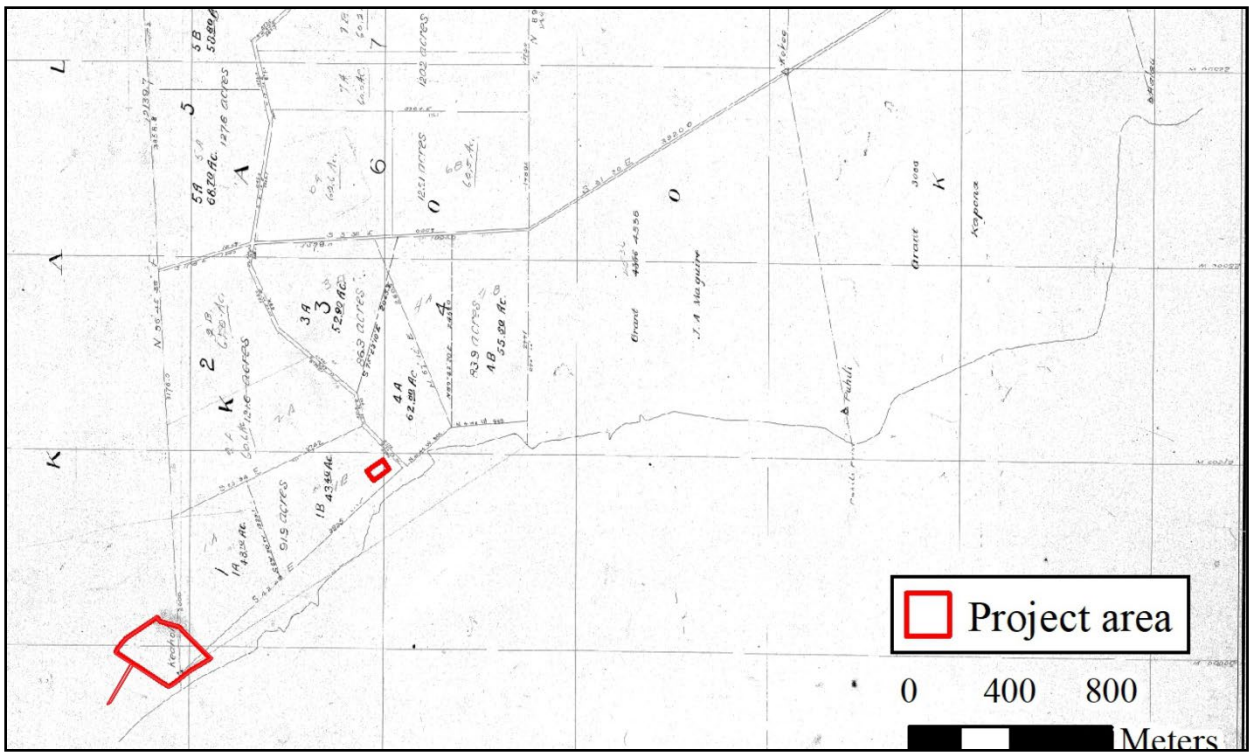



Figure 29. Hawai‘i Registered Map No. 2123 (prepared by S. M. Kanakanui and G.F. Wright, May 1902) showing the current study area outlined in red.

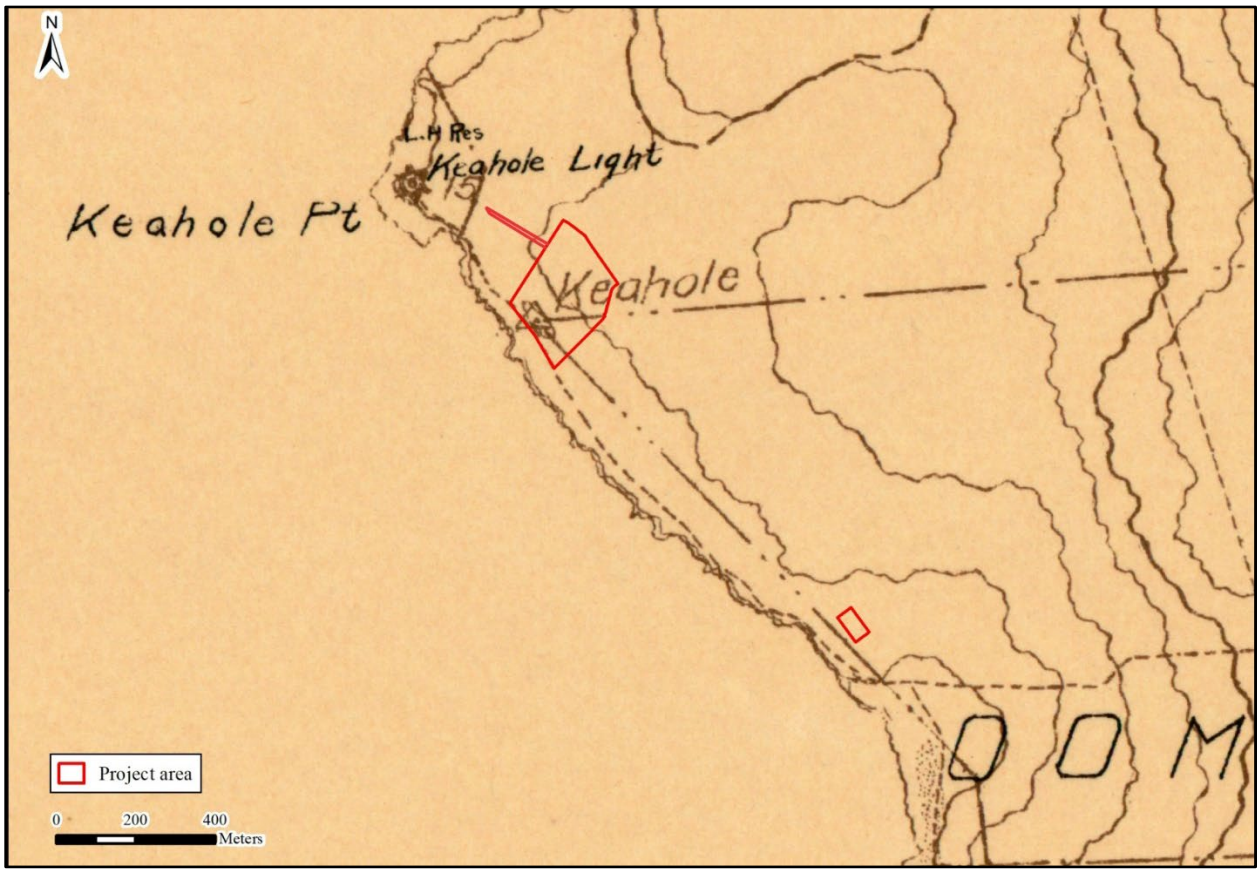



Figure 30. Portion of the 1924 U.S.G.S. Keāhole Point quadrangle showing the current project areas in red.

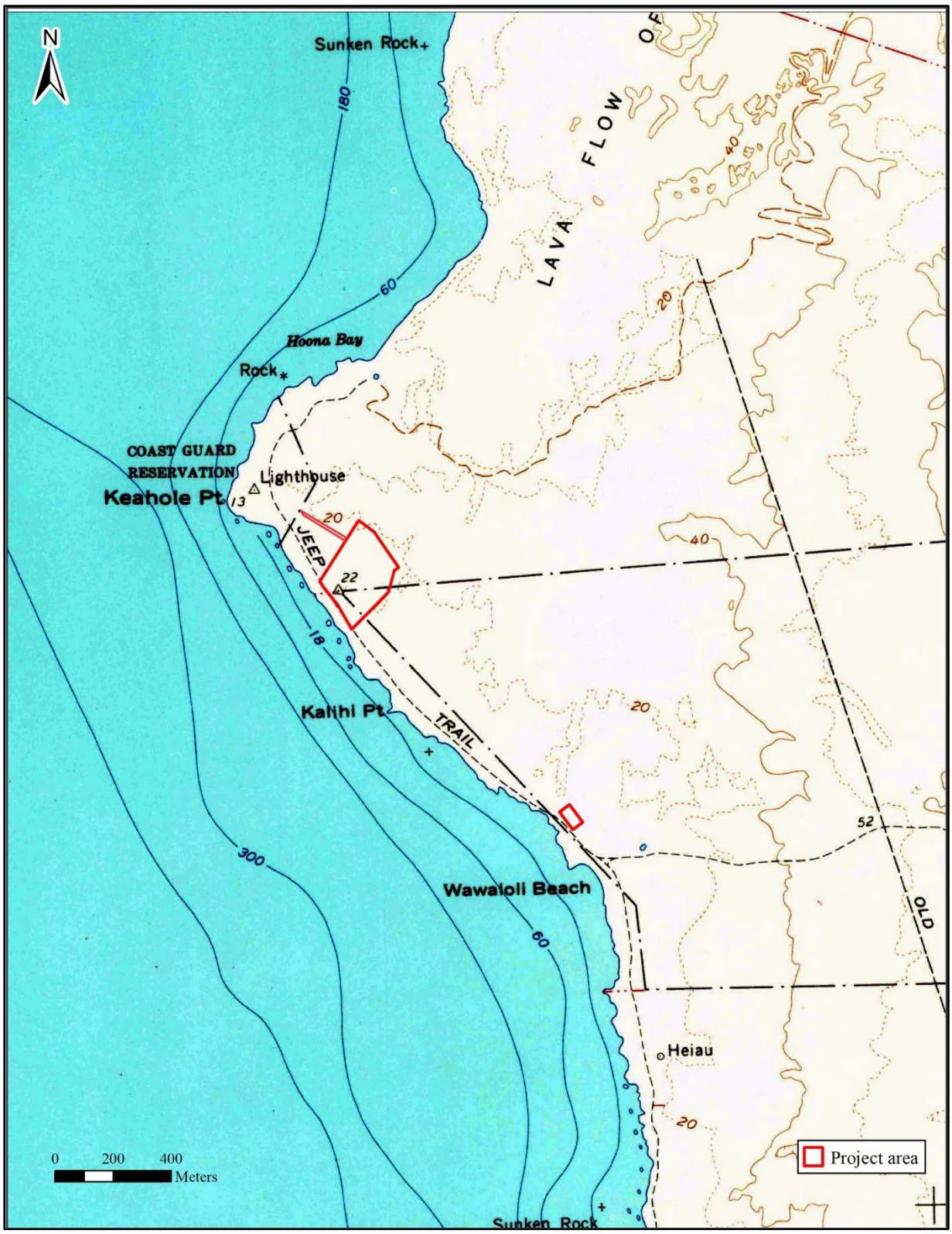



Figure 31. Portion of the 1959 U.S.G.S. Keāhole Point quadrangle.

The coastal lands of Kekaha in the vicinity of the current study area, many of which became State-owned lands after statehood in 1959, remained untouched by modern development through the 1960s (Figure 32). It was not until 1968 when construction began on a section of the new Queen Kaʻahumanu Highway right-of-way between Kealakehe Ahupuaʻa and the newly planned Keāhole Airport on State-owned lands in Awalua, ʻŌhiki, Puʻukala, Kau, Makaʻula, Haleohiu, Hamanamana, and Kalaoa 1st-4th *ahupuaʻa* that the landscape of Kekaha began to drastically change. Work on the Keāhole Airport facility began on May 27, 1969, when the first 1,000 pound ceremonial charges of dynamite signaled the start of construction, and was completed thirteen months later (Figure 33), when the airport was dedicated on July 1, 1970 (http://hawaii.gov/hawaiiaviation/hawaii-airfields-airports/hawaii/kona-international-airport-at-keahole/). The Keāhole Point airport facility has substantially expanded since its 1970 dedication. The Queen Kaʻahumanu Highway, between the airport and Kawaihae, was completed by ca. 1973, once again opening up travel across the *kula kai* (shoreward plains) of Kekaha to the general public.

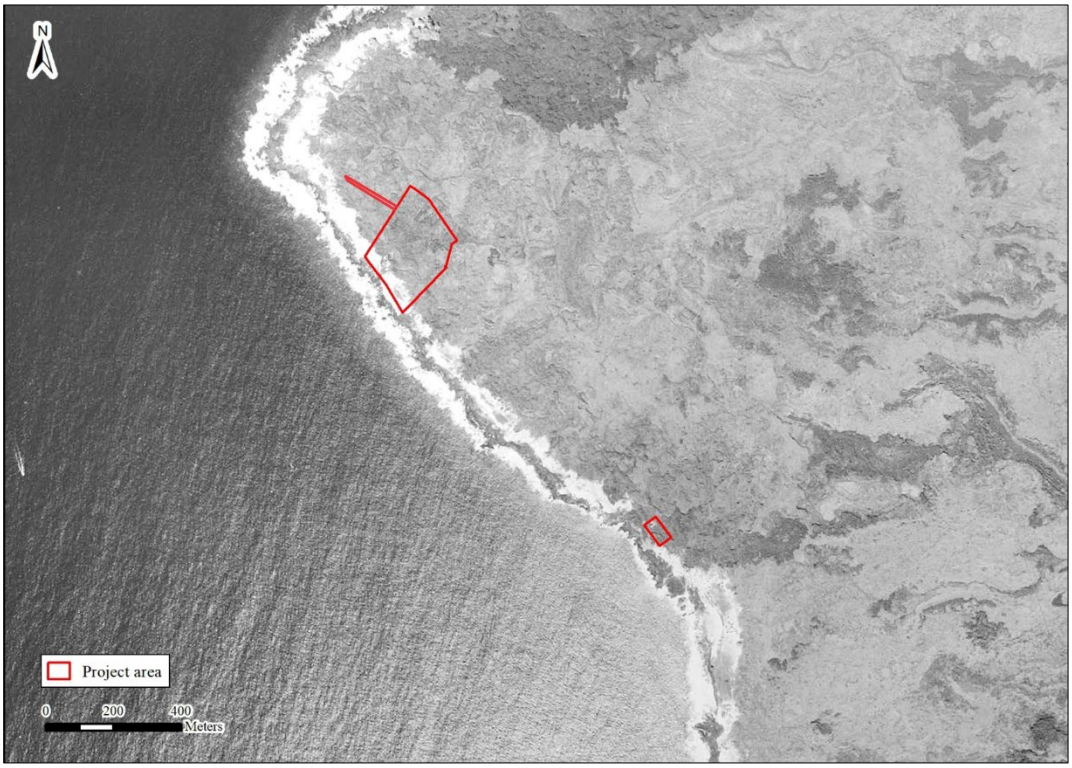



Figure 32. January 17, 1965 aerial photograph showing the Kekaha lands in the vicinity of the current project areas.

The construction of the Queen Kaʻahumanu Highway to Keāhole Airport opened up access to the Kekaha lands in the vicinity of the current study area, and created opportunities for further development of these lands. Recognizing the area's potential for ocean related research, thermal energy conversion demonstration, and aquaculture, the State of Hawaiʻi, in 1974, established the Natural Energy Laboratory of Hawai'i (NELH) at Keāhole Point (Group 70 2011). The initial NELH site (Figure 34) consisted of an access road easement from the highway and 322 acres of coastal land adjacent to (south and west of) the airport. The access road (Makako Bay Drive) was in place by 1977 (Figure 35), and construction of the initial offices, research facilities, and an Ocean Thermal Energy Conversion (OTEC) plant at NELH had begun by ca. 1980 (Figure 36). After the construction of the NELH access road, Kauhini Road and the coastal Jeep Road were no longer regularly used to access the shoreline in the vicinity of the current study area. In 1986, in an effort to provide sites for the commercialization of research activities initiated at NELH, the State added an additional 548 acres of land (including the current study area) for the creation of the Hawaiʻi and Ocean Technology (HOST) Park. These two properties, although their missions were complementary, were administered separately until 1990, when the State Legislature (Chapter 227D, HRS) consolidated management of NELH and HOST Park's 870 acres of lands and facilities (Figure 37) under a single state agency, the Natural Energy Laboratory of Hawaiʻi Authority (NELHA) (Group 70 2011). Today, with several deep water pipelines pumping seawater at a rate of more than 43,000 gallons per minute to the facility, there are more than forty tenants engaged in aquaculture, water bottling, energy projects, research, and education on the NELHA lands.

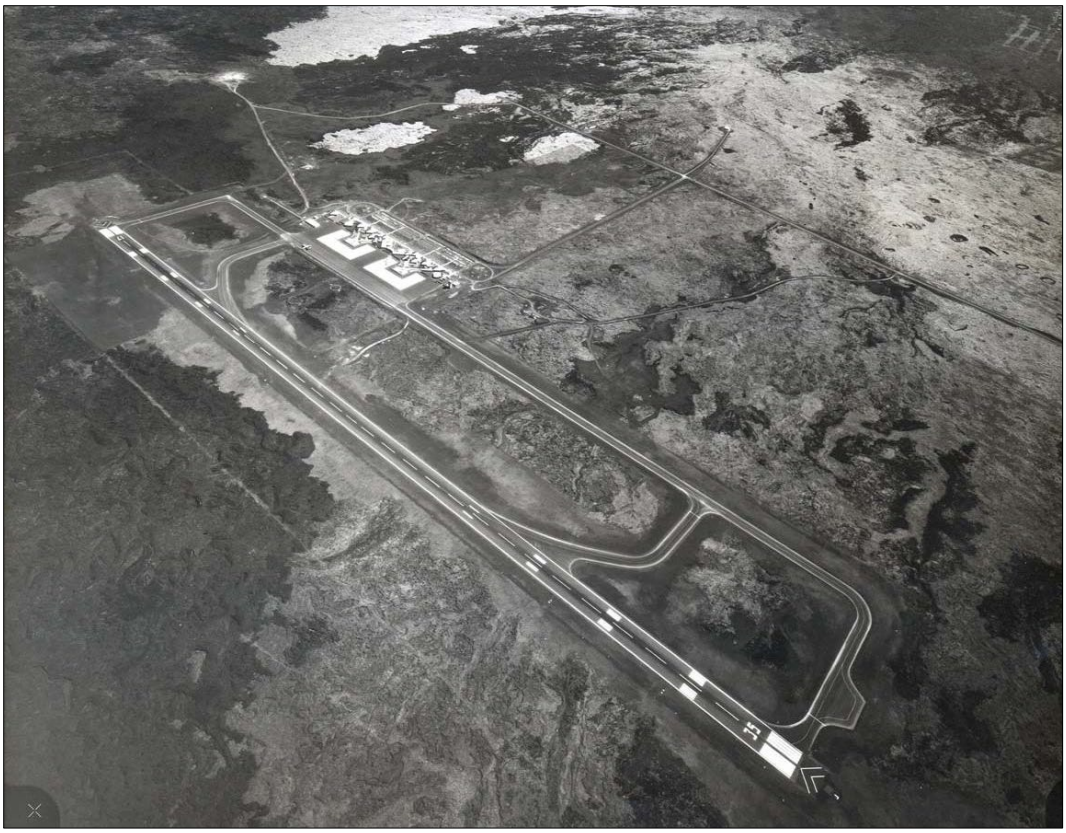


Figure 33. Oblique aerial view of the completed Keāhole Airport facility taken on October 6, 1971.

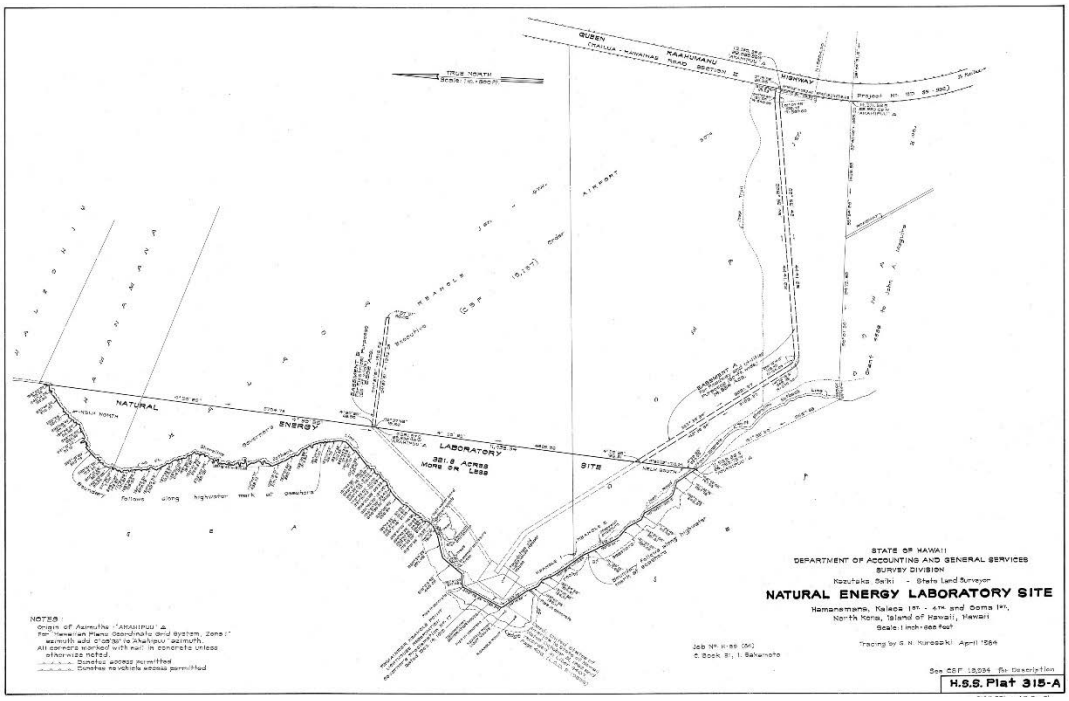



Figure 34. Map of the initial 322-acre NELH site (traced by G.H. Kurosaki April 1984).

Figure 35. March 27, 1977 aerial photograph showing the completed NELH access road.

Figure 36. Oblique aerial view of the initial NELH facilities under construction in 1980.

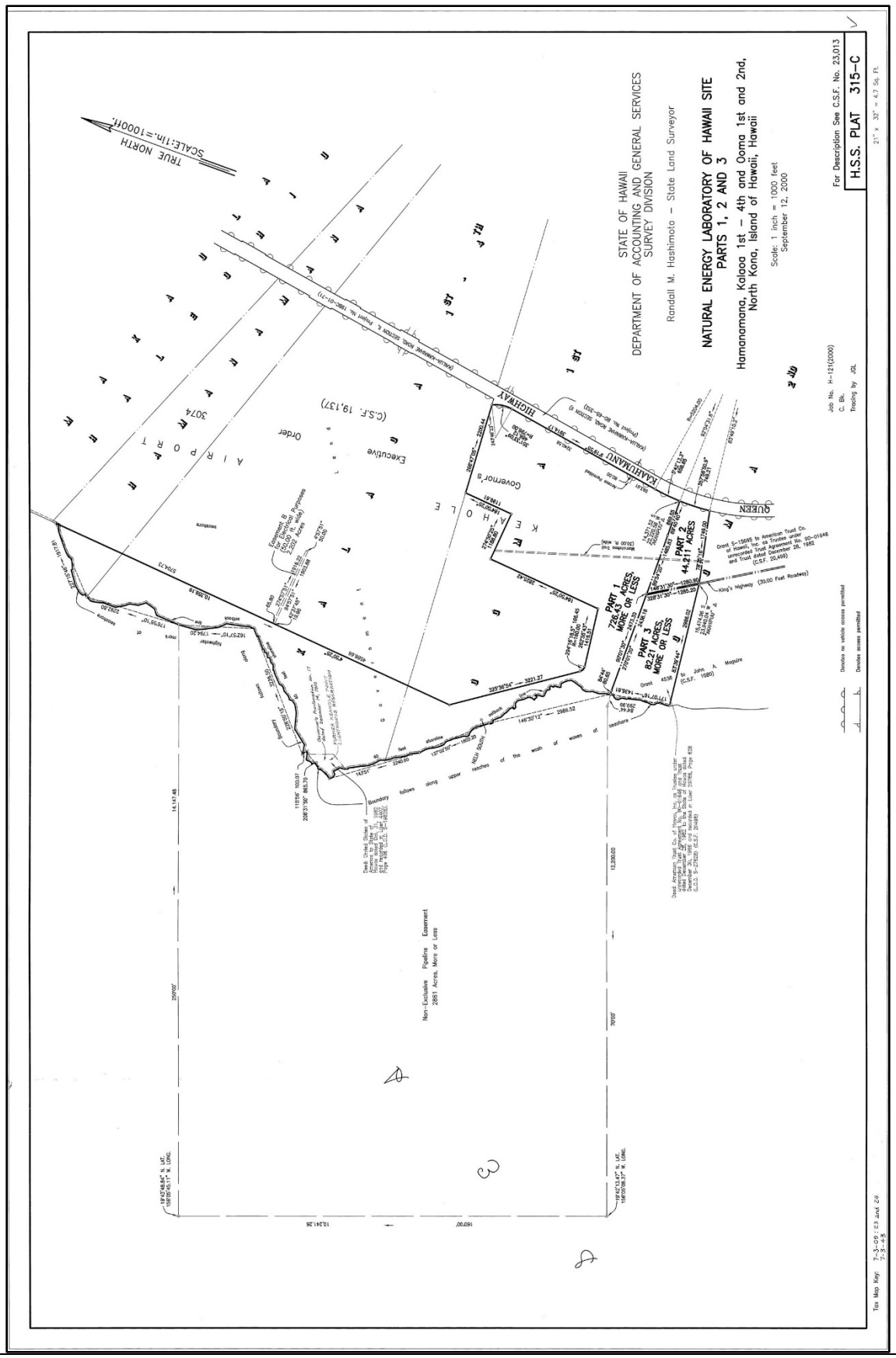



Figure 37. Map of the expanded NELH and HOST Park site (prepared on September 12, 2000).

## PREVIOUS ARCHAEOLOGICAL STUDIES

The NELHA HOST Park lands encompassed by the current project area have been the subject of many archaeological investigations. To assist in generating a set of expectations regarding the nature of historic properties that may be encountered within this area, the following archaeological background summarizes the findings of relevant studies previously conducted in the coastal portions of ‘O‘oma and Kalaoa *ahupua‘a* (Table 2). The locations of the previously conducted studies, relative to the current project area, are shown in Figure 38. The studies are presented below in chronological order.

**Table 2. Archaeological studies conducted in the coastal portions of ‘O‘oma and Kalaoa *ahupua‘a*.**

| *Year* | *Author* | *Area* | *Type of Study* |
|---|---|---|---|
| n.d. | Reinecke | Various | Survey |
| 1969 | Ching et al. | ‘O‘oma 2nd to Pu‘ukala | Survey and Testing |
| 1975 | Rosendahl and Kirch | ‘O‘oma/Kalaoa | Reconnaissance Survey |
| 1976 | Rosendahl* | ‘O‘oma/Kalaoa | Reconnaissance Survey |
| 1978 | Rogers-Jourdane | ‘O‘oma/Kalaoa | Reconnaissance Survey |
| 1979 | Barrera | ‘O‘oma/Kalaoa | Survey and Testing |
| 1980 | Rosendahl | ‘O‘oma/Kalaoa | Survey |
| 1981 | Cordy* | Various | Survey and Testing |
| 1984 | Clark | ‘O‘oma 1st to Hamanamana | Reconnaissance Survey |
| 1985a | Barrera | ‘O‘oma/Kalaoa | Reconnaissance Survey |
| 1985b | Barrera | ‘O‘oma 2nd | Reconnaissance Survey |
| 1985 | Cordy* | ‘O‘oma/Kalaoa | Archaeological Review |
| 1986 | Cordy | ‘O‘oma 2nd | Field Check |
| 1987 | Donham | ‘O‘oma 2nd | Survey and Testing |
| 1989 | Barrera | ‘O‘oma/Kalaoa | Data Recovery |
| 1992 | Barrera | ‘O‘oma 2nd | Data Recovery |
| 1999 | Moore et al. | Kalaoa 5th | Inventory Survey |
| 2000 | Corbin | ‘O‘oma 2nd | Data Recovery |
| 2001 | Roberts and Roberts | Kalaoa 5th | Data Recovery |
| 2001 | Roberts | Kalaoa 5th | Preservation Plan |
| 2004 | Rechtman and Clark | ‘O‘oma/Kalaoa | Preservation Plan |
| 2006 | Rechtman and Clark | ‘O‘oma 2nd | Preservation Plan |
| 2007 | Rechtman | ‘O‘oma 2nd | Update Inventory Survey |
| 2010a | Rechtman | ‘O‘oma 1st | Field Inspection |
| 2010b | Rechtman | ‘O‘oma 1st | Field Inspection |
| 2010c | Rechtman | Kalaoa 5th | Field Inspection |
| 2012a | Rechtman | ‘O‘oma 1st | Field Inspection |
| 2012b | Rechtman | ‘O‘oma 1st | Field Inspection |
| 2012c | Rechtman | ‘O‘oma 1st | Field Inspection |
| 2012 | Rechtman and Clark | ‘O‘oma/Kalaoa | Update Inventory Survey |
| 2015 | Nelson et al. | ‘O‘oma 1st and 2nd | Inventory Survey |
| 2017 | Rechtman | Kalaoa 5th | Field Inspection |
| 2017 | Clark et al. | ‘O‘oma/Kalaoa | Inventory Survey |

***Project location not shown in Figure** 38**.**

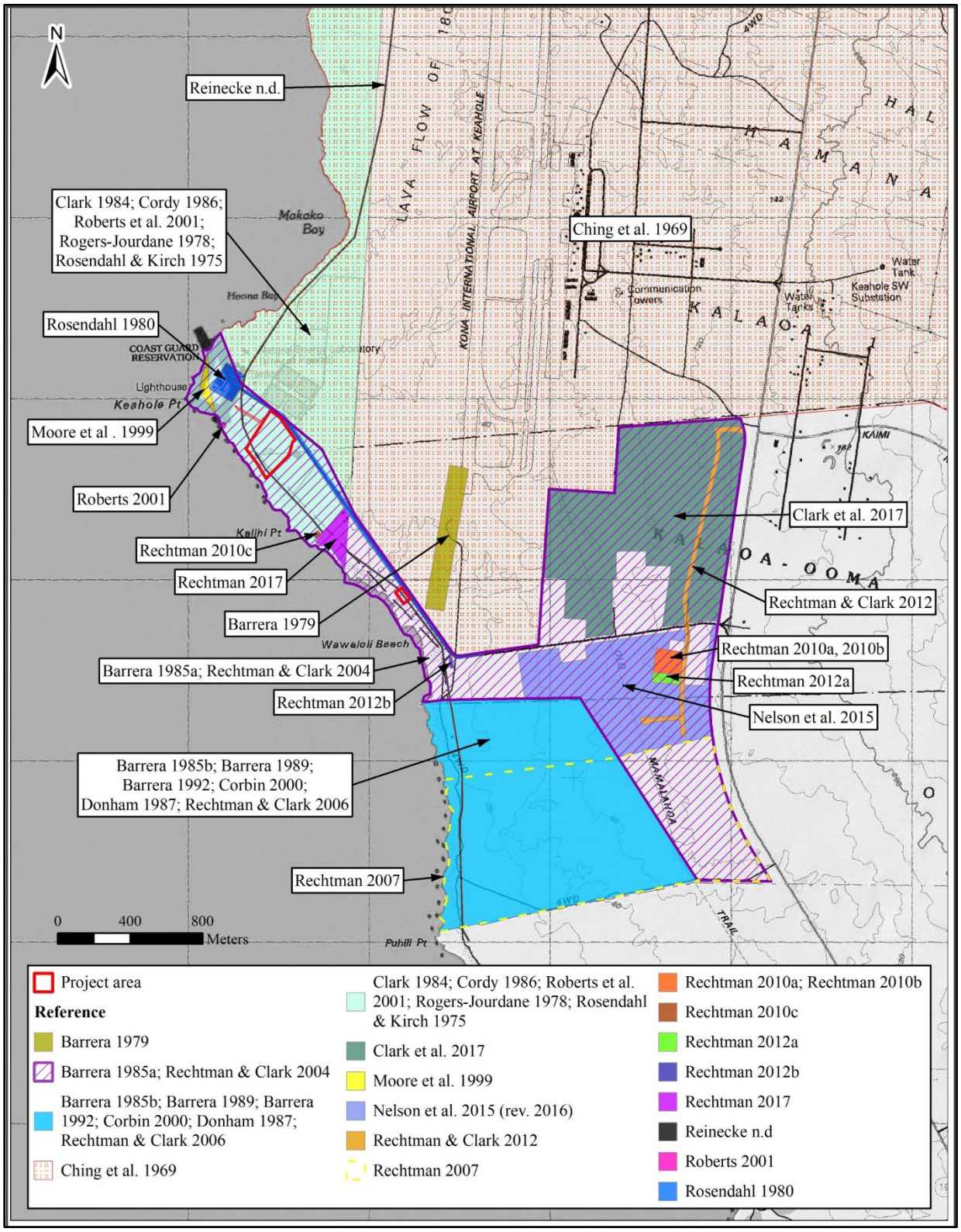



Figure 38. Previous archaeological studies conducted in the vicinity of the current project area.

In 1929-1930, the Bishop Museum contracted John Reinecke to conduct a survey of Hawaiian sites in West Hawai‘i; this was the first attempt at a survey of sites of varying function, ranging from ceremonial to residency and resource collection (Reinecke 1930). A portion of Reinecke’s survey fieldwork, extended north from Kailua as far as Kalāhuipua‘a, and included the coastal portions of the ‘O‘oma and the Kalaoa *ahupua‘a*. During his study, Reinecke traveled along the shore, documenting near-shore sites. Where he could, he spoke with the few native residents he encountered. Among his general descriptions of the Kekaha region, Reinecke observed:

> This coast formerly was the seat of a large population. Only a few years ago Keawaiki, now the permanent residence of one couple, was inhabited by about thirty-five Hawaiians. Kawaihae and Puako were the seat of several thousands, and smaller places numbered their inhabitants by the hundreds. Now there are perhaps fifty permanent inhabitants between Kailua and Kawaihae–certainly not over seventy-five.
>
> When the economy of Hawaii was based on fishing this was a fairly desirable coast; the fishing is good; there is a fairly abundant water supply of brackish water, some of it nearly fresh and very pleasant to the taste; and while there was no opportunity for agriculture on the beach, the more energetic Hawaiians could do some cultivation at a considerable distance *mauka*.
>
> The scarcity of remains is therefore disappointing. This I attribute to four reasons: (1) those simply over looked, especially those a short distance mauka, must have been numerous; (2) a number must have been destroyed, as everywhere, by man and by cattle grazing; (3) the coast is for the most part low and storm-swept, so that the most desirable building locations, on the coral beaches, have been repeatedly swept over and covered with loose coral and lava fragments, which have obscured hundreds of platforms and no doubt destroyed hundreds more; (4) many of the dwellings must have been built directly on the sand, as are those of the family at Kaupulehu, and when the posts have been pulled up, leave no trace after a very few years.
>
> The remains on this strip of coast have some special characteristics differentiating them from the rest in Kona. First, there is an unusual number of petroglyphs and papamu, especially about Kailua and at Kapalaoa. Second, probably because of the strong winds, there are many walled sites, both of houses and especially of temporary shelters… (Reinecke n.d.:1-2)

The following site descriptions are quoted from Reinecke’s manuscript of fieldwork conducted between Pūhili Point on the Kohanaiki-‘O‘oma 2nd boundary, and Keāhole Point near the Kalaoa 5th boundary. In the site descriptions below, Reinecke references the occurrence of at least six house sites; seven enclosures and pens (one of which is an “old cattle pen”); eleven terraces and platforms (one of which he felt was a “heiau”); two caves; two ahu; a stepping stone trail; three waterholes and a well; and eleven rock shelters. Apparently, no one was residing in the area at the time of his field survey. Reinecke’s description of the features, albeit limited, contains valuable information about site condition and provides a seventy plus year perspective on natural degradation along this coastline (c.f., Donham 1987:7). Based on the limited descriptions, Site 84 may be within the current project area (Parcel 100), as well as Site 77 (Parcel 088 por.). Reinecke’s site descriptions, from south to north, across ‘O‘oma 2$^{nd}$, ‘O‘oma 1$^{st}$, and Kalaoa 5$^{th}$ *ahupua‘a* (Sites 66 to 85), are as follows:

> Site 66. Very doubtful dwelling site. Then a row of sand-covered platforms at the border of the sand and the beach lava, enough for 6-10 homes. Remains of an old, large pen.
>
> Site 67. Dry well on the crest of the beach.
>
> Site 68. Water hole, two small platforms, four or more shelters, pens with very small platform.
>
> Site 69. Large cattle pen. Doubtful old, rough platform at its north end. Remains of two old platforms by an ahu to the north.
>
> Site 70. Walled platform, S.E. corner terraced, badly broken down. Platform mauka. The walls of this and of Site 73 are built of thin pieces of pahoehoe surface lava, rather unusual in appearance.
>
> Site 71. A knob partly walled on its slopes, with house site. Adjoining it on the south is a rough platform with three smooth boulders – heiau and kuula? Back of this a house platform and a platform about a fine shelter cave. Another platform and wall are about a slight natural depression filled with bones, including those of a whale.
>
> Site 72. Ruins of a pen.

Site 73. Apparently a modern dwelling site of unusual construction; two terraces of pebbles, the upper 29x25x2 in front and 4-5' high elsewhere; the lower 19x10x25x3, with a three-sided pen at N.E.; surrounded by a carefully laid wall.

Site 74. A shelter about a shallow cave; remains of another shelter; an ahu.

Site 75. Trace of site; house platform; enclosure on shore. There are many faint traces of sites on this strip of coast. Toward the north is an unmistakable small site.

Site 76. Modern shelter pen; house or shelter site; shelter mauka by kiawe tree.

Site 77. Platform; tiny pen; sites of some kind marked by stones in lines on the pahoehoe flow.

Site 78. Slightly brackish springs and pools; house site, shelters, stepping stone path leading to the walled house site…

Site 79. An old platform; remains of pen; second old platform.

Site 80. An old platform; traces of several ruins on the beach.

Site 81. Two pens, one with modern house platform; several ruins along the coast; a heap of stones on the pahoehoe – probable dwelling site.

Site 82. Cairn on knob; dwelling site adjacent to south.

Site 83. A string of ruined sites in the coral sand. Two dwelling sites on the pahoehoe stand out. There even seems to be a papamu, (?) 11x10 – a sign of leisured settlement. More traces of ruins follow.

Site 84. By the Keahole boundary ahu: small platform and enclosure, with walled cave behind.

Site 85. A broken series of ruined platforms, some apparently large, running along the coast.

[Reinecke n.d.:15-16]

No further archaeological study of this area was undertaken until the late 1960's when archaeological surveys were required prior to construction of the Keāhole Point Airport, and the Kailua-Kawaihae Road Corridor of Queen Kaʻahumanu Highway. Archaeological survey at the proposed Keāhole Point Airport and salvage operations along a two-mile extension of the Kailua-Kawaihae road and the area enclosed by the boundaries of the Keahole Airport were conducted by Francis Ching, Deborah Cluff, and Thomas Riley of the DLNR- Division of State Parks between December 26, 1968 and January 4, 1969 (Ching et al. 1969). The area surveyed extended from Puhili point in Kohanaiki Ahupuaʻa in the south to Makaʻula Ahupuaʻa in the north. Initial survey was by helicopter with follow-up ground survey conducted south of the 1801 lava flow, within the highway corridor, and along trails. A total of 343 features were recorded, with 216 located along the coast between the water's edge and 800 feet inland. Feature types along the coast included enclosures, shelter and habitation caves, terraces, platforms, walls, salt pans, *papamū*, hearths, carirns, petroglyphs, a wet cave, a well, filled crevasses, and brackish water catchments.

In 1971-72, DLNR-Division of State Parks began an inventory of known archaeological sites on the Island of Hawaiʻi and visited the sites Reinecke (n.d.) recorded along the ʻOʻoma-Kalaoa coastline. These sites were assigned State Inventory of Historic Places (SIHP) site numbers, site forms were completed, and sketch maps were made. Reinecke's sites were assigned the state site numbers 1911–1920. Reinecke's Site 77 was assigned SIHP Site number 50-10-27-1919.

In 1975, Paul H. Rosendahl and Patrick V. Kirch of the B. P. Bishop Museum conducted an archaeological reconnaissance survey of the Natural Energy Laboratory Hawaiʻi (NELH) facility at Keāhole Point (Rosendahl and Kirch 1975). This brief two day survey included a corridor that extended from Queen Kaʻahumanu Highway to the coast along the ʻOʻoma 1st/2nd boundary and then along the shore to Keāhole Point. Fourteen sites and site complexes along the coast were identified and briefly described in the survey report. Reinecke's Sites 77 (Site 1919) and 84 were relocated. Site 1919 was described by Rosendahl and Kirch (1975:7) as "a small enclosure, a small platform, and several stone alignments (possible house outlines). Site 84 was described as a small platform and enclosure with a small cave shelter nearby (Rosendahl and Kirch 1975:9). Rosendahl and Kirch reported that the cave shelter had been looted but still contained sufficient material to excavate.

In May of 1976, Rosendahl returned to NELH and conducted a one day reconnaissance survey of an alternative road corridor between Queen Kaʻahumanu Highway and the coast, and an area along the periphery of the airport property. Rosendahl (1976) noted several cairns and apparent foot trails, but did not describe them or plot them on a map.

In May of 1978, Elaine Rogers-Jourdane of the B. P. Bishop Museum conducted an archaeological reconnaissance survey of additional areas within the Natural Energy Laboratory Hawai‘i at Keāhole Point, including the access road corridor previously surveyed by Rosendahl and Kirch (1975) and the development footprint for the initial office and research facilities. During the Rogers-Jourdane (1978) study eleven site areas were located, briefly described, and photographed. Feature types identified within the survey area included cairns, walls, cave shelters, a modified depression, enclosures, and platforms. All of the site areas noted by Rogers-Jourdane (1978) were situated in the coastal portion of the NELH property. The reconnaissance survey was followed by a more intensive survey and salvage excavations (Rosendahl 1980) at eight of the eleven sites identified by Rogers-Jourdane (1978). None of the sites are located within the current project area. The excavations yielded data, including traditional Hawaiian artifacts such as files, abraders, fishhooks, and octopus lures, and later Historic artifacts, that attested to the extent of marine resource exploitation in the area.

In January of 1979, William Barrera of Chiniago Inc. surveyed two emergency service road corridors extending off either end of the of the Keāhole Airport runway (Barrera 1979). The southern corridor extended across Kalaoa 5th into ‘O‘oma 1st Ahupua‘a, and contained two sites: a habitation shelter (Site 6961), and a twelve feature complex (Site 6962) composed of three habitation shelters, a possible well, and eight mounds. A test unit was excavated within an L-shaped enclosure (Feature C) that was part of the feature complex recorded in ‘O‘oma 1st Ahupua‘a. Testing revealed a thin midden deposit beneath the wall and resting directly on bedrock. Cultural material recovered during testing included marine shell, fishbone, sea urchin, coral, and a single fish hook blank of mammal bone.

Ross Cordy carried out an intensive survey and subsurface testing program in 1975 along the coast of ‘O‘oma, Kalaoa, and seven other *ahupua‘a* of Kekaha, and synthesized the data he generated as part of his doctoral dissertation (Cordy 1981). The survey covered the immediate shoreline area extending to roughly a quarter or a half-mile inland in some areas. All sites fitting Cordy’s criteria (size, form, etc.) for permanent habitation were mapped. Test units were excavated at twenty sites, including at Site 1919, while volcanic glass and surface artifacts were collected from others. Cordy excavated a test unit at Feature A of Site 1919 and concluded that the site was a commoner household dating from A.D. 1728 to Contact and that Feature A was likely a sleeping house and Feature B was a special purpose feature. The methods and interpretive analyses are reported on in both Cordy (1981) and Cordy and Kaschko (1980).

In 1984, Stephan D. Clark of the B. P. Bishop Museum conducted an archaeological reconnaissance of the entire *makai* portion of the NELH facility between Hamanamana and ‘O‘oma 1st Ahupua‘a. Clark (1984) identified twenty-four sites with more than sixty individual features including eight platforms, fourteen enclosures, two Historic house sites, four trails five cairns, two *papamū*, nine rock-filled crevices, a petroglyph area, two C-shaped shelters, four walls, and numerous rock alignments. The previously identified sites were correlated with their earlier Reinecke (n.d.), Rosendahl and Kirch (1975), and Cordy (1978) Bishop Museum site numbers; newly identified sites were assigned new Bishop Museum site numbers. Clark noted that in the vicinity of NELH “the coastal areas are fairly rich in surface structural remains, in spite of the inhospitable environment” (1984:10-11). As part of Clark’s survey, Reinecke’s Site 84 was re-located and described using the Bishop Museum nomenclature D-15-15. Site D15-15 is described as a multi-feature complex consisting of cairns, shelter caves, walls, petroglyphs, a platform, and enclosure, and a possible old Keāhole boundary marker. A detailed description of Site D-15-15 is presented below in the findings section of this report.

In 1984, William Barrera of Chiniago Inc. began a series of archaeological studies, survey and data recovery that included most of the previously surveyed NELH lands, and all of the newly created HOST Park lands (Barrera 1985a, 1985b, 1989). The first study, an archaeological reconnaissance survey of a 450-acre portion of the NELH and HOST Park lands located between Queen Ka‘ahumanu Highway and the coast in Kalaoa 5th, ‘O‘oma 1st and 2nd *ahupua‘a* (Barrera 1985a), included the northern portion of the area previously surveyed by Clark (1984). During this survey Barrera conducted pedestrian sweeps across the area at intervals of 100-feet looking for evidence of past use. He identified 45 sites including the Māmalahoa Trail (Site 2) and four other sites previously assigned SIHP designations (Sites 1917, 1919, 5603, and 5604), and 40 sites not previously assigned SIHP designations (Sites 10151-10190).

The sites recorded by Barrera (1985a) included the Māmalahoa Trail, fourteen habitation shelters or shelter complexes, two midden scatters, twelve isolated stone mounds, four mound complexes, a habitation cave, three *pāhoehoe* excavations, six C-shaped enclosures, and two “petroglyphs” interpreted as Historic boundary markers (Site 10178). None of the sites were recorded in detail, but all were briefly described, plotted on a scaled map of the project area, and photographed; some artifacts were also surface collected by Barrera (Cordy 1985). Two of the sites (Sites 1919 and 10185) identified by Barrera were situated near the Hale Wawaloli portion of the current project area (Figure 39). Barrera relocated Site 1919 and described it as a habitation shelter (Barrera 1985a:5). Adjacent to Site 1919 was a midden scatter that was assigned the SIHP Site number 10185 (Barrera 1985a:42). Barrera summarized his findings as follows:

> The sites located during this reconnaissance indicate a light, probably temporary utilization of the inland area and primary concentration of settlement at the coast. Such inland features as were found are small, scattered mounds and crude shelters with little or no midden deposits. The coastal sites, on the whole, can be characterized as large, well built structures of a more permanent nature, as evidenced by the presence of considerably greater amounts of midden materials and artifacts. (1985a:48)

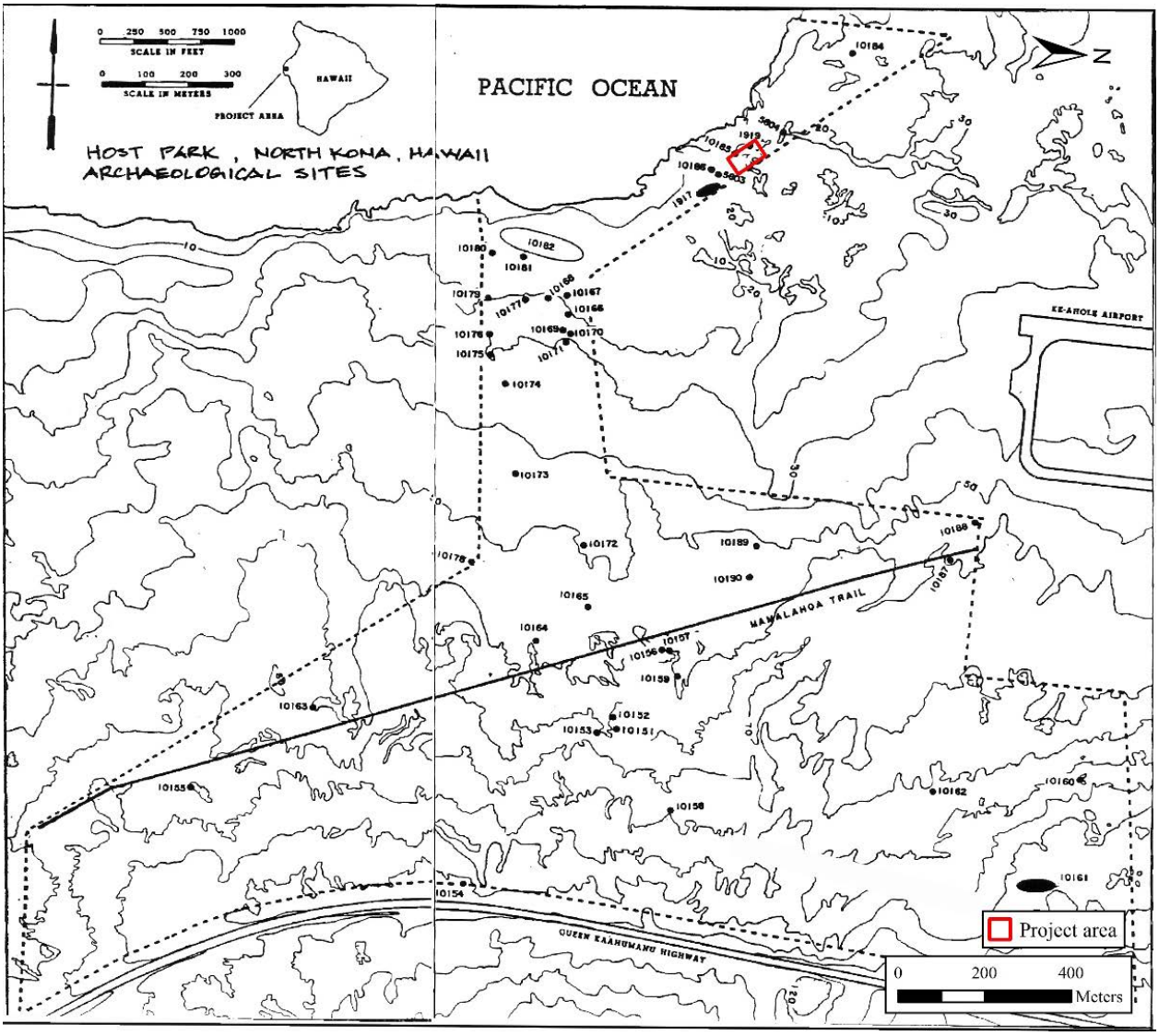



Figure 39. Barrera's (1985a) site location map showing the Hale Wawaloli portion of the current project area outlined in red.

Following the completion of this initial study, Barrera (1985b) conducted an archaeological reconnaissance of a 314-acre parcel occupying the entire seaward portion of O'oma 2nd Ahupua'a between the coastal jeep road and the previous survey area for a private ('O'oma II) resort development (the northern portion of this area would eventually become part of the NELHA administered lands). During his reconnaissance survey Barrera (1985b) located and briefly described some of the sites previously documented by Cordy (1975) and recorded an additional twenty-nine new sites containing a total of fifty-six features. A later DLNR-SHPD field check of the area (Cordy 1986; see below) concluded that while the inland portion of the Barrera (1985b) project area had been adequately surveyed, the coastal portion had not. Cordy (1986:5) found the survey to be deficient because it did not include the coastal portion of the parcel between the Jeep road and the ocean, and it failed to record numerous small coastal sites that were noted, but not reported on.

Cordy (1986) newly identified six sites during the field check. The Barrera (1985b) survey area would later be re-examined by Donham (1987).

In 1985 Ross Cordy, while at the Historic Sites Section of the DLNR-Division of State Parks, prepared a working paper summarizing the archaeology of ʻOʻoma and Kalaoa *ahupuaʻa* (Cordy 1985). The paper synthesizes the collective site data and presents a summary of site patterning by environmental zones (i.e. the coastal zone, barren zone, and upland forest zone). In the coastal zone, which includes the current study area, Cordy notes that:

> The coastal concentration of sites extends inland c. 100 meters, so it actually enters into a small portion of the Barren zone. Sites interpreted as permanent house sites, based on area and other carefully specified criteria (Cordy 1981) are common in this area. At least 22 such sites have been identified -- 8 in Ooma 2, 2 in Ooma 1, 5 in Kalaoa 5 and 7 in Kalaoa 4. These sites are located right along the shore. They include single or multiple major features such as platforms, enclosures, and pavings. Excavations indicate deposits, other than platform fill, are shallow (usually 10-15 cm).
>
> Sites interpreted as temporary dwelling areas -- caves, C-shaped shelters, etc. -- are also common on the coast. They tend to be just behind the coastal zone in the initial fringes of the Barren Zone or in spots along the shore where no permanent housing was present (e.g. , much of Ooma 1). These sites' deposits vary considerably; most are shallow (5-10 cm), but in some cases virtually no deposits are present. The cave in Dl5-20, however, had 30-40 cm of deposits. [1985:31]

Noting the sprawl of encroaching development that had gradually moved into the area in the nearly twenty years since the opening of Queen Kaʻahumanu Highway and the Keāhole Airport, Cordy (1985) offered expectations and recommendations for further study in the *ahupuaʻa* (also by environmental zones). Cordy stated that the coastal zone had been thoroughly covered, "except in Ooma 2 where only larger sites have been identified" (1985:42). He also noted that few burials had been found, with the exception of the remains of a few single individuals in barren zone caves, and that since most larger coastal platforms have already been investigated, burials were most likely to be found within caves in the coastal and barren zone.

In early June 1986, Ross Cordy, still at the Historic Sites Section of the DLNR-Division of State Parks, was asked by the ʻOʻoma II resort planners to review the reconnaissance survey prepared by Barrera (1985b). Cordy (1986) found that Barrera had failed to identify some of the previously recorded sites in the coastal portion of the *ahupuaʻa* (Cordy 1981), and poorly described others, raising concerns that inland sites had also been missed. On June 12, 1986, in an effort to evaluate the thoroughness of the earlier survey work, Cordy conducted a field check of a portion of the inland area (extending beyond the Barrera 1985b survey area into the 1985a survey area) and a small part of the coastal section (see Figure 38). Cordy identified six new sites (seven features) within the inland field check area, but described them as "minor sites," and indicated that only limited additional information would need to be collected at inland areas to "verify ideas on site function" (1986:5). In contrast, in the coastal area, Cordy reported that Barrera's "survey definitely is not complete enough for inventory purposes" (1986:5) and recommended that more intensive survey be conducted both *mauka* and *makai* of the coastal Jeep road to identify smaller sites, and adequately record the previously documented larger sites.

To remedy the deficiencies of the earlier archaeological work, the ʻOʻoma II resort planners hired Paul H. Rosendahl, Inc. (PHRI) to conduct additional archaeological survey and subsurface testing within the 314-acre study area. Fieldwork was conducted on July 16-23, 1986, and the results of the study (Donham 1987) were presented as an appendix to an Environmental Impact Statement prepared for the ʻOʻoma II resort development in 1991. Donham (1987) recorded a total of seventy-four sites containing 279 features – forty seven of which, containing ninety-five features, had been previously identified by Cordy (1975, 1986) and Barrera (1985b). The recorded sites included numerous formal feature types that were interpreted as having been used for temporary and permanent habitation, ceremonial, burial, transportation, quarry, and indeterminate purposes. The revised findings indicated that the earlier Barrera (1985b) study had indeed been inadequate, especially in the coastal portions of the project area. Two of the sites (Sites 1916 and 18028) reported on by Donham (1987) were later the subject of an archaeological data recovery report prepared by (Corbin 2000).

Following the completion of the Barrera (1985a, 1985b) reconnaissance surveys, but prior to the Donham (1987) survey, a mitigation program entitled "Hawaii Ocean Science and Technology Park Work Program for Archaeological Data Recovery" was generated by DLNR-SHPD for the Barrera (1985a) project area. Three levels of further work were called for in the plan including additional recording only (Sites 10154, 10159, 10161, 10163, 10165, 10170, 10172, 10173, 10179, 10180, 10187, 10188, and 10190), further recording and excavation (Sites 10166, 10171, 10175, and 10182), and excavation only (Sites 1917, 1919, and 10185). Two of the sites (Sites 1919 and 10185) lie within the boundaries of the current project area (Parcel 088 por.) and were included for excavation in the data recovery plan.

Barrera (1989) also provided SIHP designations, descriptions, and plan views for sites recorded by Cordy (1975) and Clark (1984) within the coastal portions of the NELH and HOST Park lands (Sites 10191-10214). Although not excavated during Barrera's data recovery, or described in greater detail, Reinecke's Site 84 (Bishop Museum Site D15-15) was assigned the SIHP Site designation 10208 as a result of the study. Figure 40 shows the locations of these sites. During the data recovery fieldwork six more sites (Sites 10169, 10170, 10181, 10194, 10201, and 10214) in the coastal area, including three sites originally documented by Clark (1984) were added to the original scope of work and excavated.

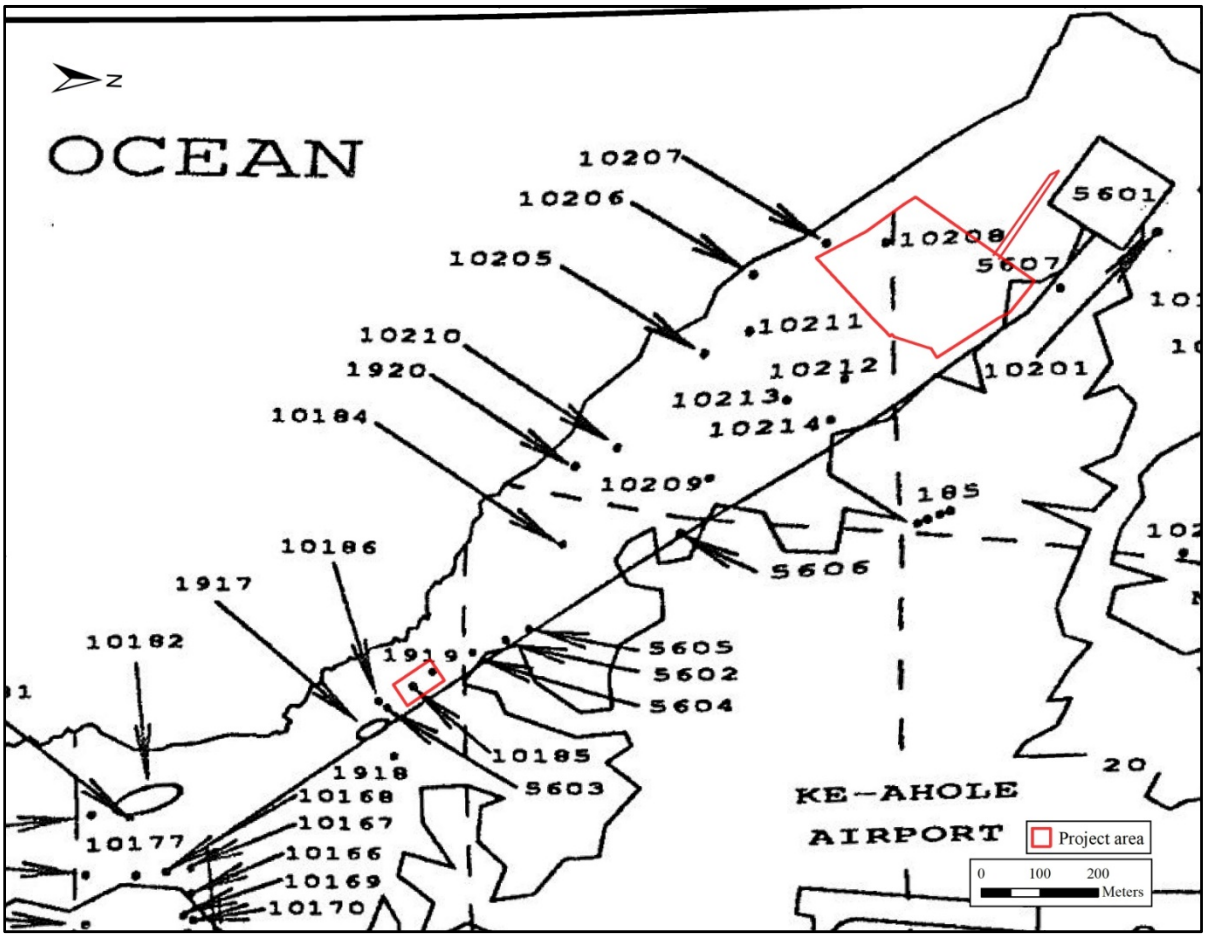



Figure 40. Barrera's (1989) site location map.

The data recovery program at the NELH and HOST Park lands (in 'O'oma 1st and 2nd and Kalaoa 4th and 5th *ahupua'*a) was implemented by Barrera (1989). The two sites (Sites 1919 and 10185) within the Hale Wawaloli portion of the current project area (Parcel 088 por.) were mapped, described in greater detail, and excavated. Barrera described Site 1919 as a platform (Feature A) and an enclosure (Feature B). Only Feature B was excavated as Feature A "was completely destroyed by a bulldozer while straightening the coastal jeep road" sometime between 1975 and 1984 (Barrera 1989:88). Following excavation efforts at Feature B, the site was interpreted as a permanent habitation site occupied by a single family during the eighteenth century, with Feature A the primary habitation locale and Feature B either an ancillary habitation or cookhouse. Site 10185 was recorded by Barrera (1989) as four midden features (Features A-D). Excavation units were placed at Features B, C, and D. The site was interpreted as the midden remains from the inhabitants of Site 1919.

In describing the findings of the data recovery excavations, Barrera (1989) suggests that the earliest occupation of the coastal portions of the NELH and HOST Park lands likely occurred around the middle of the sixteenth century, with occupation continuing and increasing throughout the seventeenth and early eighteenth centuries, but that by the end of the eighteenth century, most of the sites had been abandoned. The archaeological evidence overwhelmingly indicated that the exploitation of marine resources was the primary occupation of residents at the coastal structures in

‘O‘oma and Kalaoa. Human skeletal remains were identified at one of the excavated sites, a small well-constructed *ahu* on the *pāhoehoe* between the NELH access road and the coast (Site 10214).

In 1992, Barrera excavated three additional sites (Sites 16093, 16094, and 16132) situated near the coastal/inland boundary of ‘O‘oma 2nd Ahupua’a established by Cordy (1986). These sites were located in the northern portion of the Barrera (1985b) and Donham (1987) survey areas on a parcel of land that was transferred to NELHA control subsequent to the Donham (1987) study. The three features excavated during the investigation – each “a well constructed platform or straight-sided cairn” that was “built over some sort of modified natural feature” with “more than usual amounts of coral fragments” (Barrera 1992:13) – were interpreted by Barrera as having some sort of unspecified ceremonial association.

In this same area in 1999, near the coastal/inland boundary of ‘O‘oma 2nd Ahupua‘a in the northern portion of the Barrera (1985b) and Donham (1987) survey area near the sites excavated by Barrera (1992), PHRI (Corbin 2000) extensively excavated two habitation complexes (Sites 1916 and 18028). Radiocarbon dates collected from the sites indicated that both of the complexes were established around A.D. 1600 to 1650, and that, based on the artifact assemblage, exploitation of marine resources was the primary activity of residents of the area.

Also in 1999, Archaeological Consultants of the Pacific, Inc. (Moore et al. 1999) conducted an archaeological inventory of the land around the Keāhole Point lighthouse in Kalaoa 5th Ahupua‘a. One site of historic significance was identified within the project limits (Site 21350). This site consisted of the concrete lighthouse structure itself (Feature A; built in 1915) and three adjacent petroglyphs including a faint, indecipherable image (Feature B), and two sets of Historic names of individuals associated with the lighthouse and the coastal lands of Kalaoa (Features C and D). The lighthouse structure was replaced in 2009. Archaeological monitoring of the replacement by Rechtman Consulting, LLC revealed no additional sites or features in the area (Ketner and Rechtman 2009).

In 2001, Garcia and Associates (GANDA) conducted archaeological data recovery at three sites within NELHA, in the coastal portion Kalaoa 5th Ahupua‘a (Roberts and Roberts 2001). The three sites (Sites 10211, 10212, and 10213; see Figure 40), originally documented by Clark (1984), included two rock shelters and a complex containing a small platform, a C-shaped enclosure, and an anthropomorphic petroglyph. Radiocarbon analyses did not provide a clear indication of the chronology of site occupation, but the recovered cultural material suggested temporary, recurrent use of the rock shelters beginning during the Precontact Period and lasting into the Historic Period, that the C-shaped enclosure may have been infrequently utilized for short-term habitation purposes, and that the small platform, based on the presence of coral, was likely a fishing shrine.

In 2014 ASM Affiliates conducted an archaeological survey of roughly 110 acres within the NELHA Hawai‘i Ocean Science and Technology (HOST) Park at TMKs: (3) 7-3-043:080 por., 085, 089 por., 090, and 091 por., adjacent to Queen Ka‘ahumanu Highway (Nelson et al. 2015, revised in 2016). As a result of their survey fourteen archaeological sites containing a total of twenty features were recorded. The sites included one (Site 6432) previously documented by Davis (1977), six (Sites 2, 10153, 10164, 10165, 10173, and 10178) that were previously documented by Barrera (1985a, 1989), and seven newly identified sites (Sites 30380-30386). Two sites previously recorded by Barrera (1985a) near the boundary of the current study area (on Parcel 089), consisting of a midden scatter and a stone mound (cairn) and a *pāhoehoe* excavation (Sites 10151 and 10152), were not relocated, and are thought to have been destroyed by modern disturbance. The archaeological sites included the Māmalahoa Trail (Site 2), a core-filled boundary wall and complex of related boundary markers (Sites 6432 and 10178), three lava blisters (Sites 30380, 30381, and 30382), five rock rings and a rock alignment (Sites 10165, 30383, 30384, 30385, and 30386), a cairn (Site 10153), and a *pāhoehoe* excavation (Site 10164).

In 2015, ASM Affiliates conducted an archaeological inventory survey of roughly 210 acres within the NELHA Hawai‘i Ocean and Technology (HOST) Park at TMKs: (3) 7-3-043:072, 073, 074, and 078 por., adjacent to Queen Ka‘ahumanu Highway (Clark et al. 2017). As a result of their survey seventy-three archaeological sites containing a total of 381 features were recorded. The sites included eight (Sites 2, 10160 to 10162, and 10188 to 10190) that were previously documented by Barrera (1985a, 1989), an additional feature of a site complex (Site 28813) recorded by Monahan et al. (2012) within the Queen Ka‘ahumanu right-of-way, all three of the sites (Sites 29272 to 29274) previously documented by Rechtman and Clark (2012) within their study area, and sixty-one newly identified sites (Sites 30315 to 30375). Three sites previously recorded by Barrera (1985a) near the boundary of the current study area (on Parcels 073 and 074), consisting of two stone mounds (cairns) and a *pāhoehoe* excavation (Sites 10156 to 10158), were not relocated, and were thought to have been destroyed by modern disturbance. Newly identified site types included multiple rock rings, blisters and lava tubes used for both shelter and/or habitation, cairns, and a trail.

With the exception of the 2015 archaeological inventory survey discussed above, most of the more recent archaeological work within the NELHA administered lands has focused on preservation planning, updates of earlier archaeological surveys, and field inspections of specific development parcels. A preservation plan for Site 10211 in coastal Kalaoa 5th Ahupuaʻa was prepared by Roberts (2001), the section of the Māmalahoa Trail (Site 2) across the NELHA lands was prepared by Rechtman and Clark (2004), and a preservation plan for seven sites (Sites 1913, 1914, 1915, 16132, 18025, 18026, and 18027) in ʻOʻoma 2nd Ahupuaʻa, within the northern portion of the Barrera (1985b) and Donham (1987) survey area, was prepared by Rechtman and Clark (2006). A preservation plan was also prepared for Site 10205 by Dircks Ah Sam and Rechtman (2015). To the south of NELHA, an update inventory survey of the southern portions of the combined Donham (1987) and Barrera (1985a, 1985b) project areas (see Figure 38) was conducted by Rechtman (2007). This update inventory survey revealed the presence of two additional sites (Site 25932 and 26678) within the Barrera (1985b) and Donham (1987) survey area. Both sites consisted of lava tubes containing human skeletal remains that were located approximately 200 meters *makai* of the Māmalahoa Trail (Site 2). One site previously recorded by Barrera (1985a), a crude C-shaped shelter (Site 10163), was not relocated during the update survey.

Field inspections of specific development parcels within the NELHA HOST Park, in areas that were previously surveyed by Barrera (1985a), have generally matched the findings of the early reconnaissance survey, confirming the lack of sites in some areas (Rechtman 2010a, 2010b, 2010c, 2012b, 2012c), and the presence of previously recorded sites in others, albeit with some modern disturbance that has impacted or completely removed some of the features from the site (Rechtman 2012a, 2017).

# 3. PROJECT AREA EXPECTATIONS

Based on the previously conducted archaeological studies (Barrera 1985a, 1989; Clark 1984; Cordy 1981; Reinecke 1930; Rosendahl and Kirch 1975) that have included portions of the subject parcels and surrounding lands, combined with the culture-historical background information presented above, a set of field expectations specific to the current project areas is presented. The prior archaeological studies conducted in the vicinity of the project area have documented numerous Precontact to early Historic Period archaeological feature types that generally confirm Cordy's (1985) model of expected site patterning for the coastal zone of ʻOʻoma and Kalaoa. The site patterning for the coastal zone of ʻOʻoma and Kalaoa consists of large permanent habitation sites (enclosures and platforms), smaller temporary habitation sites usually located within caves or c-shapes, and associated midden piles. Cairns marking places or trails may also be present.

Three archaeological sites (Sites 1919, 10185, and 10208) were previously identified within the project area as a result of the prior archaeological studies (see Figure 40). These sites are indicative of permanent habitation and generally confirm Cordy's (1985) model of expected site patterning for the coastal zone of ʻOʻoma and Kalaoa. Sites 1919 and 10208 are both habitation sites and Site 10185 consists of midden piles associated with Site 1919.

Site 10208 is expected to be within the Innovation Center project area (Parcel 100). Although this site was never excavated, and an archaeological preservation area is shown on the current TMK plat (see Figure 3), extensive bulldozing has occurred and many of the features of Site 10208 are expected to have been destroyed. If present, features of Site 10208 could include cairns, shelter caves, walls, petroglyphs, a platform, an enclosure, and the old Keāhole boundary marker.

Sites 1919 and 10185 were formerly present within the Hale Wawaloli portion of the current project area (Barrera 1985a; Cordy 1981; Reinecke 1930; Rosendahl and Kirch 1975), but have both been extensively excavated and impacted by development activities. Feature B of Site 1919 and Features B, C, and D of Site 10185 were excavated by Barerra (1989). Excavation of Site 1919 Feature B included four excavation units within the enclosure, and the removal of the northwest and northeast sections of the enclosure's walls. Excavation of Site 10185 included the complete excavation of Feature B, one excavation unit at Feature C, and five excavation units at Feature D. During his work, Barrera noted that Feature A of Site 1919 had been destroyed by a bulldozer during straightening of the coastal jeep road sometime between 1975 and 1984. Because of the past data recovery efforts and bulldozing at Site 1919 and Site 10185, no archaeological features are expected to remain within the Hale Wawaloli portion of the current project area.

# 4. FIELDWORK

Fieldwork for the current study was conducted on April 21, 2021, and May 19, 2021, by Manuel Lopez, B.S. and Matthew Clark, M.A. (Principal Investigator). A total of sixteen person-hours were expended to complete the fieldwork.

## FIELD METHODS

During the archaeological field survey, the entire (100%) ground surface of the project area was visually inspected by field technicians walking transects oriented north-south, spaced at no more than 10 meters apart. The locations of all archaeological features encountered during the survey were recorded using a handheld tablet computer running ESRI's Collector application connected to an EOS Arrow 100 GNSS receiver with sub-meter accuracy (set to the NAD 83 Zone 4 North). The identified features were then cleared of vegetation, photographed (both with and without a meter stick for scale), depicted on a scaled drafted plan map, and described using standardized feature record forms. Previously identified features were correlated to their existing SIHP site and feature designations; newly identified features were assigned temporary site (T-1, T-2, etc.), and feature (A, B, C, etc.) sequentially as they were documented. No subsurface testing was conducted as part of the current study.

## FINDINGS

As a result of the fieldwork for the current study, one previously recorded site (Site 50-10-27-10208) was relocated, and two new sites (Sites 50-10-27-T-1 and -T-2) were recorded (Table 3). All three sites are located within the Innovation Center survey area on Parcel 100. Due to the extensive excavations and prior bulldozing at Site 1919 and 10185, no new or previously recorded archaeological features were observed within the Hale Wawaloli Welcome Center portion of the project area on Parcel 088 (por.). The locations of Sites 10208, T-1, and T-2 relative to the current project area boundaries are presented in Figure 41. The sites are described in detail below.

**Table 3. Archaeological sites recorded during the current study.**

| *SIHP Site Number* | *Type* | *Function* | *Age* |
|---|---|---|---|
| 50-10-27-10208 | Complex | Habitation | Precontact/Historic |
| 50-10-27-T-1 | Complex | Possible marker | Unknown |
| 50-10-27-T-2 | Complex | Resource excavation | Unknown/Precontact |

### Site 50-10-27-10208

Site 10208 is a habitation complex located along the western boundary of Parcel 100 (see Figure 41). Site 10208 was first recorded by Reinecke (1930) as Site 84 and described as "a small platform and enclosure with walled cave behind." Subsequent archaeological surveys expanded the site to include ten features (Features 1-10). Following Reinecke's survey, Site 84 was assigned site number D15-15 by the Bishop Museum in the early 1970's. In 1975, During Ross Cordy's Ph.D. work in 'O'oma and Kalaoa, Site D15-15 was relocated, and a map of Feature 1 was made (Figure 42). Then in 1984, the entire site was mapped (Figure 43) and described in detail (Clark 1984). During prior data recovery efforts at the HOST Park and NELH (Barrera 1989), Site D15-15 was assigned SIHP Site number 10208. Barrera did not excavate Site 10208 or update Clark's 1984 site description.

The following description of Site 10208 is reproduced from Clark (1984:20); the site is described using the B.P. Bishop Museum designation D15-15 followed by the numerical feature designations (1 through 10; see Figure 43):

> D15-15. Feature complex situated on the pahoehoe bluff containing the U.S.G.S. "Keahole 22" survey pole and bench marks, and in the adjacent northeast roughly rectangular pahoehoe depression. It is composed of ten features.
>
> D15-15-1. Rectangular, three-sided enclosure situated near the east edge of the pahoehoe bluff about 9.3 m east of the U.S.G.S. survey pole. Open to the west, it measures 6.2 by 4.8 m in size and has stacked basalt boulder-and-cobble walls from 0.6 to 0.7 m in height. Interior floor surface comprises coral pebbles, gravel, and sand with a basaltic gravel and sand component. Surface midden includes marine shell (Cellana, Cypraea, Nerita, Drupe, and Conus) and sea urchin (Echinometra matheii). Surface volcanic glass flakes are present. A U.S. dime (seated liberty type) dating to the 1850's was collected from the surface adjacent to the enclosure on the northwest. Mean age range is from A.D. 1662±67 to 1807±50.

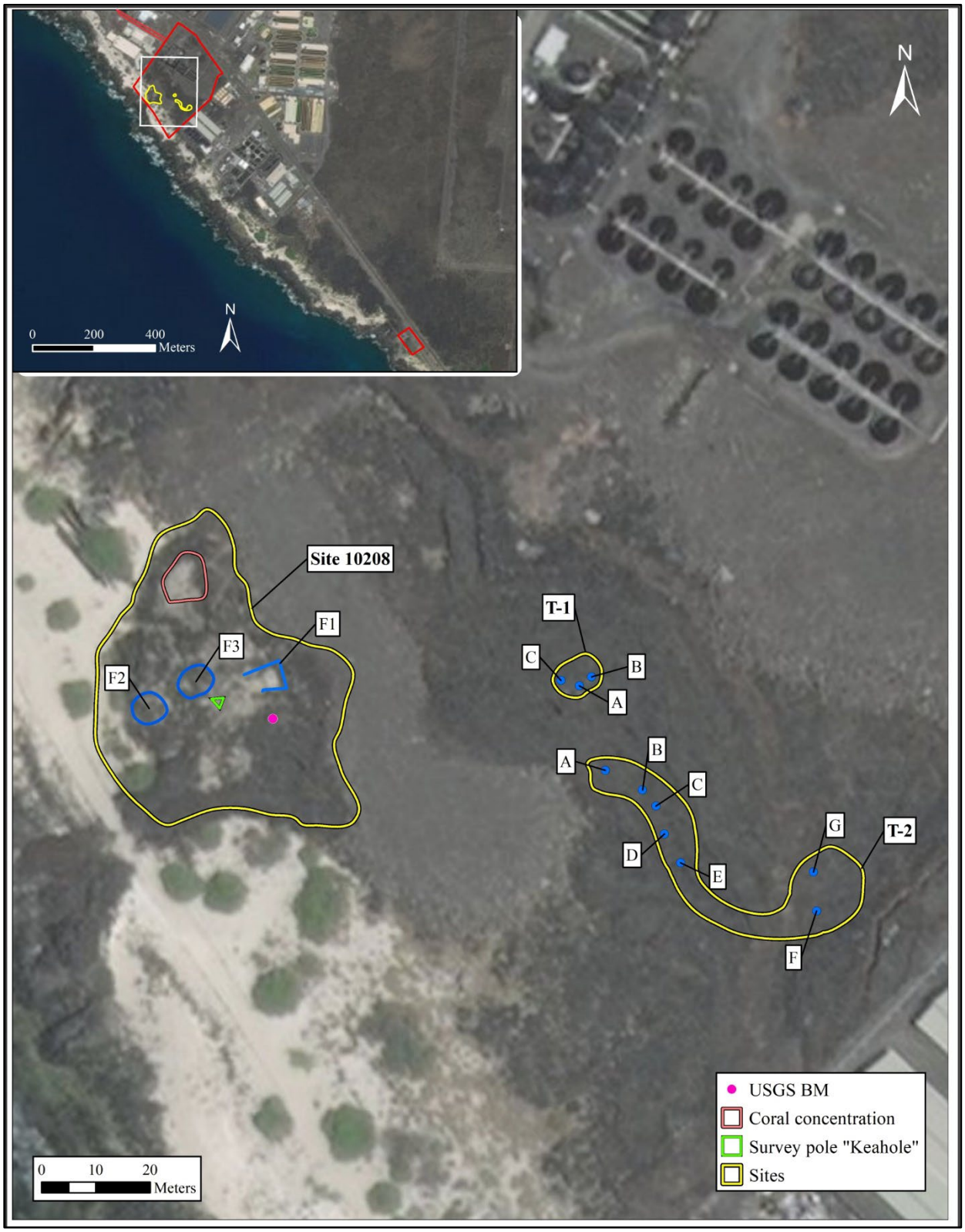



Figure 41. Site location map.

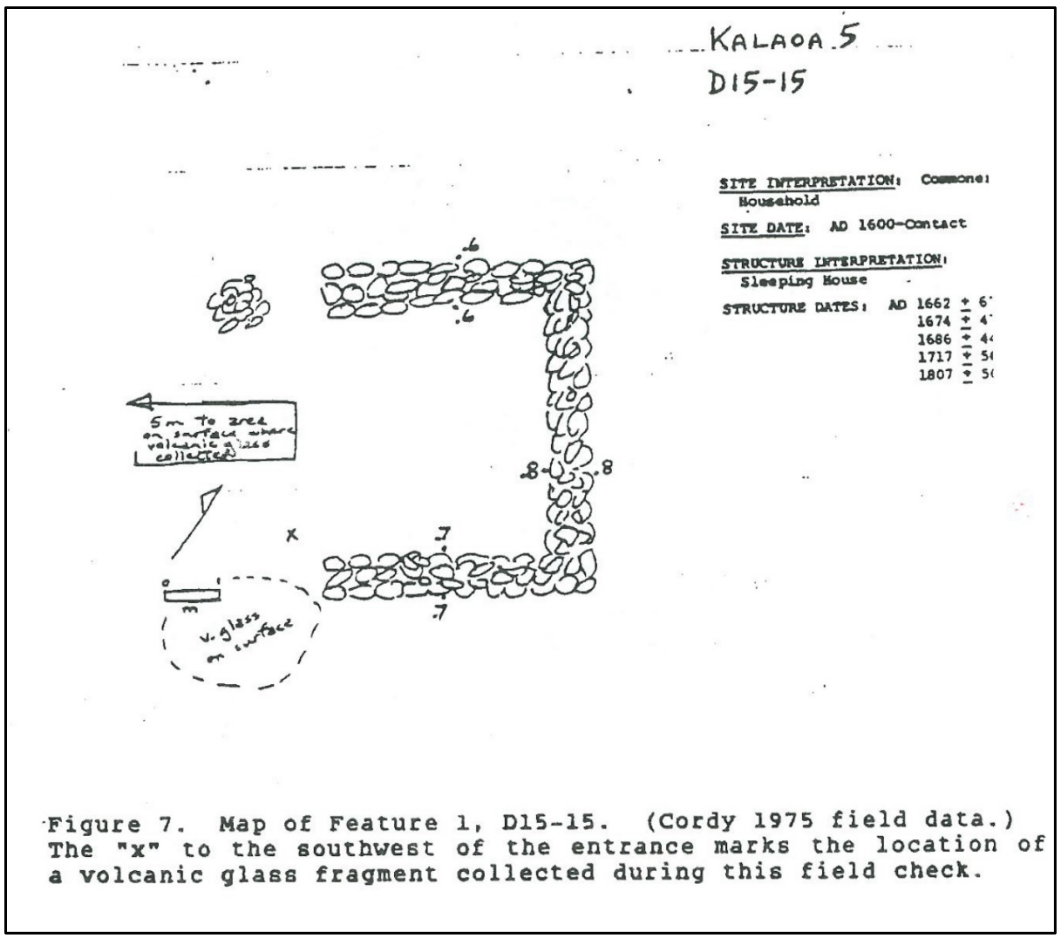



Figure 42. Site 10208 Feature 1 plan view from Cordy (1975).

D15-15-2. Roughly rectangular platform remnants situated near west edge of bluff about 9 m west of U.S.G.S. survey pole. It measures 3.1 by 2.9 m in size, and ranges from 0.45 to 0.72 m in height. Poor condition. Surface made up of basalt boulders and cobbles with sparse coral and gravel deposits. Marine shell (Cellana and Cypraea) present on surface.

D15-15-3. Scattered basalt boulders and cobbles and waterworn coral cobbles within in an area c. 4 by 2 m in size. Situated c. 4 m north of U.S.G.S. survey pole. Possible remains of old Keāhole boundary ahu. Marine shell (Cellana and Cypraea) present on surface. Wooden stake fragments and rusted wires observed among the scattered rocks.

D15-15-4. Walled shelter cave with adjacent terrace situated near northeast corner of the pahoehoe depression, about 46 northeast (028° TN) of U.S.G.S. survey pole. Cave interior measures c. 8.0 by 2.3 m in size. Basalt boulder-and-cobble wall, 3.2 m in length, 0.75 to 0.95 m in width, and 0.6 to 0.8 m in height, parallels north portion of cave adjacent to overhang. Two connecting basalt boulder alignments form a small (3.8 by 2.5 m) terrace adjacent (west) to cave shelter. Deposits in the cave are somewhat disturbed but remain sufficiently intact for controlled excavations. Surface midden includes marine shell (Cellana, Cypraea, Nerita, Drupe, and Conus) and sea urchin (Heterocentrotus mammalatus). Metal fragments, olive-green bottle glass fragments, a polished adz fragment, a sea-urchin spine abrader, and volcanic glass flakes were observed in the cave. Two broken sake bottles are present on the adjacent terrace.

D15-15-5. A small petroglyph area situated on the sloping east side of the pahoehoe depression, c. 10 m south of cave shelter D15-15-4, and from 1.5 to 2.3 m above the ground surface. The petroglyphs comprise four distinct human (linear in form) figures measuring from 20 to 24 cm in length and 14 to 16 cm in width. An adjacent (south) area of similar size may contain more. The pahoehoe surface here is fairly eroded.

D15-15-6. A roughly circular ahu (cairn) situated less than 2 m west of petroglyph area D15-15-5. It measures c. 1.2 m in diameter and 0.4 m in height, and is constructed of basalt boulders and cobbles and waterworn coral cobbles and pebbles. The roughly level surface contains an elongated, waterworn, basalt boulder (35 by 10 cm). No midden or artifacts observed on or immediately adjacent to the ahu.

D15-15-7. Roughly triangular-shape ahu (cairn) situated c. 8 m northwest of ahu D15-15-6. It measures c. 1.87 by 1.46. m in size and 0.55 m in height, and is built with basalt boulders and cobbles. The ahu is surrounded by an artifact and midden scatter extending from the adjacent D15-15-8 shelter cave.

D15-15-8. Low shelter cave situated c. 10 m north of ahu D15-15-7. Cave interior measures c. 10.00 by 1.75, and comprises, coral, sand, and gravel. Access under the overhang ranges from 0.5 to 0.8 m in height. A basalt cobble feature (shelf?); c. 1.0 by 0.6 m in size, is situated near the east end. A midden and artifact scatter originating from the cave extends c. 17 m south in the approximate center of the depression. Midden includes marine shell (Cellana, Cypraea, Drupe, Nerita, and Conus) and sea urchin (Heterocentrotus mammalatus). Artifacts observed in the scatter and the cave include coral files and abraders, sea urchin-spine files, and volcanic glass flakes.

D15-15-9. Two low walls, 1.3 m apart, situated just south of the southeast corner of the depression. They measure 1.45 and 1.20 m in length and from 0.3 to 0.4 m in height, and are constructed with basalt boulders and cobbles. Sparse marine shell (Cypraea) observed in this area. No artifacts observed.

D15-15-10. Two shelter caves that contain brackish (anchialine) pools situated in the small gully connected to the depression on the south. Probable water source for the D15-15 complex. Entrances are c. 4.0 by 2.0 m and 3.0 by 1.5 m in size, and are situated c. 18 m apart. Possible interior alignments in both cave. No surface midden or artifacts observed. Recent trash present.

Features 1, 2, and 3 of Site 10208 were relocated on Parcel 100 during the current fieldwork (Figure 44). These features are situated on an elevated *pāhoehoe* bedrock tumulus near the seaward edge of the parcel. The area to the east of the tumulus, where Features 4 through 10 were previously mapped (see Figure 43), has been subject to extensive mechanical disturbance (Figure 45), and those features are no longer present. Features 1, 2, and 3 were not impacted by the grading activities, however, and are in similar condition to what was previously described by Clark (1984:20). These features were photographed during the current fieldwork (Figures 46-50), and a GIS map showing their locations was prepared (see Figure 44). The map also depicts the location of the U.S.G.S. Keahole survey pole (Figures 51 and 52), a nearby U.S.G.S. benchmark (Figure 53), and a concentration of coral (Figure 54) that were mentioned by Clark (1984), as well as a waterworn cobble with cupules (Figure 55) that may be the "basalt salt pan" shown on Figure 43, and the locations of nearby modern petroglyphs and spray paint graffiti (Figures 56 and 57), that were not present in 1984.

Overall, Site 10208 is in poor condition and seven features previously described as part of the habitation complex by Clark (1984) are no longer present. While the three remaining features of the site are in similar condition to that which was previously described, only Feature 1 is in good condition and is representative of the use of the site for habitation purposes. The other two remaining features (Features 1 and 2) are in poor condition and are likely related to the creation or use of Keahole survey marker. The general site area has been impacted by mechanical disturbance and the creation of seemingly recent petroglyphs and graffiti and is littered with modern trash. Despite these impacts, Site 10208 retains enough integrity to be assed as significant under Criterion d for the information it has yielded relative to Precontact/Historic land use in the coastal zone of ʻOʻoma and Kalaoa. While this site was previously recommended for preservation, and a preservation easement was created for it on TMK: (3) 7-3-043:100 (see Figure 3), a formal preservation plan for the site was never prepared and no short-term or long-term preservation measures were ever implemented for its protection. It is therefore recommended that the remaining portions of Site 10208 be formally preserved as part of the development of the new Innovations Center project and that an Archaeological Preservation Plan for the site be prepared.

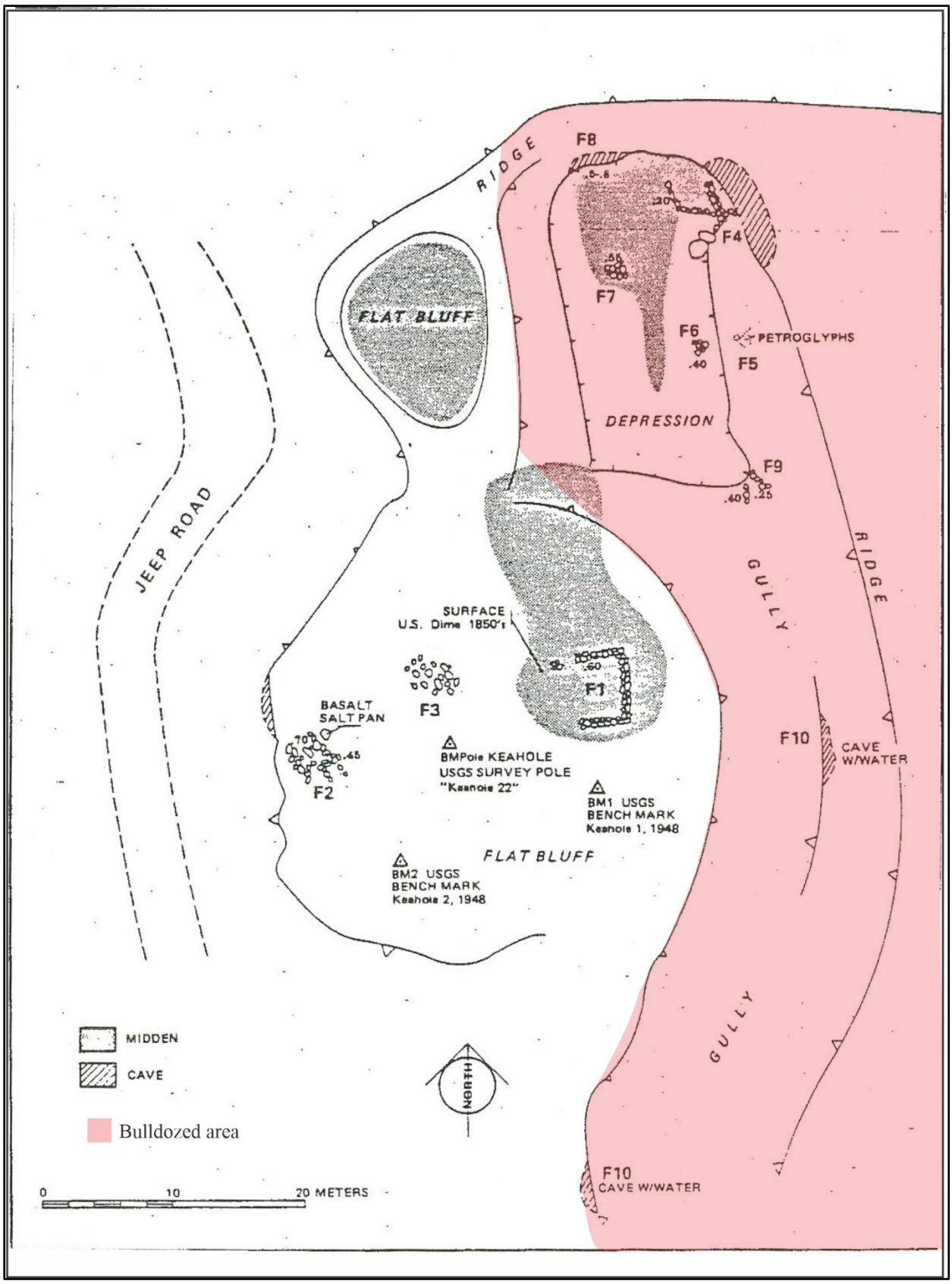



Figure 43. Plan view of Site 10208 (D15-15) from Clark (1984:17).

Figure 44. Site 10208 plan view.

Figure 45. Bulldozing along eastern side of Site 10208 where Features 4 through 10 were formerly located, view to the south.

Figure 46. Site 10208 Feature 1, view to the east.

Figure 47. Site 10208 Feature 1, view to the west.

Figure 48. Site 10208 Feature 1, view to the southeast.

Figure 49. Site 10208 Feature 2, view to the south.

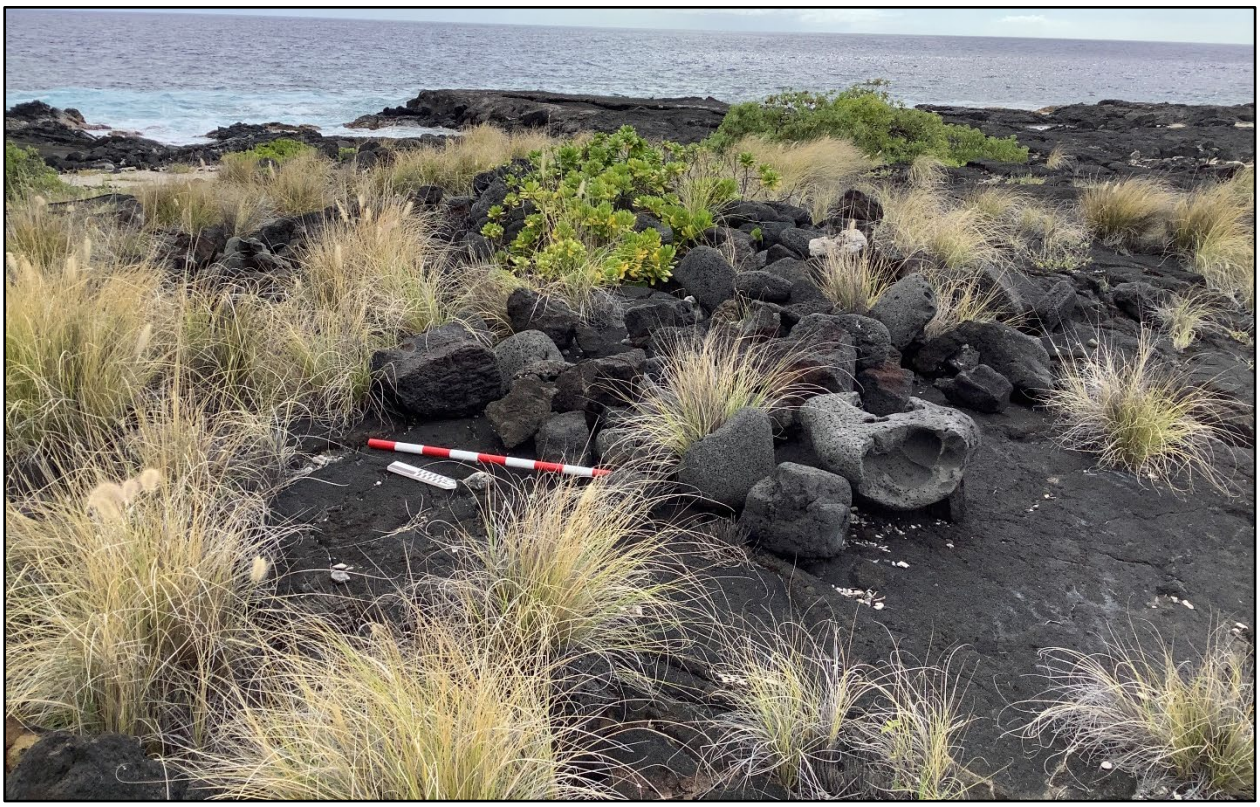


Figure 50. Site 10208 Feature 3, view to the southwest.

Figure 51. U.S.G.S. Keahole survey pole located within the Site 10208 complex, view to the south.

Figure 52. Top view of U.S.G.S. Keahole survey pole foundation at Site 10208, view to the south.

Figure 53. U.S.G.S. Keahole benchmark within the Site 10208 complex.

Figure 54. Concentration of coral in the northern portion of Site 10208, view to the northeast.

Figure 55. Possible basalt salt pan mapped by Clark (1984) adjacent to Feature 2 of Site 10208.

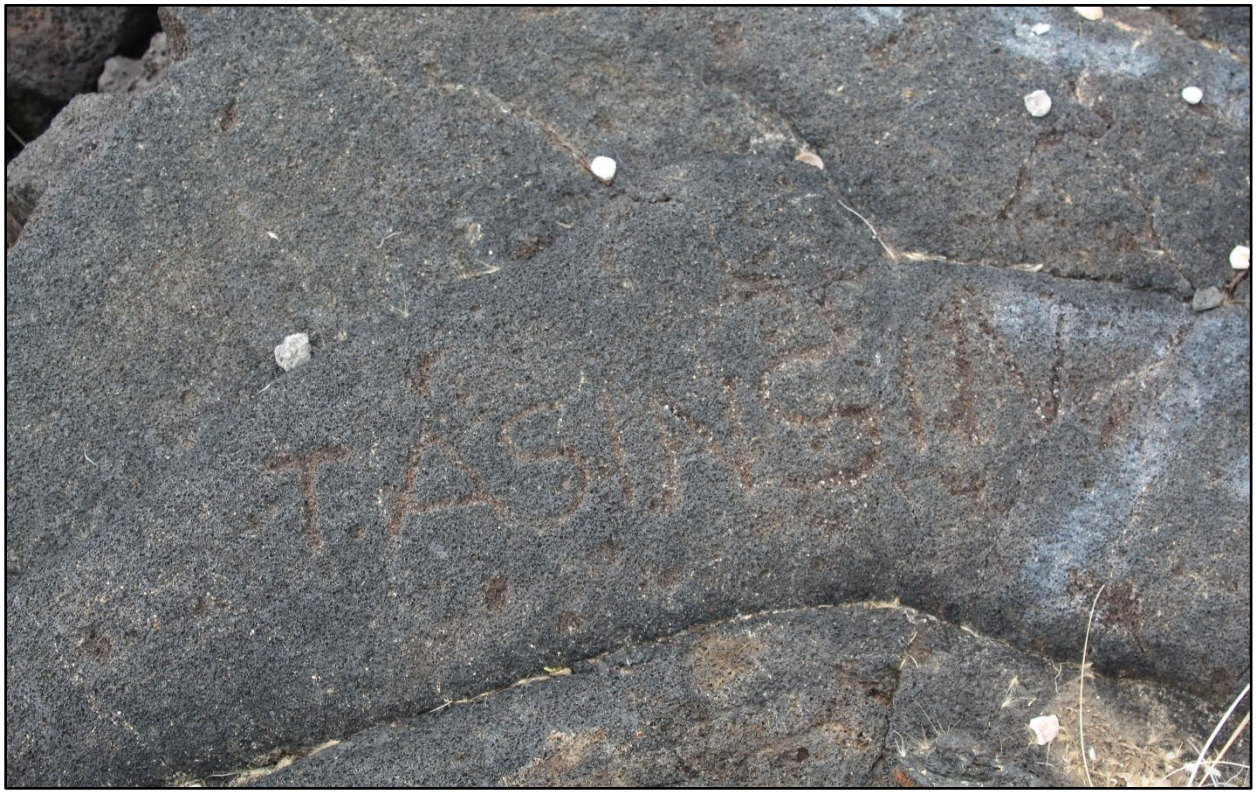


Figure 56. Recent petroglyph at Site 10208, appears to read" T. ASINSU."

Figure 57. Recent spray paint graffiti at Site 10208.

## Site 50-10-27-T-1

Site T-1 is a complex consisting of three cobble piles (Features A, B, and C) located in the west central portion of the Innovation Center project area on Parcel 100, approximately 37 meters east of Site 10208 (see Figure 41). The cobble piles have been constructed on the narrow strip of ropey *pāhoehoe* bedrock extending north/south through the western portion of the project area that has not been subject to prior land disturbance. There are bulldozer push piles located to the east and west of Site T-1 (Figure 59). A large crack trending east/west in the bedrock is located 1.5 meters south of Feature A. Numerous pieces of coral and marine shell fragments are present on the surface of the site. Cobble piles such as these have been recorded in ‘O‘oma and Kalaoa and are generally associated with boundaries and Historic surveys of the area (Clark et al. 2015). These cobble piles are located along the Kaloa 4$^{th}$ and 5$^{th}$ boundary near the Keahole survey marker and could be associated with an Historic survey of that boundary. Site T-1 is in poor condition and is considered significant under Criterion d for the information yielded relative to the history of boundary marking at Keahole Point. The features of Site T-1 are described below and shown in Figure 58.

*Feature A*

Feature A is a cobble pile located in the southern portion of Site T-1 (see Figure 58). The pile is comprised of approximately 75 small to large cobbles and is arranged in a circular pattern on *pāhoehoe* bedrock. It measures 1.7 meters by 1.7 meters and stands 45 centimeters tall (Figure 60). Sand, coral, and marine shell fragments are scattered in a roughly 2 meter by 3 meter area extending north from Feature A.

*Feature B*

Feature B is a cobble pile located 2.5 meters northeast of Feature A (see Figure 58). The pile is comprised of approximately 10 large cobbles mixed with small cobbles and is arranged in a circular pattern on *pāhoehoe* bedrock. It measures 1.9 meters by 1.3 meters and stands 50 centimeters tall (Figure 61).

*Feature C*

Feature C is a cobble pile located 2.3 meters northwest of Feature A and 4.2 meters southwest of Feature B (see Figure 58). The pile is comprised of approximately 3 large cobbles mixed with at least 50 small cobbles and is arranged in a circular pattern on *pāhoehoe* bedrock. It measures 1 meter by 1 meter and stands 20 centimeters tall (Figure 62). Sand, coral, and marine shell fragments are scattered in a roughly 1 meter by 0.5-meter area extending south from Feature C.

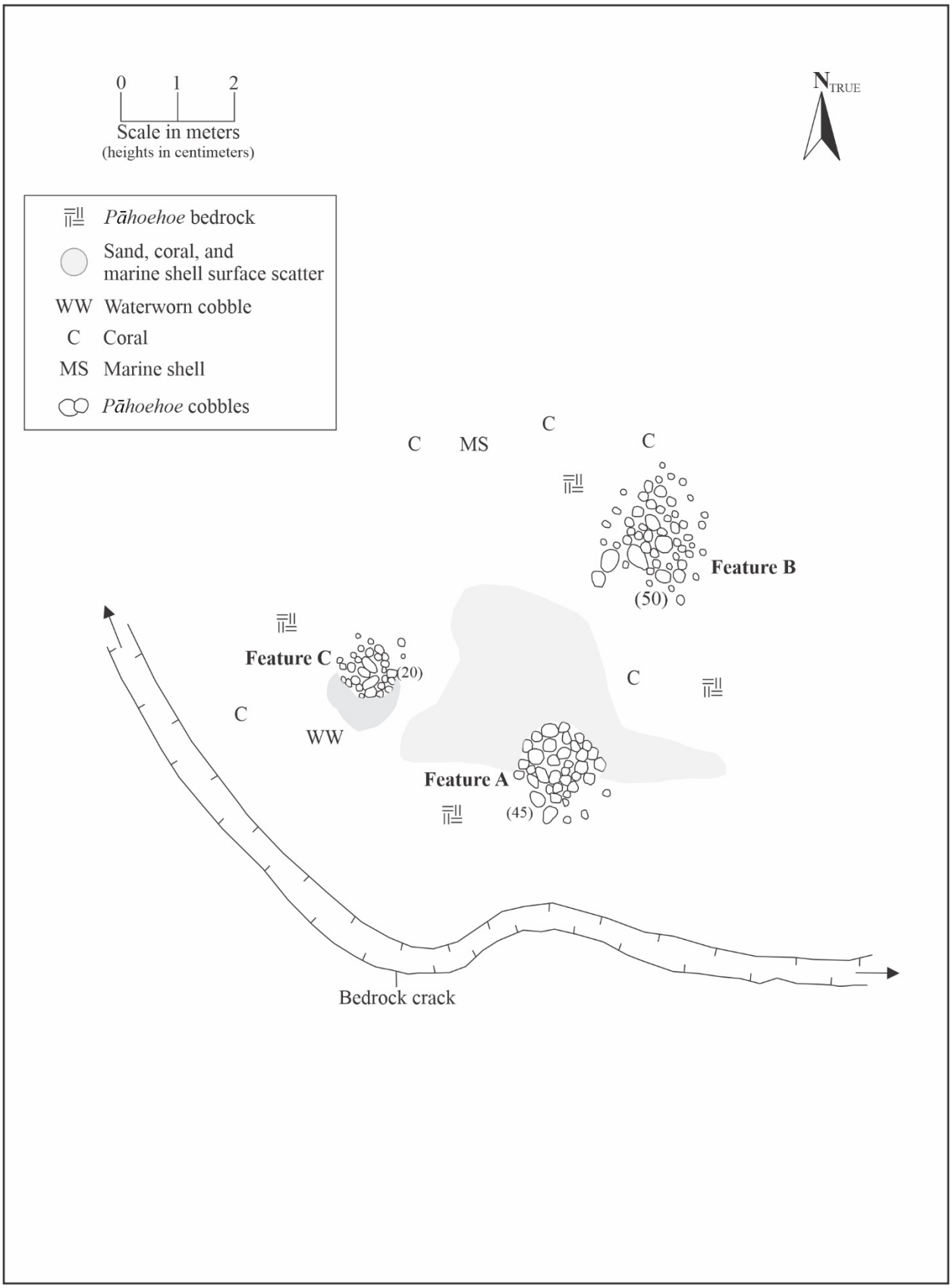



Figure 58. Site T-1 plan view.

Figure 59. Overview of Site T-1 showing the large crack (lower right) and bulldozer push (upper left), view to the east.

Figure 60. Site T-1 Feature A, view to the north.

Figure 61. Site T-1 Feature B, view to the southwest.

Figure 62. Site T-1 Feature C, view to the southwest.

## Site 50-10-27-T-2

Site T-2 is an excavation complex consisting of seven *pāhoehoe* excavations (Features A through G) located in the southwestern corner of the Innovation Center project area on Parcel 100, approximately 12 meters south of Site T-1 (see Figure 41). The site is located on the narrow strip of ropey *pāhoehoe* bedrock extending north/south through the western portion of the project area and that has not been subject to bulldozing. A bulldozer push pile of large cobbles lies 2 meters west of Feature A and a bulldozed road traverses north/south along the western edge of Features F and G. Features A through E are located along a crack in the bedrock that trends northwest/southeast. Features F and G are located approximately 24 meters southeast of Feature E. The features of Site T-2 are in poor condition, but are considered significant under Criterion d for information they have yielded relative to the history and prehistory of the current study area and resource procurement in the coastal zone of North Kona. The features of Site T-2 are described below and shown in Figure 63.

*Feature A*

Feature A is a *pāhoehoe* excavation located at the northern extent of Site T-2 (see Figure 63). Large cobbles have been excavated from a 2.2 meter by 1.4 meter area along a bedrock crack up to 0.8 meters deep (Figure 64). A bulldozer push consisting of large cobbles is located 2 meters west of Feature A (Figure 65). Two waterworn cobbles were observed on the ground surface near Feature A (Figure 66) and numerous marine shell fragments were scattered nearby.

*Feature B*

Feature B is a *pāhoehoe* excavation located 8 meters southeast of Feature A (see Figure 63). Large cobbles have been excavated from a 1.6 meter by 1.4 meter area along the bedrock crack up to 0.75 meters deep (Figure 67).

*Feature C*

Feature C is a *pāhoehoe* excavation located 1 meter south of Feature B (see Figure 63). Large cobbles have been excavated from a 1.5 meter by 0.7 meter area along the bedrock crack up to 0.4 meters deep (Figure 68). Modern trash was observed on the ground surface to the south of Feature C.

*Feature D*

Feature D is a *pāhoehoe* excavation located 2.5 meters south of Feature C (see Figure 63). Small to large cobbles have been excavated from a 2.5 meter by 0.7 meter area along the bedrock crack up to 0.5 meters deep (Figure 69). Bottle glass fragments and coral were observed on the ground surface near Feature D as well as a waterworn cobble 3.5 meters southeast of the feature (Figure 70).

*Feature E*

Feature E is a *pāhoehoe* excavation located 5 meters south of Feature D (see Figure 63). Large cobbles have been excavated from a 1.2 meter by 0.6 meter area along the bedrock crack up to 0.5 meters deep (Figure 71). Bottle glass fragments were observed on the ground surface near Feature E.

*Feature F*

Feature F is a *pāhoehoe* excavation located 23 meters east of Feature E (see Figure 63). Large cobbles have been excavated from a 1.6 meter by 0.8 meter area of flat *pāhoehoe* ground surface up to 0.6 meters deep (Figure 72).

*Feature G*

Feature G is a *pāhoehoe* excavation located 5 meters east of Feature F (see Figure 63). Small to large cobbles have been excavated from a 2.6 meter by 2.2 meter area at the transition from a north facing slope and flat *pāhoehoe* ground surface up to 0.6 meters deep (Figures 73 and 74).

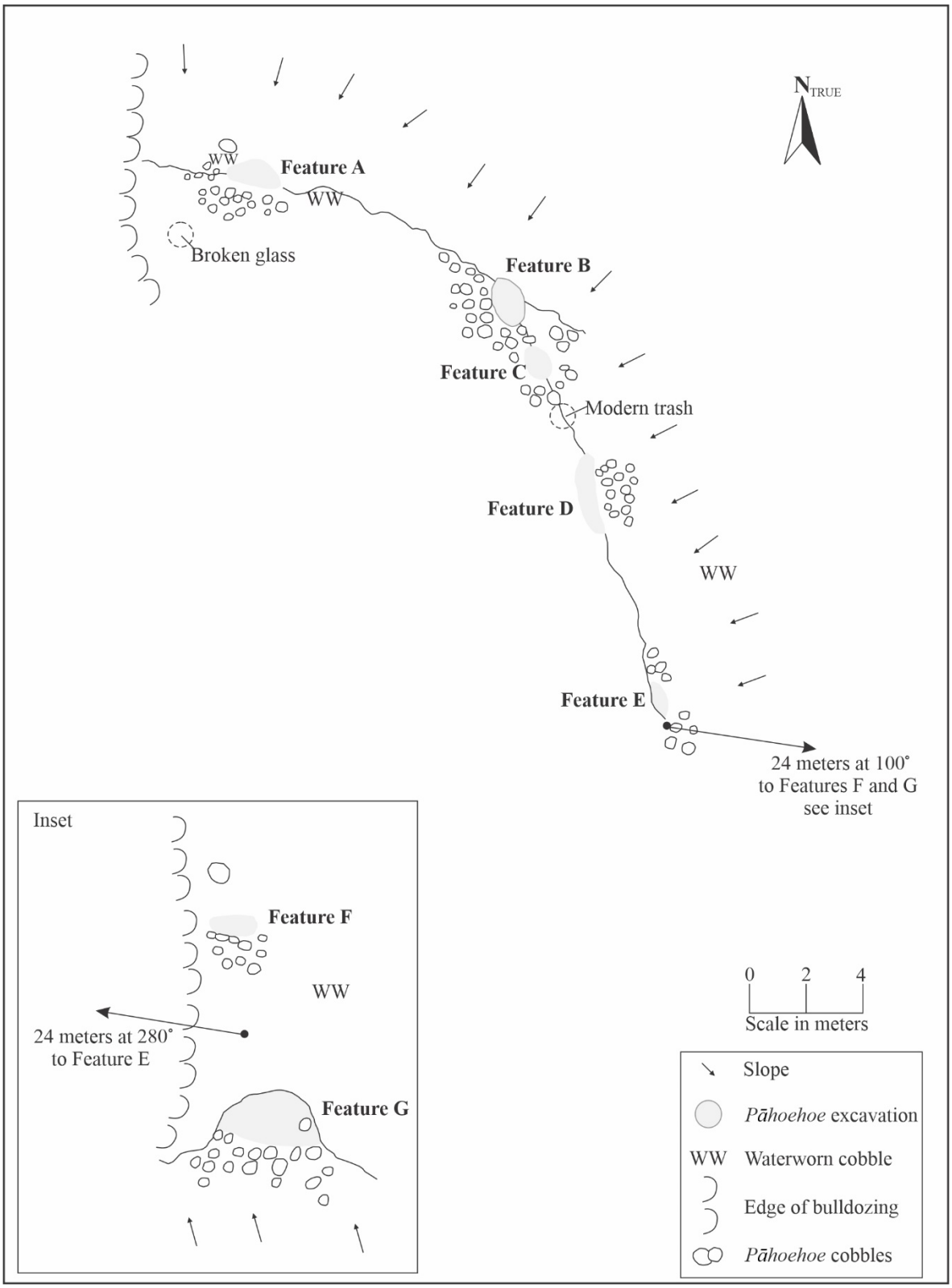



Figure 63. Site T-2 plan view.

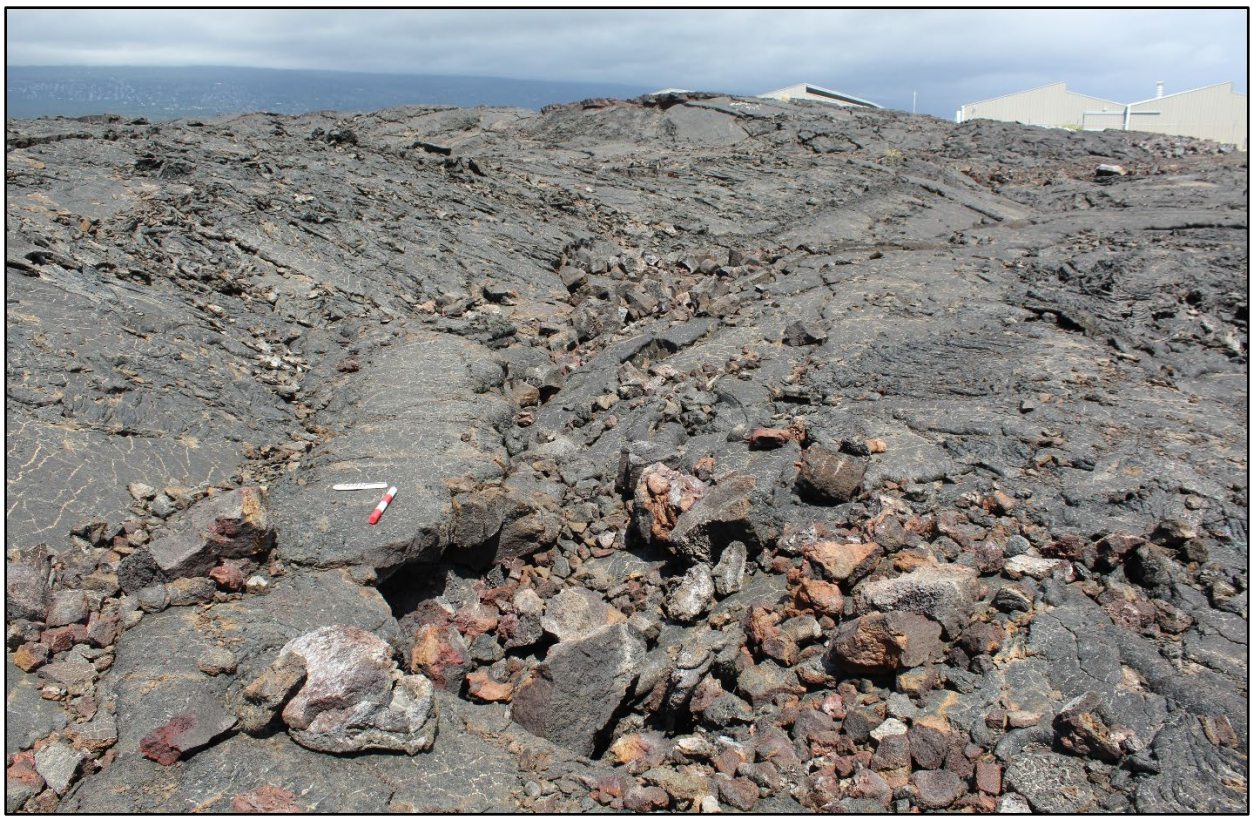


Figure 64. Site T-2 Feature A, view to the east.

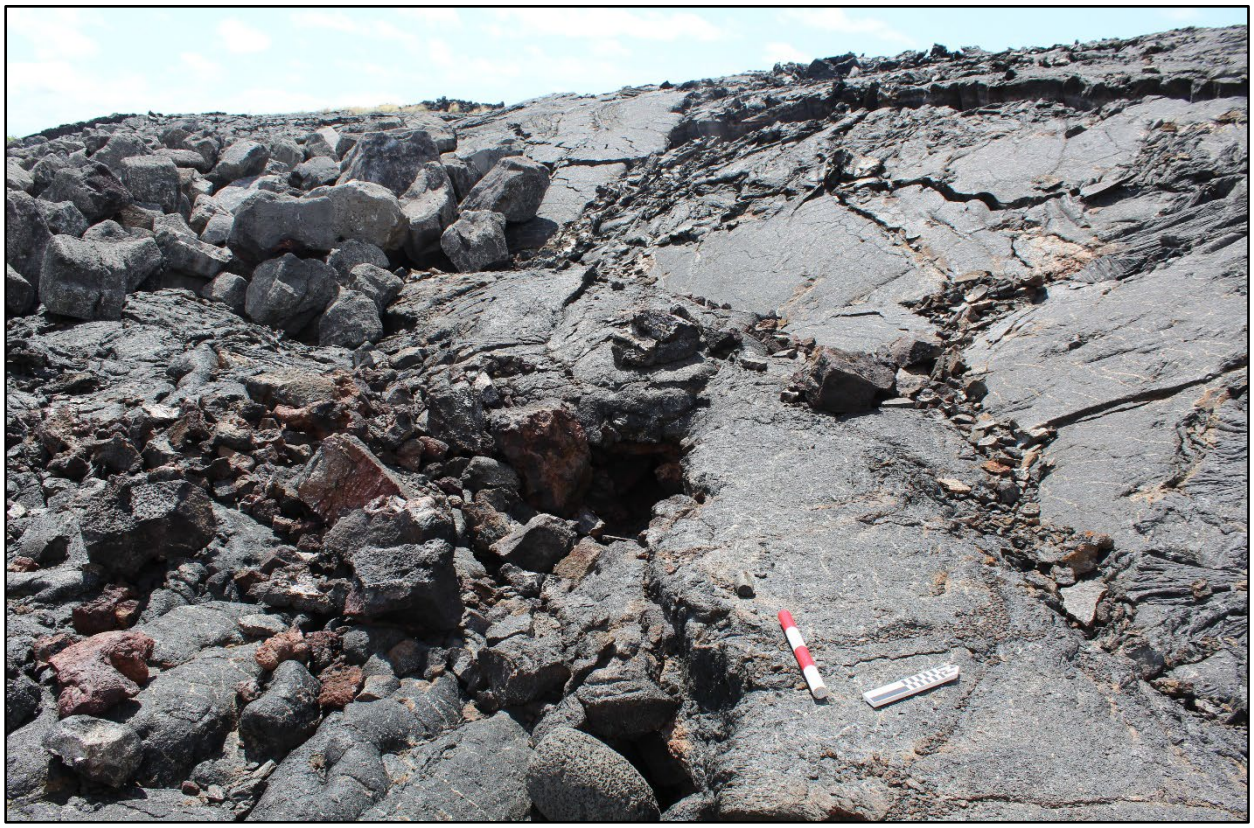


Figure 65. Site T-2 Feature A with bulldozer push in background, view to the west.

Figure 66. Waterworn cobble observed at Site T-2 Feature A, view to the south.

Figure 67. Site T-2 Feature B, view to the northeast.

Figure 68. Site T-2 Feature C, view to the northeast.

Figure 69. Site T-2 Feature D, view to the south.

Figure 70. Waterworn cobble located near Site T-2 Feature D, overview to the east.

Figure 71. Site T-2 Feature E, view to the west.

Figure 72. Site T-2 Feature F, view to the west.

Figure 73. Site T-2 Feature G, view to the north.

Figure 74. Site T-2 Feature G, view to the south.

# 5. SIGNIFICANCE EVALUATIONS AND TREATMENT RECOMMENDATIONS

The recorded archaeological sites are assessed for their significance based on criteria established and promoted by the DLNR-SHPD and contained in the Hawai‘i Administrative Rules 13§13-275-6. For a resource to be considered significant it must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

a Be associated with events that have made an important contribution to the broad patterns of our history;

b Be associated with the lives of persons important in our past;

c Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;

d Have yielded, or is likely to yield, information important for research on prehistory or history;

e Have an important traditional cultural value to the native Hawaiian people or to another ethnic group of the state due to associations with traditional cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group’s history and cultural identity.

The significance and recommended treatment for the recorded sites are presented in Table 4 and discussed below.

**Table 4. Site significance and treatment recommendations.**

| *SIHP Site No.* | *Site Type* | *Age* | *Significance* | *Treatment Recommendation* |
|---|---|---|---|---|
| 50-10-27-10208 | Habitation complex | Precontact/Historic | d | Preservation |
| 50-10-27-T-1 | Cobble complex | Unknown | d | No Further work |
| 50-10-27-T-2 | Excavation complex | Unknown/Precontact | d | No Further work |

## SITE 50-10-27-10208

Site 10208 is a Precontact to early Historic Period habitation complex that formerly consisted of ten features (Features 1-10) located on TMK: (3) 7-3-043:100. The site was previously documented as part of several prior archaeological surveys, but subsequent to those studies, Features 4 through 10 were destroyed by bulldozing. The remaining features of Site 10208 (Features 1-3) are in fair condition and retain enough integrity in all categories to be assessed as significant under Criterion d for the information that the site has yielded relative to Precontact/Historic land use in the coastal zone of ‘O‘oma and Kalaoa. Although Site 10208 was previously set aside for preservation, and a preservation easement was created for the site (as shown on the TMK plat map for the subject parcel; see Figure 3), a formal preservation plan was never prepared. It is recommended that the remaining features of Site 10208 be preserved in place and that a preservation plan for the extant portions of the site be prepared in accordance with HAR §13-277 and submitted to DLNR-SHPD for review and acceptance prior to any development activities occurring within the Phase 2A development area for the Innovation Center.

## SITE 50-10-27-T-1

Site T-1 is a complex consisting of three cobble piles (Features A, B, and C) located on TMK: (3) 7-3-043:100. The site is in poor condition, but retains enough integrity in all categories to be assessed for its significance under Criterion d for the information it has yielded relative to the history of boundary marking at Keahole Point. The research conducted during this study has adequately documented the marker complex, and therefore the treatment recommendation for Site T-1 is no further work.

## SITE 50-10-27-T-2

Site T-2 is an excavation complex consisting of seven *pāhoehoe* excavations (Features A-G) located on TMK: (3) 7-3-043:100. The site is in poor condition, but retains enough integrity in all categories to be assessed for its significance under Criterion d for the information it has yielded relative to the history and prehistory of the current study area and resource procurement in the coastal zone of North Kona. The research conducted during this study has adequately documented the excavation complex, and therefore the treatment recommendation for Site T-2 is no further work.

# 6. DETERMINATION OF EFFECT

The current archaeological survey identified three archaeological sites within the proposed Innovation Center project area (Parcel 100): a previously recorded habitation complex (Site 10208), a newly recorded cobble complex (Site T-1), and a newly recorded excavation complex (Site T-2). Sites T-1 and T-2 have been sufficiently documented as a result of the current AIS and their research potential has been exhausted, therefore no further work is recommended at these two sites. Only Features 1 through 3 of Site 10208 are currently extant within the Innovation Center survey area, as Features 4 through 10 were destroyed by prior bulldozing. Features 1 through 3 are recommended for preservation. The HRS Chapter 6E-8 effect for the proposed Innovation Center project on TMK: (3) 7-3-043: 042 (por.), 051, 100, and 101 (por.) is therefore "effect, with proposed mitigation commitments." The proposed mitigation commitments are the preparation of an Archaeological Preservation Plan for the three remaining features of Site 10208 (Features 1-3) in accordance with HAR §13-277.

The proposed Hale Wawaloli Welcome Center project area was completely disturbed by prior grading activities, therefore no archaeological sites, including two sites previously documented in that general area (Sites 1919 and 10185), were observed during the current AIS. The HRS Chapter 6E-8 effect for the proposed Hale Wawaloli Welcome Center project on TMK: (3) 7-3-043:088 (por.) is "no historic properties affected." With respect to the historic preservation review process of the DLNR–SHPD, our recommendation is that no further work needs to be conducted within the Hale Wawaloli project area prior to or during project implementation.

In the unlikely event that significant archaeological resources are discovered during the proposed ground disturbing activities within either the Innovation Center or Hale Wawaloli portions of the current project area, work will cease in the area of the discovery and the DLNR-SHPD will be contacted pursuant to HAR 13§13-280-3.

# REFERENCES CITED


Barrera, W., Jr.

1985a Ke-ahole Point, Hawaii: Archaeological Reconnaissance (Revised Version). Chiniago, Inc. Prepared for Helber, Hastert, Van Horn and Kimura, Honolulu.

1985b Ooma II, Hawaii: Archaeological Reconnaissance. Chiniago Inc. Prepared for Helber, Hastert, Van Horn & Kimura.

1989 Archaeological Data Recovery at the Host Park and NELH Kalaoa and O‘oma Ahupua‘a, North Kona, Hawai‘i Island. Chinago, Inc. Prepared for R.M. Towill Corporation, Honolulu.

1992 O‘oma, North Kona, Hawaii Island: Archaeological Excavations. Chiniago, Inc. Prepared for Natural Energy Laboratory of Hawaii, Kailua-Kona, HI.

Barrera, W. J.

1979 Ke-ahole Airport Emergency Roads: Arcaheological Survey. Chiniago, Inc.

Beckwith, M. W.

1970 *Hawaiian Mythology*. University of Hawai'i Press, Honolulu.

Buke Māhele

1848 *Buke Kakau Paa no ka mahele aina i Hooholoia iwaena o Kamehameha III a me Na Lii a me Na Konohiki ana*, Hale Alii, Honolulu.

Char, W.

1991 Botanical Survey of Honokohau 1 and 2, North Kona District, Island of Hawaii. Prepared for Lanihau Partners, LP.

Ching, F., D. Cluff, and T. J. Riley

1969 Preliminary Report of Archaeological Surface Survey and Salvage Operations at Keahole, North Kona, Hawai‘i Island. Section II Keahole Point Airport & Kailua-Kawaihae Road. Department of Land and Natural Resources, Division of State Parks. Prepared for Department of Transportation.

Clark, M. R., A. K. Dircks Ah Sam, J. D. Nelson, and R. Rechtman

2015 An Archaeologica Inventory Survey of a roughly 210-acre portion of the NELHA HOST Park situated North of Makako Bay Drive. ASM Affiliates Project Number 23390. Prepared for Natural Energy Laboratory of Hawai‘i Authority (NELHA), Kailua-Kona, HI.

Clark, S.

1984 An Archaeological Reconnaissance of Natural Energy Laboratory Hawaii (NELH) Property, Keāhole Point, North Kona, Hawai‘i. Department of Anthropology, B.P. Bishop Museum Ms. 110784. Prepared for Marine Sciences Group, Department of Paleontology, University of California, Berkley, CA.

Corbin, A. B.

2000 Archaeological Data Recovery Excavations at SIHP Sites 1916 and 18028, The Natural Energy Laboratory of Hawaii Project Area, Land of ‘O‘oma II, North Kona District, Island of Hawai‘i (TMK:3-7-3-09:4). Paul H. Rosendahl, Ph.D., Inc. Report 1976-113000. Prepared for The Natural Laboratory of Hawaii Authority.

Cordy, R.

1981 *A Study of Prehistoric Social Change: The Development of Complex Societies in the Hawaiian Islands*. Academic Press, New York.

1985 Working Paper 1, Hawaii Island Archaeology, Ooma & Kalaoa Ahupua‘a, Kekaha, North Kona. Prepared for Historic Sites Section, Division of State Parks, Department of Land & Natural Resources, State of Hawaii.

1986 Fieldcheck, Ooma 2, North Kona, Hawaii. Historic Sites Section.

Cordy, R. and M. Kaschko
1980 Prehistoric Archaeology in the Hawaiian Islands: Land Units Associated with Social Groups. *The Journal of Field Archaeology* 7:403-416.

Dircks Ah Sam, A. and R. B. Rechtman
2015 An Archaeological Preservation Plan for SIHP Site 10205 within NELHA Host Park, TMK: (3) 7-3-043:042 (por.), Kalaoa 5th Ahupuaʻa, North Kona District, Island of Hawaiʻi. . ASM Affiliates Project Number 23390. Prepared for Natural Energy Laboratory of Hawaiʻi Authority, Kailua-Kona.

Donham, T.
1987 Archaeological Survey and Testing Ooma II Resort Project Area, Land of Ooma II, North Kona, Island of Hawaii (TMK: 3-7-3-09:4), Appendix N. Vol. II. Paul H. Rosendahl, Ph.D., Inc. Report 254-081286. Prepared for Helbert, Hastert, Van Horn & Kimura, Honolulu.

Fornander, A.
1880 *An Account of the Polynesian Race: Its Origins and Migrations, and the Ancient History of the Hawaiian People to the Times of Kamehameha I*, vol. II. Trübner & Co., London.

Giambelluca, T. W., X. Shuai, M. L. Barnes, R. J. Alliss, R. J. Longman, et al.
2014 Evapotranspiration of Hawaiʻi. Prepared for Water Resource Management, State of Hawaiʻi.

Handy, E. S. C., E. G. Handy, and M. K. Pukui
1991 *Native Planters in Old Hawaii: Their Life, Lore, and Environment*. Bernice P. Bishop Museum Bulletin 233. Bishop Museum Press, Honolulu.

Hommon, R.
1976 The Formation of Primitive States in Pre-Contact Hawaii. Ph.D. Dissertation, University of Arizona, Department of Anthropology, Tucson, AZ.

1986 Social Evolution in Ancient Hawaiʻi. In *Island Societies: Archaeological Approaches to Evolution and Transformation*, pp. 55-88. edited by P. Kirch. Cambridge University Press, Cambridge, Massachusetts.

Jensen, P.
1994 Phased Archaeological Inventory Survey, Hapuna Beach State Recreation Area Expansion Project: Phase III–Data Analyses and Final Report. Paul H. Rosendahl, Ph. D., Inc. Prepared for Harrison Associate, Honolulu.

Kamakau, S. M.
1961 *Ruling Chiefs of Hawaii*. Kamehameha Schools Press, Honolulu.

Kirch, P. V.
1984 *The Evolution of the Polynesian Chiefdoms*. Cambridge University Press, New York.

1985 *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. University of Hawaii Press, Honolulu.

2011 When did the Polynesians Settle Hawaiʻi? A Review of 150 Years of Scholarly Inquiry and a Tentative Answer. *Hawaiian Archaeology* 12:3-26.

Maguire, E.
1926 *Kona Legends*. Paradise of the Pacific Press, Honolulu.

Malo, D.
1951 *Hawaiian Antiquities*. Second ed. Translated by N. B. Emerson. B. P. Bishop Museum Special Publication 2. B. P. Bishop Museum Press, Honolulu.

Moore, J., M. Maigret, and J. Kennedy
1999 Results of an Archaeological Inventory Suvey for a Property Located at Keʻahole Point, In Kalaoa 4th Ahupuaʻa, North Kona District, On the Island of Hawaiʻi. Archaeological Consultants of the Pacific, Inc. Prepared for United States Coast Guard, Alameda, CA.

Nelson, J. D., A. K. Dircks Ah Sam, M. R. Clark, and R. Rechtman
2015 An Archaeological Inventory Survey of a roughly 110-acre portion of the NELHA HOST Park Situated South of Makako Bay Drive, TMKs: (3) 7-3-043:080 (por.), 085, 089 (por.), 090, and 091 (por.), ʻOʻoma 1st and 2nd *ahupuaʻa*, North Kona District, Island of Hawaiʻi. . ASM Affiliates Project Number 23390.01. Revised 2016. Prepared for Natural Energy Laboratory of Hawaiʻi Authority (NELHA), Kailua-Kona, HI.

Pogue, J. F.
1978 *Moolelo of Ancient Hawaii*. Translated by C. W. Kenn. Topgallant Press, Honolulu.

Pukui, M. K., S. H. Elbert, and E. Moʻokini
1974 *Place Names of Hawaii*. Revised and Expanded ed. University of Hawaii Press, Honolulu.

Pukui, M. K. and A. Korn
1973 *The Echo of Our Song: Chants and Poems of the Hawaiians*. University Press of Hawaii, Honolulu.

Rechtman, R. B.
2007 Archaeological Inventory Survey Update for the ʻOʻoma Beachside Village Project Area, (TMK: 3-7-3-009:022), ʻOʻoma 2nd Ahupuaʻa, North Kona District, Island of Hawaiʻi. Rechtman Consulting, LLC Report RC-0445. Prepared for North Kona Village, LLC, Atascadero, CA.

2010a Letter Report Field Inspection of a Roughly 2.6 Acre Lot within the HOST Park at NELHA, Kalaoa 5th Ahupuaʻa, North Kona, Island of Hawaiʻi. Rechtman Consulting, LLC Letter Report RC-0728. Prepared for Marine Mammal Center.

2010b Letter Report Field Inspection of a Roughly Four Acre Lot (Lot 12A) within the HOST Park at NELHA, ʻOʻoma 1st Ahupuaʻa, North Kona, Island of Hawaiʻi. Rechtman Consulting, LLC Letter Report RC-0726. Prepared for Ken Melrose of Paʻahana Enterprises LLC.

2010c Letter Report Field Inspection of a Roughly One Acre Lot within the HOST Park at NELHA, ʻOʻoma 1st Ahupuaʻa, North Kona, Island of Hawaiʻi. Rechtman Consulting, LLC Letter Report RC-0704. Prepared for Goodfellow Brothers, Inc.

2012a Field inspection of a roughly 1.9 acre project area (portion of TMK:3-7-3-43:087) within the HOST park at NELHA, in ʻOʻoma 1st Ahupuaʻa, North Kona, Island of Hawaiʻi. Rechtman Consulting, LLC Letter Report RC-0791. Prepared for North Shore Consultants.

2012b A field inspection of a roughly 2.5 acre project area (a portion of TMK: 3-7-3-43:106) within the HOST park at NELHA, Kalaoa 4 Ahupuaʻa, North Kona, Island of Hawaiʻi. Rechtman Consulting, LLC Letter Report RC-0825. Prepared for Carl Roesner, Blue Ribbon Builders.

2012c Letter Report Additional Field Inspection of a Roughly 3 acre Area Immediately Adjacent to the Roughly 4 Acre Lot (Lot 12A) for the New Campus within the HOST Park at NELHA, ʻOʻoma 1st Ahupuaʻa, North Kona, Island of Hawaiʻi. Rechtman Consulting, LLC Letter Report RC-0726. Prepared for Paʻahana Enterprises, LLC.

2017 Letter Report Field Inspection of TMK: (3) 7-3-043:111, Kalaoa 5th Ahupuaʻa, North Kona, Island of Hawaiʻi. ASM Affiliates Project Number 27720. Prepared for Stephen J. Herbert of Kona Wai Engineering.

Rechtman, R. B. and M. R. Clark
2004 A Preservation Plan for a Section of the Māmalahoa Trail (SIHP Site 50-10-27-2), ʻOʻoma 1st Ahupuaʻa, North Kona District, Island of Hawaiʻi. Rechtman Consulting, LLC Report RC-0267. Prepared for Natural Energy Laboratory of Hawaiʻi Authority (NELHA), Kailua-Kona, HI.

2006 A Preservation Plan for Seven Archaeological Sites Located within the NELHA Host Park, 9TMK:3-7-3-009:023), ʻOʻoma 2nd Ahupuaʻa, North Kona District, Island of Hawaiʻi. Rechtman Consulting, LLC Report RC-0391. Prepared for NELHA, Kailua-Kona, HI.

2012 Archaeological Inventory Survey Update for the Proposed NELHA Roads C, D, and E (MKs: 3-7-3-43:portions 073, 080, 083m and 091), ʻOʻoma 1st and 2nd and Kalaoa 5th ahupuaʻa, North Kona

District, Island of Hawai‘i. Rechtman Consulting, LLC Report RC-0732. Prepared for Parsons Brinckerhoff, Inc., Honolulu.

Rechtman, R. B. and K. Maly
2003 Cultural Impact Assessment for the Proposed Development of TMK:3-7-3-9:22, ‘O‘oma 2nd Ahupua‘a, North Kona District, Island of Hawai‘i, Volumes I and II. Rechtman Consulting Report RC-0154. Prepared for Helber Hastert & Fee, Honolulu, HI.

Reinecke, J.
1930 Survey of Hawaiian Sites, 1929-1930. Department of Anthropology, B.P. Bishop Museum, Honolulu. 1930.

Roberts, A.
2001 Final Preservation Plan for Site 50-10-27-10,211, Natural Energry Laboratory of Hawaii Authority. Garcia and Associates (GANDA). Prepared for Natural Energry of Hawaii Authority, Kailua-Kona, HI.

Roberts, A. and S. Roberts
2001 Final Report, Archaeological Data Recovery For Sites: 50-10-27-10,211; 50-10-27-10,212; 50-10-27-10,213; For the Natural Energy Laboratory of Hawaii Authority, Kalaoa 5 Ahupua‘a, Ke-‘āhole Point, North Kona District, Island of Hawaii, Hawaii, TMK 7-3-43:3. Garcia and Associates (GANDA). Prepared for Natural Energy Laboratory of Hawaii Authority, Kailua-Kona, HI.

Rogers-Jourdane, E.
1978 Archaeological Reconnaissance Survey of the NELH Proposed Facilities Areas at Keahole Point, North Kana, Hawaii. Department of Anthropology, B.P. Museum Ms. 061378.

Rosendahl, P. H.
1972 Archaeological Salvage of the Hapuna-Anaehoomalu Section of the Kailua-Kawaihae Road (Queen Kahumanu Highway), Island of Hawaii. Department of Anthropology *Departmental Report Series* 72-5. B. P. Bishop Museum.

1976 Additional Archaeological Reconnaissance Survey at the Ke-ahole Point Natural Energy Laboratory Site, North Kona, Hawaii Island. . Department of Anthropology, B.P. Bishop Museum, Honolulu Ms. 111775.

1980 Intensive Archaeological Survey and Salvage Excavations at the Natural Energy Laboratory Hawaii (NELH) Site, Ke-ahole Point, North Kona, Hawaii Island. Archaeological Research Associates ARA 2-123179. Prepared for The Research Corporation of the University of Hawaii.

Rosendahl, P. H. and P. Kirch
1975 Archaeological Reconnaissance Survey of the Ke-ahole Point Natural Energy Laboratory Site, North Kona, Hawaii Island. . Department of Anthropology, B.P. Bishop Museum, Honolulu Ms. 111775.

Soehren, L.
2005 A Catalog of Hawai‘i Place Names Compiled from the Records of the Boundary Commission and the Board of Commissioners to Quiet Land Title of the Kingdom of Hawaii. Part 4: Ka‘ū. 2005. Electronic document, http://ulukau.org/cgi-bin/hpn?, accessed September 14, 2016.

Soil Survey Staff (United States Department of Agriculture, Natural Resources Conservation Service)
2020 Web Soil Survey. Electronic document, http://websoilsurvey.nrcs.usda.gov.

Tatar, E.
1982 Nineteenth Century Hawaiian Chant *Pacific Anthropological Records*. Prepared for Department of Anthropology, B.P. Bishop Museum.

Wolfe, E. W. and J. Morris
1996 *Geologic Map of the Island of Hawai‘i*. U.S. Department of the Interior, U.S. Geological Survey. Geologic Investigations Series Map 1-2524-A.

# APPENDIX 5

## Traffic Impact Analysis Report

# NELHA Innovation Center & Welcome Center Traffic Impact Analysis Report

Kailua-Kona, Hawaii

October 2021

*Updated November 2021*

Stantec

# I. Table of Contents


II. PROJECT DESCRIPTION ..... 4

III. EXISTING CONDITIONS ..... 7

A. Geometric Configuration ..... 7

1. Roadway Configuration ..... 7

B. Volumes ..... 12

1. Vehicular Volumes ..... 12

C. Level of Service ..... 15

1. Methodology ..... 15

2. Existing Intersection Level of Service Results ..... 15

IV. FUTURE CONDITIONS ..... 17

A. Surrounding Area Conditions ..... 17

B. Volumes ..... 17

1. Future Without Project Volumes ..... 17

C. Future (2024) without Project Level Of Service ..... 19

1. Future without Project Intersection Level of Service Results ..... 19

D. Future (2024) with Project Level of Service ..... 20

1. Project Related Volumes ..... 20

2. Future (2024) With Project Volumes ..... 23

3. Future with Project Intersection Level of Service Results ..... 25

V. SUMMARY AND RECOMMENDATIONS ..... 26

VI. REFERENCES ..... 27


# Figures


FIGURE 1 - PROJECT SITE PLAN ..... 5

FIGURE 2 - PROJECT LOCATION MAP ..... 6

FIGURE 3 - INNOVATION CENTER MASTER PLAN ..... 8

FIGURE 4 - WELCOME CENTER PLAN ..... 9

FIGURE 5 - EXISTING LANE CONFIGURATION ..... 11

FIGURE 6 - 24-HOUR TRAFFIC VOLUMES ON QUEEN KAAHUMANU HIGHWAY ..... 13

FIGURE 7 - EXISTING PEAK HOUR VOLUMES ..... 14

FIGURE 8 - FUTURE (2024) WITHOUT PROJECT PEAK HOUR VOLUMES ..... 19

FIGURE 9 - FUTURE (2024) PROJECT-RELATED PEAK HOUR VOLUMES ..... 23

FIGURE 10 - FUTURE (2024) WITH PROJECT PEAK HOUR VOLUMES ..... 25

# Tables

TABLE 1 – EXISTING LEVEL OF SERVICE ..... 15
TABLE 2 – FUTURE (2024) WITHOUT PROJECT LEVEL OF SERVICE ..... 19
TABLE 3 – INNOVATION CENTER AND WELCOME CENTER 2024 TRIP GENERATION ..... 20
TABLE 4 – FUTURE (2024) WITH PROJECT LEVEL OF SERVICE ..... 24

# Appendices

APPENDIX A – INTERSECTION LEVEL OF SERVICE DEFINITIONS
APPENDIX B – INTERSECTION CAPACITY ANALYSIS WORKSHEETS

# II. PROJECT DESCRIPTION

The Natural Energy Laboratory of Hawaii Authority (NELHA) administers the Hawaii Ocean Science and Technology Park (HOST Park) at Keahole Point, North Kona on the island of Hawaii. As an economic development agency of the State, NELHA manages and operates facilities that support research, development, and commercialization of natural energy resources and ocean-related research, technology, and industry. The Park has a strong focus on innovative advances in sustainable technologies particularly in the aquaculture sector. Other areas of interest are sustainable water supplies, green building, conservation, managing carbon footprint and climate change. NELHA seeks to construct the first building in a new Innovation Center, as well as a separate new visitor center for HOST Park – Hale Wawaloli.

The new Innovation Center is an expansion of Feature D – Research Village in the NELHA Master Plan and shown in Figure 1 below. The current research campus is essentially at full capacity at this time and the expansion to include a new Innovation Center or a "south campus" will provide additional growth capacity for the foreseeable future. Hale Wawaloli is an expansion of the existing Wawaloli Beach Park facilities and is identified as Feature C – Wawaloli Ahupua'a Hale on Figure 2. Figure 2 provides additional detail on the specific location of these sites and their relation to existing facilities.

Two Projects in One. The Innovation Center builds upon the existing and nearby 6-acre research campus and is intended to become a world-leading focal-point for state-of-the art research and development of ocean or blue economy technologies. Some of the technologies will be aimed at addressing the challenges of feeding the global population into the next century as well as reduce human dependence on wild fisheries and stressed ocean ecosystems. Others will be focused on improving monitoring of the worlds' oceans. The first element of this new campus is a building that will become home to the world's first aquaculture business accelerator program and will provide space and resources to researchers and entrepreneurs focused on developing and demonstrating disruptive technologies in the blue economy sector.

As currently envisioned, the building would enclose approximately 20,000 sq. ft. of usable interior area on two stories, and include office, common, and conference space, laboratory and wet-room research space with flowing seawater, and a "maker-space" workshop, outside work-spaces and meeting nooks, as well as support areas for maintenance and storage, vehicular and pedestrian accessible routes, parking areas for motorized and non-motorized vehicles, security, and environmentally appropriate landscaping. Every aspect of the project should reflect NELHA's commitment to environmental stewardship, cultural awareness, and vision for practical, meaningful solutions for now and the future. Hale Wawaloli – is to be the public viewport on the science, engineering, and business activities at HOST Park, as well as a Ho'okupu (gift) to the people of West Hawaii. In addition to serving as a visitor education center, the development will include multi-purpose covered pavilion and open amphitheater spaces for community gatherings and public events, so that all may enjoy the blessings of Wawaloli Beach Park. The hale is currently envisioned to be comprised of a melding of covered-open, fully enclosed, and outdoor spaces along with vehicular and pedestrian accessible routes, a parking area, public restrooms, security features, and environmentally appropriate landscaping. The area under roof totaling about 2,250 sq. ft would accommodate office, common, and conference uses.

*Figure 1 - Project Site Plan*

*Figure 2 - Project Location Map*

# III. EXISTING CONDITIONS

Figures 3 and 4 illustrate the proposed plans for the Innovation Center and Welcome Center, respectively.

The majority of NELHA lands are in the State Urban district which offers minimal constraints to development. Three sections are located in the State Conservation District which restricts many of the proposed or potential activities identified in the master plan. The three areas that comprise the Conservation District include: the tip at Keahole Point including the lighthouse site, a triangular section north of Wawaloli Beach and makai of the Makako Bay Drive; the end of the airport runway buffer, a larger piece mauka of one of the deep ocean cold water pump stations; and an archaeological site adjacent to Ooma.

The County General Plan and the Kona Community Development Plan include the NELHA site within their designated urban area. The County Land Use Pattern Allocation Guide (LUPAG) also identifies the shoreline area as an open district. There are restrictions on development in the open district usually limited to open space, recreational uses, single family homes, and accessory recreational facilities

Kona International Airport occupies the land just north of NELHA. Kona International Airport is classified as a primary commercial service small hub airport, reporting 1,519,345 total passenger enplanements (boardings) for 2007. This equates to approximately 0.20 percent of the total annual enplanements in the United States. In 2007, Kona International Airport ranked 76th out of 575 commercial service airports, and ninth of 73 small-hub airports in enplanements. For comparison, Honolulu International Airport ranked 25th for commercial service airports by reporting 10,279,791 total passenger enplanements in 2007.

Kona International Airport is situated on approximately 3,450 acres within the City of Kailua/Kona corporate limits, approximately nine miles northwest of the central business district.

The airport currently has an 11,000-foot runway but plans to build additional runways makai of the existing runway, which will impact NELHA's operations. Additional conceptual plans for the airport include developing the frontage along Queen Kaahumanu Highway with operations that complement the airport and surrounding development, including a hotel/conference center and a cultural education center. Potential areas for partnership between the airport and NELHA include supplying renewable energy and deep seawater cooling for airport developments, renewable fuel vehicle transport for arriving passengers, and synergy between tenants along the Queen Kaahumanu Highway corridor.

## A. Geometric Configuration

### 1. Roadway Configuration

The island of Hawaii is served by a network of 1,393 miles of public roads. This includes 394 miles of state highways. The backbone of the system is the Hawaii Belt Road which circles the island. The Belt Road is comprised of a state highway (State Route 11) to the south and a state highway (State Route 19) to the north. Queen Kaahumanu Highway (State Route 19) provides access to NELHA's Makako Bay Drive and is part of the Hawaii Belt Road.

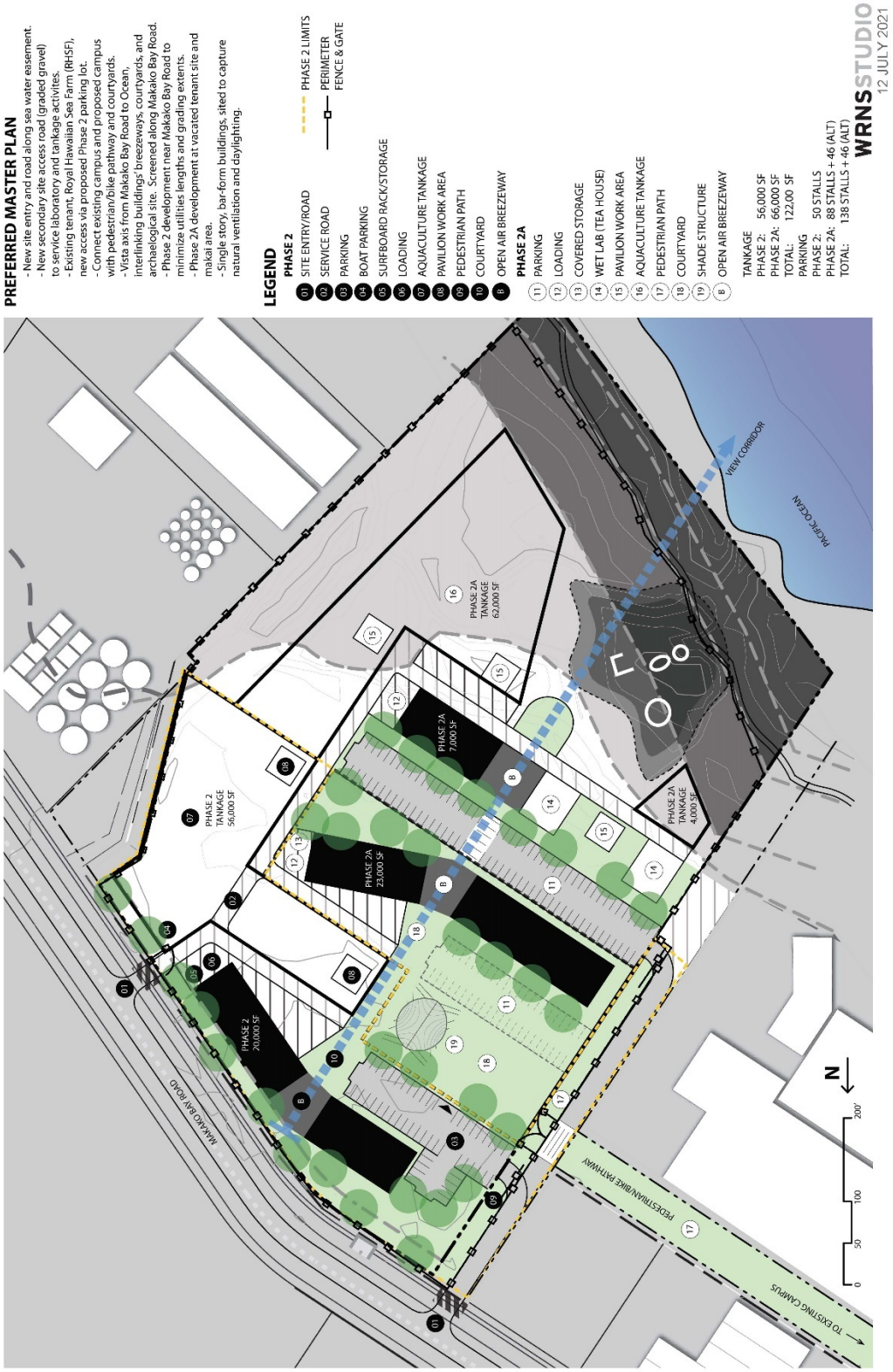



*Figure 3 – Innovation Center Master Plan*

*Figure 4 – Welcome Center Plan*

The roadway network and lane configurations local to the Proposed Project are represented in Figure 5.

a. Queen Kaahumanu Highway
Queen Kaahumanu Highway is located west of the project side. Queen Kaahumanu Highway has recently been built-out to a four-lane highway (from just north of Keahole Airport Road to just south of Kealakehe Parkway). It is a Class I State Highway with limited access and a posted speed limit of 45 miles per hour near the project location. Queen Kaahumanu Highway is a link in the principal highway system that circles the island.

b. Keahole Airport Road
Keahole Airport Road provides primary airport access from the highway to the passenger terminal as well as other airport facilities. Keahole Airport Road is a two-lane, undivided roadway. The posted speed limit on Keahole Airport Road is 25 mph.

c. Kaiminani Drive
Kaiminani Drive is a collector road that extends west from Mamalahoa Highway, past Queen Kaahumanu Highway to Kahilihili Street where it currently transitions into a 90-degree turn southbound. However, the two roadways are terminated as stub-outs forming a pseudo-four-leg intersection for future expansion within the NELHA park. Just mauka of Queen Kaahumanu Highway, Kaiminani Drive is a two-lane, undivided roadway. It provides Eastbound and Westbound left-turn lanes and right-turn storage lanes at its signalized intersection with Queen Kaahumanu Highway. The posted speed limit is 35 mph.

d. Kahilihili Street
Kahilihili Street is currently a north-south running roadway within the NELHA park that terminates just south of Makako Bay Drive (and provides access to the West Hawaii Explorations Academy, Keahole Solar Power Plant, and NELHA Gateway Center). It is a two-lane, undivided roadway.

e. Makako Bay Drive
Makako Bay Drive is a 24-foot-wide asphaltic concrete pavement road. It is a two-lane, undivided roadway. The right-of-way varies between 80 feet and 110 feet. The wider 110-foot section begins just after the first interior intersection and ends near the main roadway bend near the booster pump station site. The Access Road is approximately 11,600 feet in length and is a public roadway. The road provides access to NELHA and tenant facilities, the north end of the Ooma shoreline area, and Wawaloli Beach Park. There is an access gate near Makako Bay Drive's intersection with Queen Kaahumanu Highway. This gate is closed between 8 p.m. and 6 a.m. The posted speed limit is 25 mph.

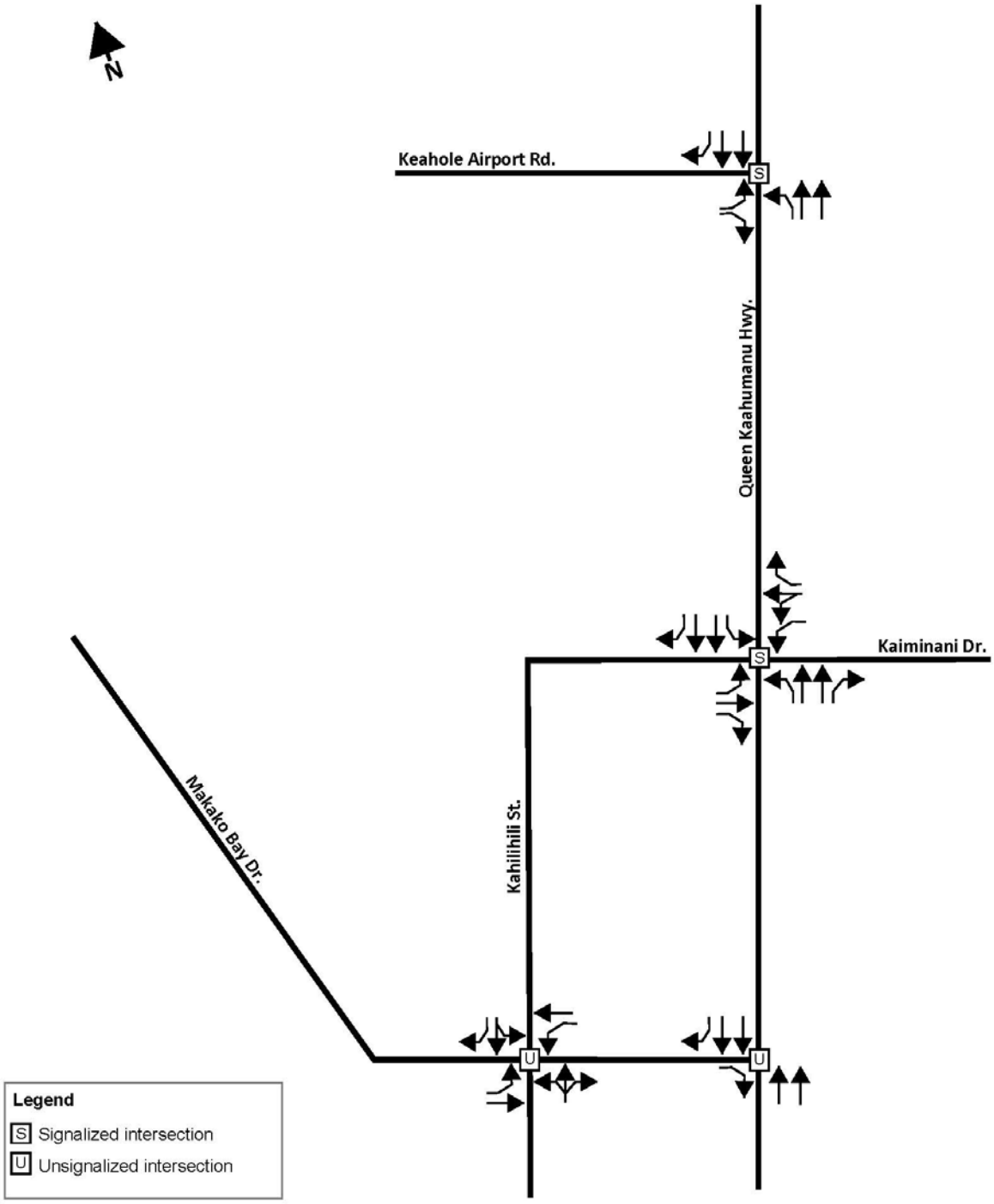



*Figure 5 - Existing Lane Configuration*

## B. Volumes

### 1. Vehicular Volumes

Due to the decrease in traffic volumes caused by the various COVID-19 pandemic shutdowns and general reduction in travel activity beginning in March of 2020, traffic volumes and counts from 2018 were utilized in this study as a baseline. It is assumed that travel activity and traffic volumes will resume pre-pandemic levels by the time construction of the proposed project is completed in 2024. Therefore, the future background traffic volumes will be derived by implementing the historical traffic growth rate of 1.6% for this area, applied to the baseline 2018 traffic volumes.

<u>24-Hour Volumes</u>

Figure 6 shows 24-hour traffic volume plots along Queen Kaahumanu Highway just north of Makako Bay Drive. The Queen Kaahumanu Highway data was taken from HDOT counts at station T8M on Tuesday, September 16 and Wednesday, September 17, 2011. This data was only utilized to determine the peak hours for the region. The 24-hour plot on Makako Bay Drive indicated three peak hours during the day that are associated with work and school-related trips during morning peak hours, lunch break related trips during the mid-day period, and home and school-related trips during afternoon peak hours.

Per 2019 HDOT data (prior to the COVID-19 pandemic slowdown), Annual Average Daily Traffic (AADT) On Queen Kaahumanu Highway south of Makako Bay Drive (Milepost 93.74) was 37,772 vehicles. The AADT on Queen Kaahumanu Highway north of Keahole Airport Access Road (between Mileposts 86.91 to 92.67) was 15,000, with 451 single unit trucks and 18 combination trucks. The AADT on Queen Kaahumanu Highway south of Keahole Airport Access Road for the section of the highway that runs directly adjacent to the entrance to the NELHA park was 28,000, with 1,270 single unit trucks and 174 combination trucks (mileposts 92.67 to 97.19).

<u>Turning Movement Counts</u>

In addition, turning movement counts were recorded in 2018 via traffic counting personnel at the intersections of Queen Kaahumanu Highway and Keahole Airport Road, Queen Kaahumanu Highway and Kaiminani Drive, Queen Kaahumanu Highway and Makako Bay Drive, and Makako Bay Drive and Kahilihili Street. Figure 7 shows the existing peak hour traffic volumes at the recorded intersection locations. Based upon historical peak hour data and KOA flight schedules, counts were performed between 7am to 9am, 10am to noon, and from 2:30pm to 4:30pm, respectively.

2018 turning movement counts were utilized to represent the existing condition due to the COVID-19 slowdown. It is assumed that traffic volumes are getting back to pre-pandemic levels and that, moving forward, the historical traffic growth of 1.6% will continue.

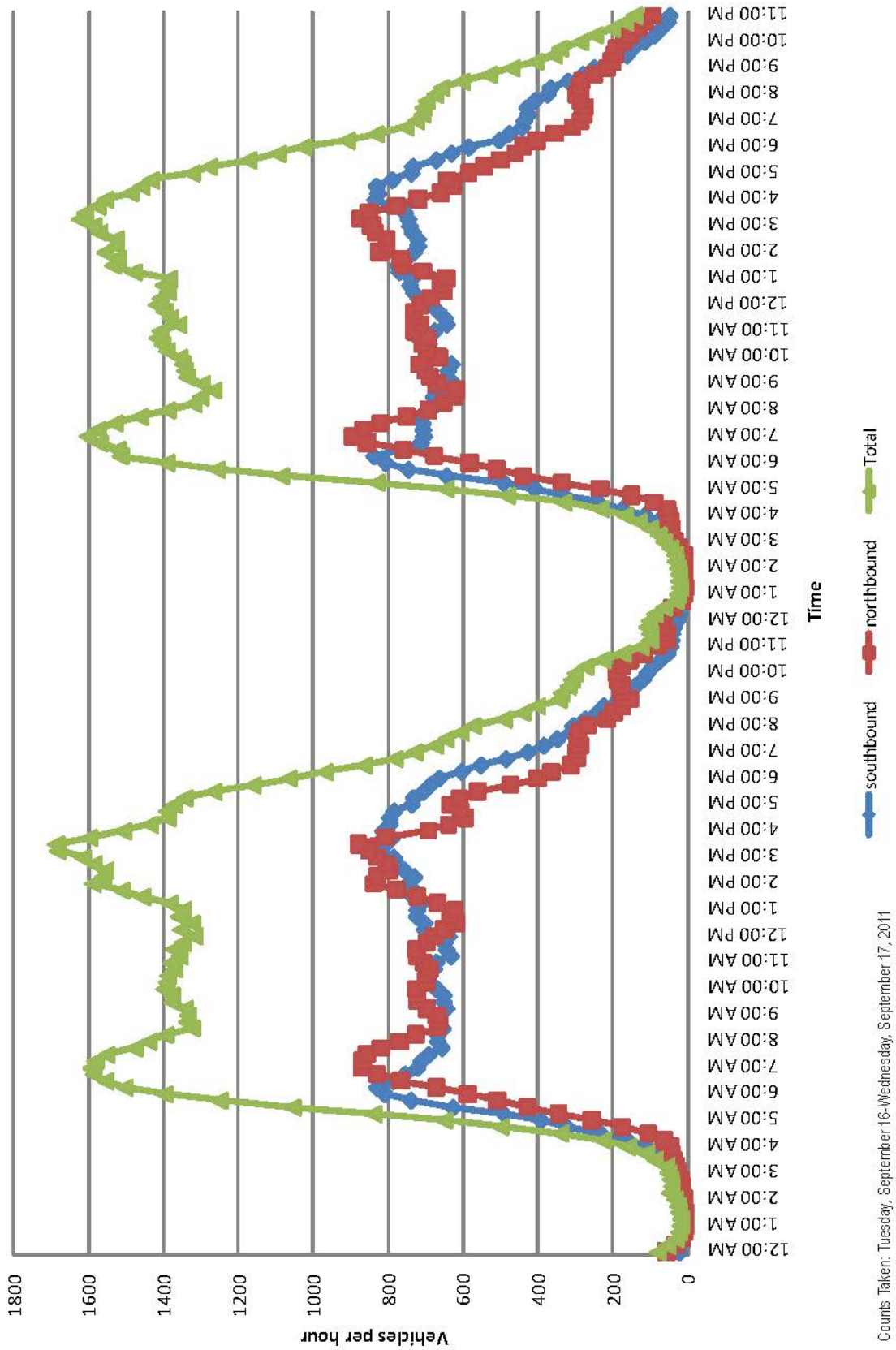



Figure 6 – 24-hour Traffic Volumes on Queen Kaahumanu Highway

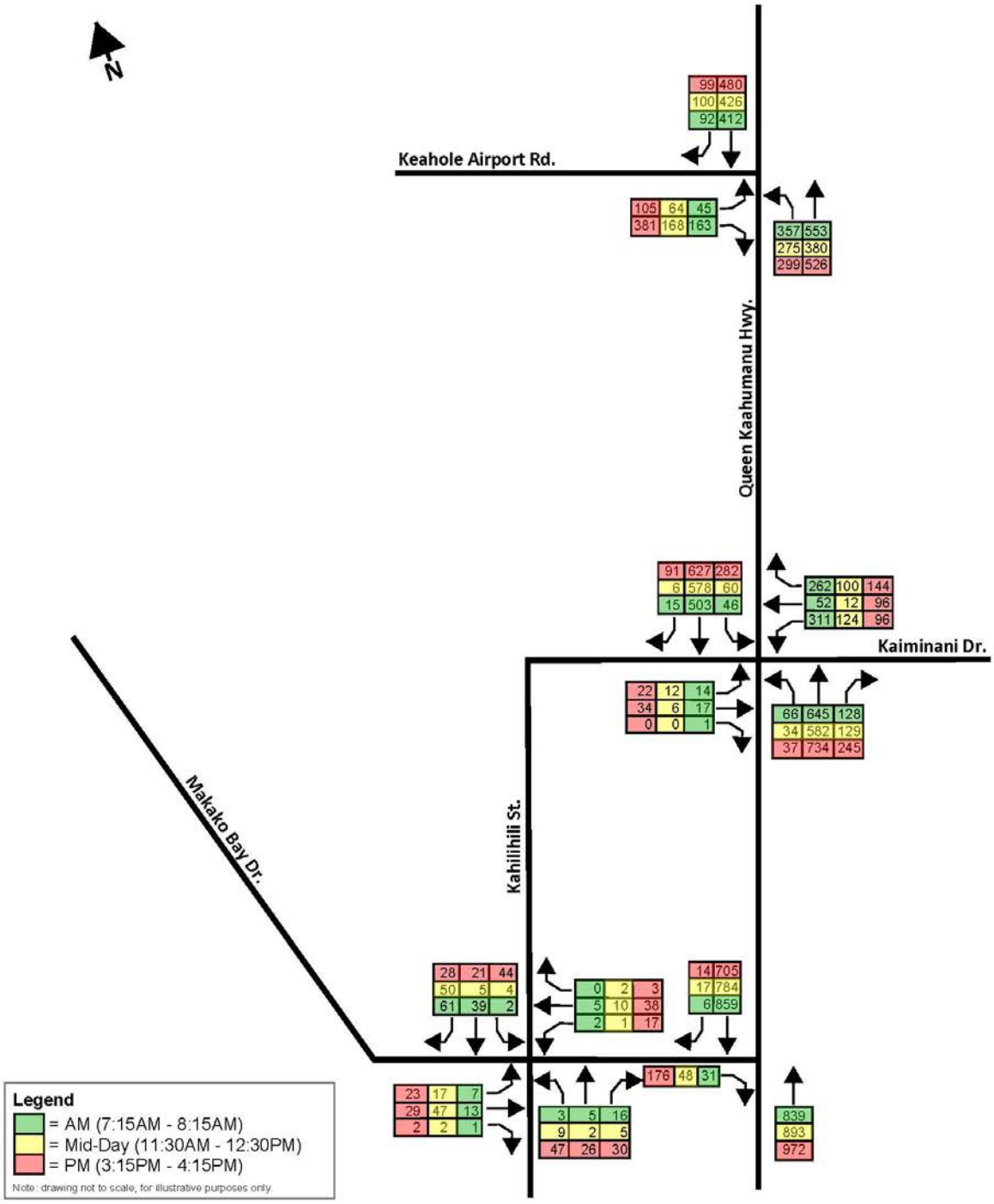



*Figure 7 - Existing Peak Hour Volumes*

## C. Level of Service

### 1. Methodology

The methodology used in the *Institute of Transportation Engineers* (*ITE*), *Trip Generation Manual, 10th Edition*, was reviewed and applied on this project.

Appendix A – Intersection Level of Service defines the vehicle delay categories utilized in this study.

### 2. Existing Intersection Level of Service Results

Table 1 below outlines the 2020 roadway network Level of Service. The turning movement counts from 2018 were utilized and an historical traffic growth rate (1.6%) applied as a baseline in lieu of the existing turning movement counts which would be artificially low due to the COVID-19 pandemic.

| 2020 | AM | | Mid-Day | | PM | |
|---|---|---|---|---|---|---|
| | LOS | Delay (s/veh) | LOS | Delay (s/veh) | LOS | Delay (s/veh) |
| **Queen Kaahumanu Hwy & Keahole Airport Rd** | **B** | **13.4** | **B** | **13.4** | **B** | **15.3** |
| Queen Kaahumanu NB Thru | A | 2.7 | A | 2.8 | A | 3.9 |
| Queen Kaahumanu NB Left | C | 25.2 | C | 27.2 | C | 26.4 |
| Queen Kaahumanu SB Thru | B | 13.5 | B | 11.5 | B | 15.3 |
| Queen Kaahumanu SB Right | B | 11.6 | A | 9.9 | B | 12.7 |
| Keahole Airport EB Left | C | 22.4 | C | 20.2 | C | 21.7 |
| Keahole Airport EB Right | C | 21.6 | B | 19.1 | C | 21.0 |
| **Queen Kaahumanu Hwy & Kaiminani St** | **C** | **21.5** | **B** | **17.8** | **C** | **26.4** |
| Queen Kaahumanu NB Thru | C | 20.2 | B | 14.0 | C | 30.3 |
| Queen Kaahumanu NB Left | D | 44.9 | E | 72.2 | D | 41.4 |
| Queen Kaahumanu NB Right | B | 15.7 | B | 11.3 | C | 21.1 |
| Queen Kaahumanu SB Thru | C | 20.2 | B | 13.1 | B | 15.3 |
| Queen Kaahumanu SB Left | D | 44.3 | E | 72.6 | D | 48.9 |
| Queen Kaahumanu SB Right | B | 15.7 | B | 10.1 | B | 12.2 |
| Kaiminani EB Thru | C | 35.3 | C | 24.0 | C | 29.7 |
| Kaiminani EB Left | D | 53.8 | E | 57.9 | D | 52.4 |
| Kaiminani EB Right | C | 30.4 | A | 0.0 | A | 0.0 |
| Kaiminani WB Thru | B | 12.4 | B | 14.4 | B | 18.9 |
| Kaiminani WB Left | B | 16.7 | C | 24.5 | C | 32.3 |
| Kaiminani WB Right | B | 15.0 | B | 17.7 | C | 22.7 |
| **Queen Kaahumanu Hwy & Makako Bay Dr** | Unsignalized | | | | | |
| Queen Kaahumanu NB Thru | A | 0.0 | A | 0.0 | A | 0.0 |
| Queen Kaahumanu SB Thru-Right | A | 0.0 | A | 0.0 | A | 0.0 |
| Makako Bay EB Right | A | 0.0 | A | 0.0 | A | 0.0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Makako Bay EB Thru-Right | A | 0.0 | A | 0.0 | A | 0.0 |
| **Makako Bay Dr & Kahilihili St** | Unsignalized | | | | | |
| Makako Bay EB Left | A | 7.2 | A | 7.3 | A | 7.3 |
| Makako Bay WB Thru-Right | A | 0.0 | A | 0.0 | A | 0.0 |
| Makako Bay WB Left | A | 7.2 | A | 7.3 | A | 7.3 |
| Kahilihili St NB Thru-Right-Left | A | 8.8 | A | 9.4 | B | 10.4 |
| Kahilihili St SB Thru-Left | A | 8.9 | A | 8.7 | B | 10.1 |
| Kahilihili St SB Right | A | 0.0 | A | 0.0 | A | 0.0 |

*Table 1 – Existing Level of Service*

# IV. FUTURE CONDITIONS

## A. Surrounding Area Conditions

Queen Kaahumanu Highway was recently constructed to its current four-lane configuration. This configuration is represented in both the existing and future roadway analyses.

## B. Volumes

### 1. Future Without Project Volumes

As described in Section III.C.1 Methodology above, the Future Without Project Volumes are the projected background traffic volumes within the local roadway network, absent the proposed development.

Background traffic volumes are volumes not directly associated with the proposed development. These volumes are comprised of regional volumes using Queen Kaahumanu Highway and the rest of the local roadway network (Makako Bay Drive and Kahilihili Street) to travel past and through the existing NELHA development.

Embedded in the regional background traffic volumes are those trips generated by the expansion of the Kona International Airport. The airport's passenger traffic has risen at a steady rate. According to the 'Kona International Airport at Keahole Draft Airport Master Plan, January 2009, total airport passenger traffic was anticipated to rise at the steady rate of approximately 1.8% between 2005 and 2030. Historically, this rate has coincided and is anticipated to continue to coincide with the 1.6% annualized traffic growth along queen Kaahumanu Highway in the vicinity of the proposed Innovation Center and Welcome Center.

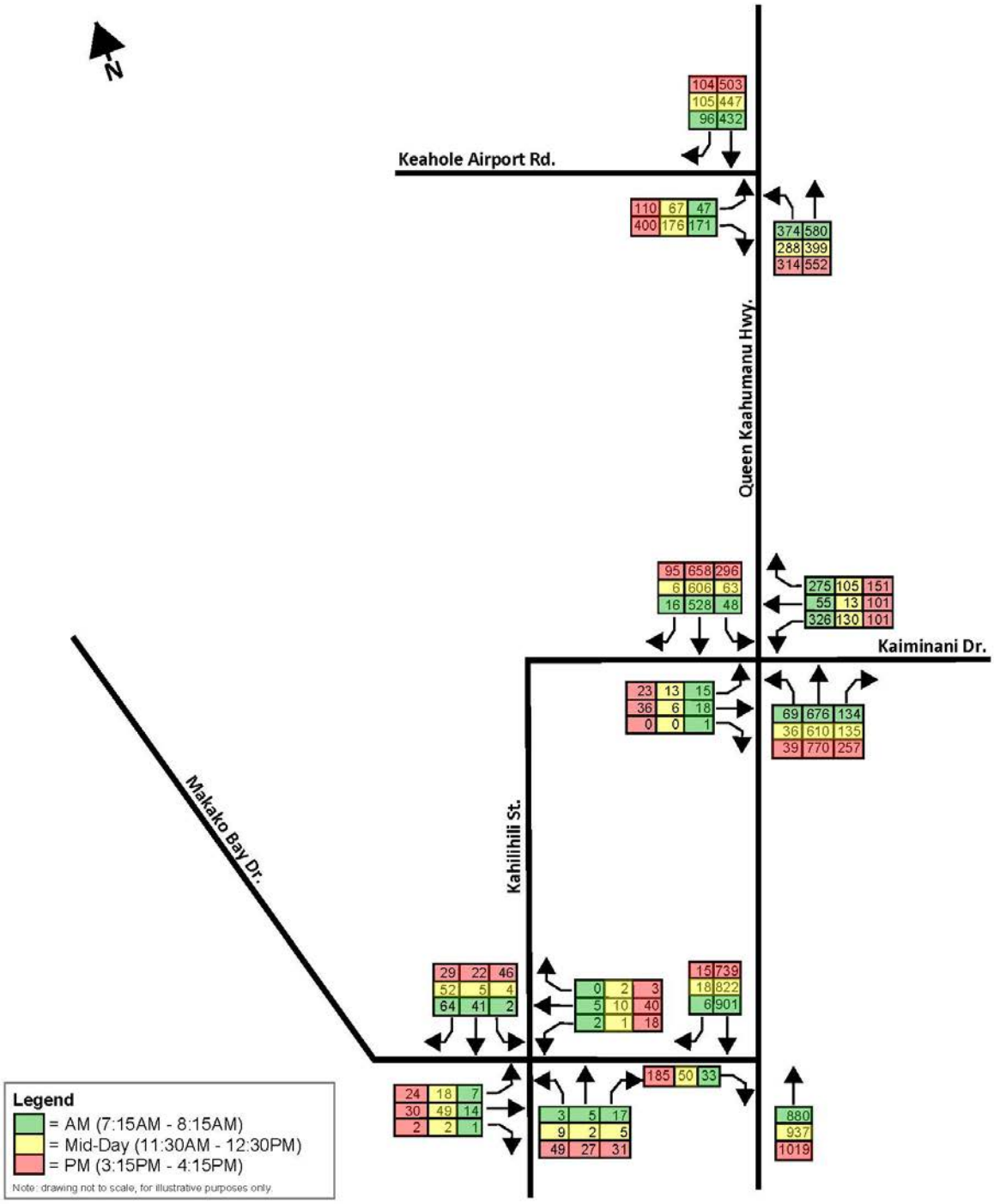



*Figure 8 - Future (2024) without Project Peak Hour Volumes*

## C. Future (2024) without Project Level Of Service

### 1. Future without Project Intersection Level of Service Results

Table 4 below outlines the Future without Project roadway network Level of Service

| Future (2024) without Project | AM | | Mid-Day | | PM | |
|---|---|---|---|---|---|---|
| | LOS | Delay | LOS | Delay | LOS | Delay |
| **Queen Kaahumanu Hwy & Keahole Airport Rd** | **B** | **14.3** | **B** | **14.0** | **B** | **15.7** |
| Queen Kaahumanu NB Thru | A | 3.2 | A | 2.8 | A | 4.0 |
| Queen Kaahumanu NB Left | C | 27.1 | C | 30.2 | C | 27.6 |
| Queen Kaahumanu SB Thru | B | 15.0 | B | 11.6 | B | 15.9 |
| Queen Kaahumanu SB Right | B | 12.6 | A | 9.9 | B | 13.0 |
| Keahole Airport EB Left | C | 21.4 | C | 20.3 | C | 21.8 |
| Keahole Airport EB Right | C | 20.9 | B | 19.1 | C | 21.1 |
| **Queen Kaahumanu Hwy & Kaiminani St** | **C** | **21.8** | **B** | **18.6** | **C** | **27.0** |
| Queen Kaahumanu NB Thru | C | 23.0 | B | 14.2 | C | 30.1 |
| Queen Kaahumanu NB Left | D | 52.2 | F | 82.7 | D | 42.0 |
| Queen Kaahumanu NB Right | B | 16.5 | B | 11.3 | C | 20.7 |
| Queen Kaahumanu SB Thru | C | 21.6 | B | 13.3 | B | 15.0 |
| Queen Kaahumanu SB Left | D | 52.1 | F | 81.3 | D | 54.1 |
| Queen Kaahumanu SB Right | B | 16.4 | B | 10.1 | B | 11.8 |
| Kaiminani EB Thru | C | 31.7 | C | 23.6 | C | 31.4 |
| Kaiminani EB Left | F | 85.3 | E | 67.6 | D | 51.7 |
| Kaiminani EB Right | C | 30.0 | A | 0.0 | A | 0.0 |
| Kaiminani WB Thru | B | 12.3 | B | 14.4 | B | 19.7 |
| Kaiminani WB Left | B | 17.6 | C | 24.6 | C | 31.8 |
| Kaiminani WB Right | B | 14.8 | B | 17.8 | C | 23.6 |
| **Queen Kaahumanu Hwy & Makako Bay Dr** | Unsignalized | | | | | |
| Queen Kaahumanu NB Thru | A | 0.0 | A | 0.0 | A | 0.0 |
| Queen Kaahumanu SB Thru-Right | A | 0.0 | A | 0.0 | A | 0.0 |
| Makako Bay EB Right | A | 0.0 | A | 0.0 | A | 0.0 |
| **Makako Bay Dr & Kahilihili St** | Unsignalized | | | | | |
| Makako Bay EB Left | A | 7.2 | A | 7.3 | A | 7.3 |
| Makako Bay WB Thru-Right | A | 0.0 | A | 0.0 | A | 0.0 |
| Makako Bay WB Left | A | 7.3 | A | 7.3 | A | 7.3 |
| Kahilihili St NB Thru-Right-Left | A | 8.8 | A | 9.4 | B | 10.5 |
| Kahilihili St SB Thru-Left | A | 8.9 | A | 8.7 | B | 10.2 |
| Kahilihili St SB Right | A | 0.0 | A | 0.0 | A | 0.0 |

* = Delay > 300 sec/veh.

*Table 2 - Future (2024) without Project Level of Service*

## D. Future (2024) with Project Level of Service

### 1. Project Related Volumes

#### *a) Trip Generation*

The Institute of Transportation Engineers (ITE), Trip Generation, 10th Edition (2009) methodology was utilized to project the trips generated by the subject development in the Horizon Year of 2024. Land Use 760 (Research and Development Center) was used to represent the Innovation Center and Land Use 411 (Public Park) was used to represent the Welcome Center addition to Wawaloli Beach Park. The corresponding average rates or fitted curve equations and directional distributions were applied during the pertinent peak hours to produce projected generated trips. See Table 3.

The Innovation Center and Welcome Center are anticipated to be completed in the horizon year of 2024.

The traffic generated by the 122,000 square-foot Innovation Center and 7-acre Wawaloli Beach Park with the Welcome Center by the Horizon Year (2024), shown in Figure 9 was combined with the projected background traffic in 2024. This sum represents the Horizon, or Future, Year (2024) traffic volumes with the Proposed Project. These volumes are represented in Figure 10.

| | | AM Peak Hour of Traffic | | | MD Peak Hour of Traffic | | | PM Peak Hour of Traffic | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Land Use Designation** | **No. Units** | **Avg Rate** | **Enter (vph)** | **Exit (vph)** | **Avg Rate** | **Enter (vph)** | **Exit (vph)** | **Avg Rate** | **Enter (vph)** | **Exit (vph)** |
| Research and Development Center (1000 Sq. Ft. GFA) | 122 | 0.42 | 51 | | 0.42 | 51 | | 1.11 | 135 | |
| Directional Split % | | | 75% | 25% | | 75% | 25% | | 16% | 84% |
| | | **Pass-By %** | 38 | 13 | **Pass-By %** | 38 | 13 | **Pass-By %** | 22 | 113 |
| Pass-By Trips | | 0% | 0 | 0 | 0% | 0 | 0 | 0% | 0 | 0 |
| *Subtotal* | | | 38 | 13 | | 38 | 13 | | 22 | 113 |
| Public Park (Acres) | 7.0 | 0.02 | 0 | | FC | 16 | | FC | 16 | |
| Directional Split % | | | 59% | 41% | | 40% | 60% | | 40% | 60% |
| | | **Pass-By %** | 0 | 0 | **Pass-By %** | 6 | 10 | **Pass-By %** | 6 | 10 |
| Pass-By Trips | | 0% | 0 | 0 | 0% | 0 | 0 | 0% | 0 | 0 |
| *Subtotal* | | | 0 | 0 | | 6 | 10 | | 6 | 10 |
| **Total Net Trips (external)** | | | 38 | 13 | | 44 | 23 | | 28 | 123 |

FC = Fitted Curve Equation Result

*Table 3 – Innovation Center and Welcome Center 2024 Trip Generation*

#### *b) Trip Distribution and Assignment*

The traffic generated by the Proposed Project for the Horizon Year (2024) was distributed and assigned to the network based on the regional travel patterns, or trend analysis, observed from pre-pandemic 2018 turning movement count data. It is reflected in the project-generated traffic turning movement volumes.

The regional traffic north and southbound along Queen Kaahumanu Highway within the localized Proposed Project roadway network is projected to continue to increase based on past data. This background growth rate was identified as

1.6%. This rate was determined via Hawaii Department of Transportation (HDOT) counts on Queen Kaahumanu Highway and was therefore projected as the background traffic growth rate from the present to the Horizon Year of 2024.

The without Project traffic volumes became the base traffic volumes for which the Project Related traffic volumes were added to arrive at the Total Traffic Volumes with the Project in the Horizon Year (2024).

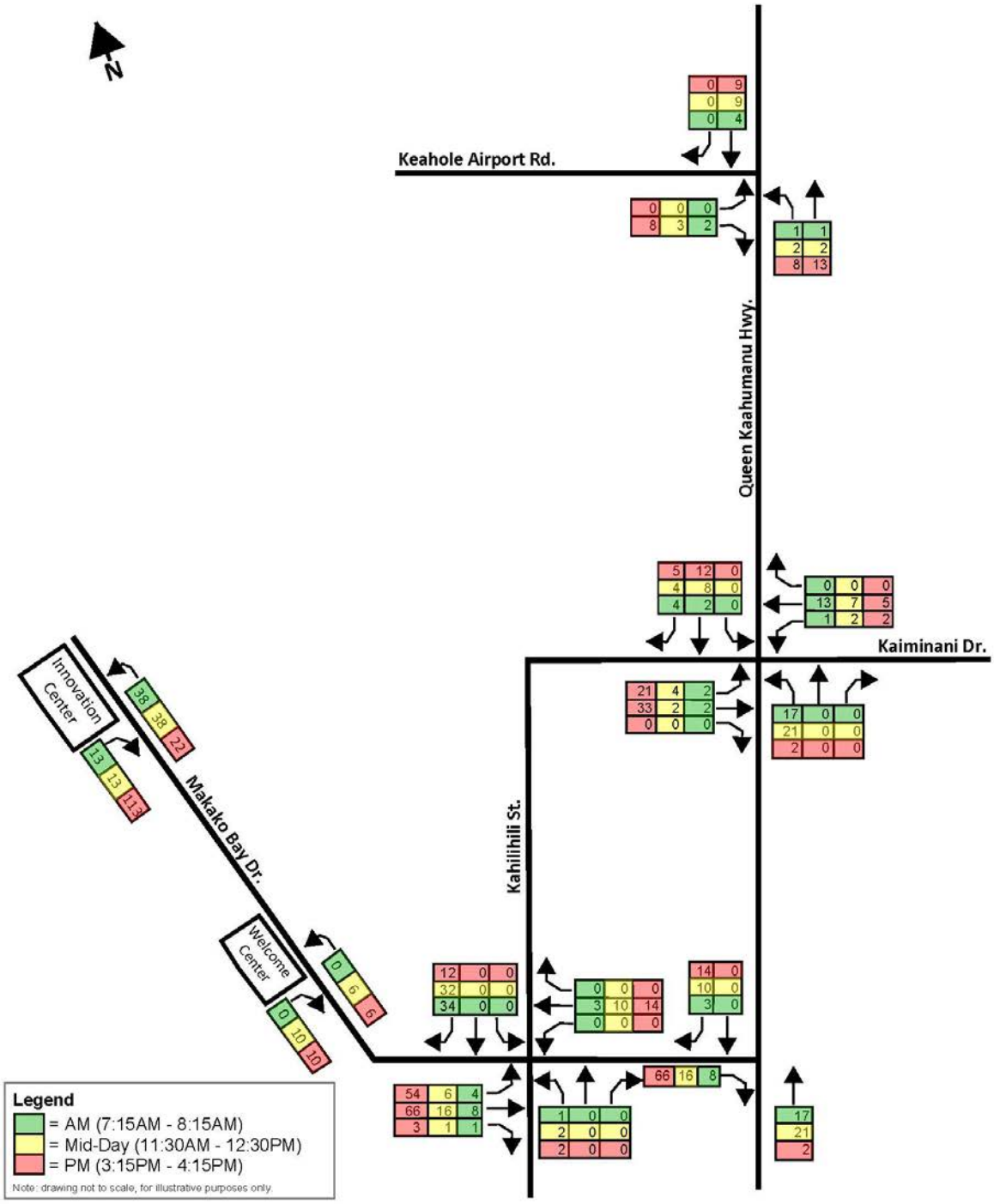



*Figure 9 – 2024 Project-related Peak Hour Volumes*

## 2. Future (2024) With Project Volumes

The traffic generated by the Proposed Project by the Horizon Year (2024), shown in Figure 9 was combined with the projected background traffic in 2024, shown in Figure 8. This sum represents the Horizon, or Future, Year (2024) traffic volumes with the Proposed Project. These volumes are represented in Figure 10.

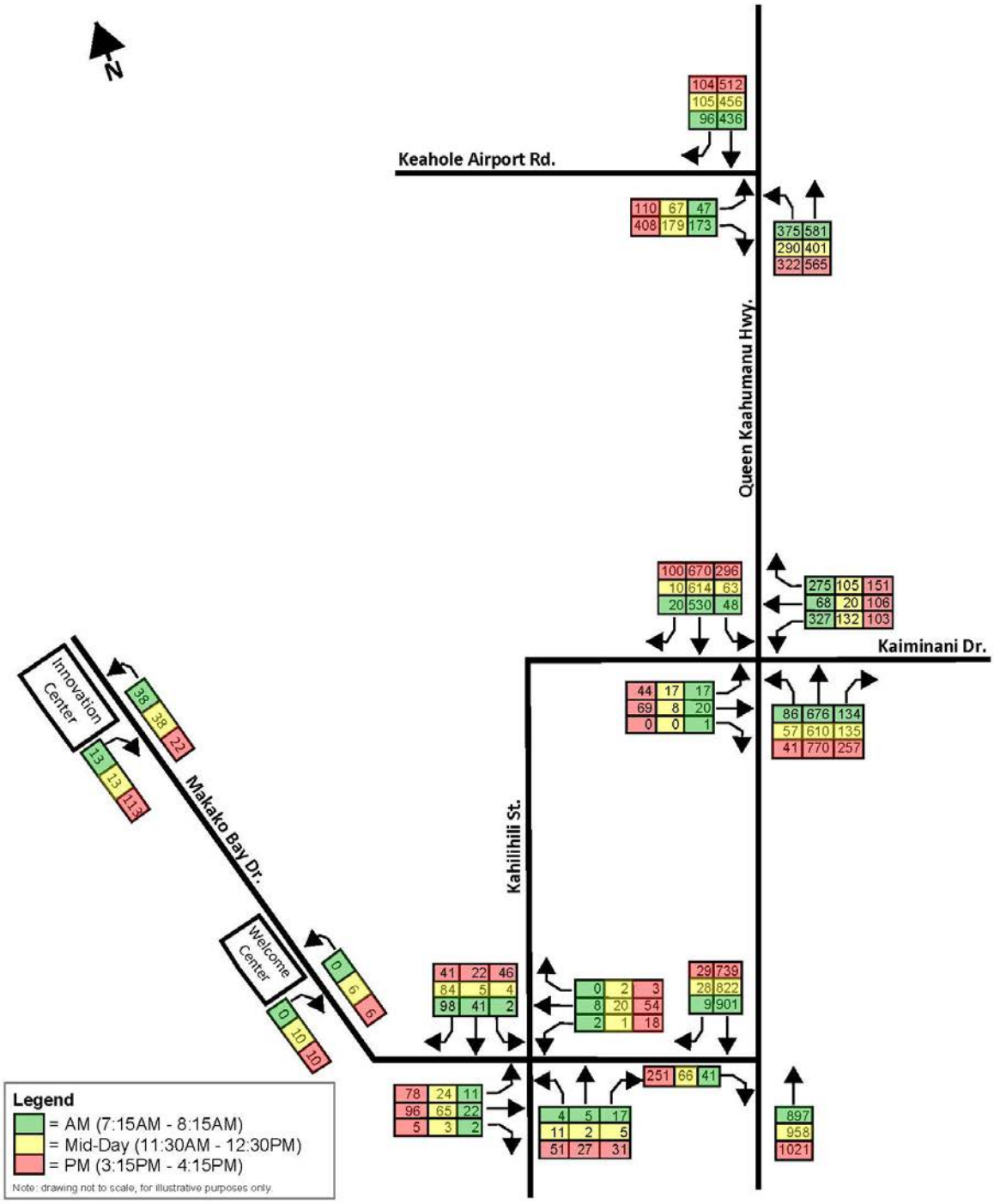



*Figure 10 - Future (2024) with Project Peak Hour Volumes*

## 3. Future with Project Intersection Level of Service Results

Table 4 below outlines the Future with Project roadway network Level of Service.

| Future (2024) with Project | AM | | Mid-Day | | PM | |
|---|---|---|---|---|---|---|
| | LOS | Delay | LOS | Delay | LOS | Delay |
| **Queen Kaahumanu Hwy & Keahole Airport Rd** | **B** | **14.3** | **B** | **14.1** | **B** | **15.8** |
| Queen Kaahumanu NB Thru | A | 3.2 | A | 2.8 | A | 4.0 |
| Queen Kaahumanu NB Left | C | 27.2 | C | 30.6 | C | 28.0 |
| Queen Kaahumanu SB Thru | B | 15.0 | B | 11.7 | B | 16.2 |
| Queen Kaahumanu SB Right | B | 12.6 | A | 9.9 | B | 13.1 |
| Keahole Airport EB Left | C | 21.4 | C | 20.3 | C | 21.8 |
| Keahole Airport EB Right | C | 20.9 | B | 19.2 | C | 21.1 |
| **Queen Kaahumanu Hwy & Kaiminani St** | **C** | **23.8** | **B** | **19.5** | **C** | **30.2** |
| Queen Kaahumanu NB Thru | C | 23.0 | B | 14.4 | C | 30.2 |
| Queen Kaahumanu NB Left | F | 86.5 | E | 61.9 | E | 56.9 |
| Queen Kaahumanu NB Right | B | 16.5 | B | 11.5 | C | 21.9 |
| Queen Kaahumanu SB Thru | C | 21.6 | B | 14.5 | B | 15.0 |
| Queen Kaahumanu SB Left | D | 52.1 | E | 77.8 | D | 53.1 |
| Queen Kaahumanu SB Right | B | 16.5 | B | 10.8 | B | 11.9 |
| Kaiminani EB Thru | C | 28.3 | C | 23.1 | C | 29.8 |
| Kaiminani EB Left | F | 112.6 | F | 109.5 | E | 58.3 |
| Kaiminani EB Right | C | 27.6 | A | 0.0 | A | 0.0 |
| Kaiminani WB Thru | B | 12.4 | B | 14.1 | C | 24.3 |
| Kaiminani WB Left | B | 20.0 | C | 24.3 | F | 97.6 |
| Kaiminani WB Right | B | 14.8 | B | 17.4 | C | 27.4 |
| **Queen Kaahumanu Hwy & Makako Bay Dr** | Unsignalized | | | | | |
| Queen Kaahumanu NB Thru | A | 0.0 | A | 0.0 | A | 0.0 |
| Queen Kaahumanu SB Thru-Right | A | 0.0 | A | 0.0 | A | 0.0 |
| Makako Bay EB Right | A | 0.0 | A | 0.0 | A | 0.0 |
| **Makako Bay Dr & Kahilihili St** | Unsignalized | | | | | |
| Makako Bay EB Left | A | 7.2 | A | 7.3 | A | 7.5 |
| Makako Bay WB Thru-Right | A | 0.0 | A | 0.0 | A | 0.0 |
| Makako Bay WB Left | A | 7.3 | A | 7.4 | A | 7.5 |
| Kahilihili St NB Thru-Right-Left | A | 9.0 | A | 9.9 | B | 12.9 |
| Kahilihili St SB Thru-Left | A | 9.0 | A | 8.8 | B | 11.8 |
| Kahilihili St SB Right | A | 0.0 | A | 0.0 | A | 0.0 |

* = Delay > 300 sec/veh.

*Table 4 - Future (2024) with Project Level of Service*

# V. SUMMARY AND RECOMMENDATIONS

In summary, the traffic analysis indicates that the existing roadway network can handle the project's traffic volumes. The only detectable increase to roadway network Level of Service due to the proposed Project through the Horizon Year of 2024 will be at Queen Kaahumanu Highway and Kaiminani St intersection. Without mitigating traffic signal timing modifications, the left-turning movements in the NB (Queen Kaahumanu Highway NB to Kahilihili St WB) EB (Kaiminani St EB to Queen Kaahumanu Highway SB), and WB (Kaiminani St WB to Queen Kaahumanu Highway NB) directions are anticipated to experience increased delay from the 2024 without Project condition to the 2024 with Project condition.

For the Queen Kaahumanu Highway NB Left turn the control delay is projected to increase from 52.2 seconds/vehicle (LOS D) to 86.5 seconds/vehicle (LOS F) in the AM peak period. The control delay is projected to increase from 42.0 seconds/vehicle (LOS D) to 56.9 seconds/vehicle (LOS D) in the PM peak period.

For the Kaiminani Street EB Left turn the control delay is projected to increase from 85.3 seconds/vehicle (LOS F) to 112.6 seconds/vehicle (LOS F) in the AM peak period. The control delay is projected to increase from 67.6 seconds/vehicle (LOS E) to 109.5 seconds/vehicle (LOS F) in the MD peak period. The control delay is projected to increase from 51.7 seconds/vehicle (LOS D) to 58.3 seconds/vehicle (LOS E) in the PM peak period.

For the Kaiminani Street WB Left turn the control delay is projected to increase from 31.8 seconds/vehicle (LOS C) to 97.6 seconds/vehicle (LOS F) in the PM peak period.

It is recommended that the traffic signal cycle and phase timing be modified at the Queen Kaahumanu Highway and Kaiminani Street/Kahilihili Street intersection to provide more green time to the left turning movements should the projected delays materialize. The thru movements at this intersection are all projected to operate at B or C LOS and could absorb a few seconds of additional delay without lowering their LOS designations.

# VI. REFERENCES

"NELHA/Matsuyama Food and Fuel, Traffic Impact Analysis Report," Kailua-Kona, Hawaii, Stantec, April 2018.

"Kona International Airport at Keahole Draft Airport Master Plan," January 2009.

"Traffic Study: Natural Energy Laboratory of Hawaii Authority," Kailua-Kona, Hawaii, Parsons Brinckerhoff, April 2011.

"Final, Laaloa Avenue County Park, Tax Map Key 7-7-008:030, Traffic Impact Analysis Report," Kailua-Kona, Island of Hawaii, SSFM International, September 12, 2017.

# APPENDIX A – INTERSECTION LEVEL OF SERVICE DEFINITIONS

# INTERSECTION LEVEL OF SERVICE DEFINITIONS

The *Highway Capacity Manual* defines six Intersection Levels of Service (LOS), labeled A through F, from free flow to congested conditions.

Levels of Service for signalized intersections is defined in terms of control delay, which is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. The delay experienced by a motorist is made up of a number of factors that relate to control, geometrics, traffic, and incidents. Total delay is the difference between the travel time actually experienced and the reference travel time that would result during base conditions: in the absence of traffic control, geometric delay, any incidents, and any other vehicles. Specifically, LOS criteria for traffic signals are stated in terms of the average control delay per vehicle, typically for a 15-minute analysis period. Delay is a complex measure and depends on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group.

LEVEL-OF-SERVICE A: Low control delay, up to 10 s/veh. This LOS occurs when progression is extremely favorable and most vehicles arrive during the green phase. Many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delay values.

LEVEL-OF-SERVICE B: Control delay greater than 10 and up to 20 s/veh. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of delay.

LEVEL-OF-SERVICE C: Control delay greater than 20 and up to 35 s/veh. These higher delays may result from only fair progression, longer cycle lengths, or both.
Individual cycle failures may begin to appear at this level. Cycle failure occurs when a given green phase does not serve queued vehicles, and overflows occur. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LEVEL-OF-SERVICE D: Control delay greater than 35 and up to 55 s/veh. At LOS D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, and high v/c ratios.

LEVEL-OF-SERVICE E: Control delay greater than 55 and up to 80 s/veh. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent.

LEVEL-OF-SERVICE F: Control delay in excess of 80 s/veh. This level, considered unacceptable to most drivers, often occurs with oversaturation, that is when arrival flow rates exceed the capacity of lane groups. It may also occur at high v/c ratios with many individual cycle failures. Poor progression and long cycle lengths may also contribute significantly to high delay levels.

For unsignalized intersections, the *Highway Capacity Manual* evaluates gaps in the major street traffic flow and calculates available gaps for left-turns across oncoming traffic and for the left and right-turns onto the major roadway from the minor street. Average control delay, based on these factors, is still used to define the levels of service.

LEVEL-OF-SERVICE A: Low control delay, up to 10 s/veh.

LEVEL-OF-SERVICE B: Control delay greater than 10 and up to 15 s/veh.

LEVEL-OF-SERVICE C: Control delay greater than 15 and up to 25 s/veh.

LEVEL-OF-SERVICE D: Control delay greater than 25 and up to 35 s/veh.

LEVEL-OF-SERVICE E: Control delay greater than 35 and up to 50 s/veh.

LEVEL-OF-SERVICE F: Control delay in excess of 50 s/veh.

# APPENDIX B – INTERSECTION CAPACITY ANALYSIS WORKSHEETS

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 7 | 13 | 1 | 2 | 5 | 0 | 3 | 5 | 16 | 2 | 39 | 61 |
| Future Volume (Veh/h) | 7 | 13 | 1 | 2 | 5 | 0 | 3 | 5 | 16 | 2 | 39 | 61 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 8 | 14 | 1 | 2 | 5 | 0 | 3 | 5 | 17 | 2 | 42 | 66 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 5 | | | 15 | | | 94 | 40 | 14 | 58 | 40 | 5 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 5 | | | 15 | | | 94 | 40 | 14 | 58 | 40 | 5 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 100 | 99 | 98 | 100 | 95 | 94 |
| cM capacity (veh/h) | 1616 | | | 1603 | | | 800 | 847 | 1065 | 914 | 847 | 1078 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 8 | 15 | 2 | 5 | 25 | 110 |
| Volume Left | 8 | 0 | 2 | 0 | 3 | 2 |
| Volume Right | 0 | 1 | 0 | 0 | 17 | 66 |
| cSH | 1616 | 1700 | 1603 | 1700 | 976 | 1797 |
| Volume to Capacity | 0.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.06 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 | 2 | 5 |
| Control Delay (s) | 7.2 | 0.0 | 7.2 | 0.0 | 8.8 | 8.9 |
| Lane LOS | A | | A | | A | A |
| Approach Delay (s) | 2.5 | | 2.1 | | 8.8 | 8.9 |
| Approach LOS | | | | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.7 | | |
| Intersection Capacity Utilization | 20.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 14 | 17 | 1 | 311 | 52 | 262 | 66 | 645 | 128 | 46 | 503 | 15 |
| Future Volume (vph) | 14 | 17 | 1 | 311 | 52 | 262 | 66 | 645 | 128 | 46 | 503 | 15 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1681 | 1709 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 0.55 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 1681 | 978 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 15 | 18 | 1 | 338 | 57 | 285 | 72 | 701 | 139 | 50 | 547 | 16 |
| RTOR Reduction (vph) | 0 | 0 | 1 | 0 | 0 | 188 | 0 | 0 | 95 | 0 | 0 | 11 |
| Lane Group Flow (vph) | 15 | 18 | 0 | 196 | 199 | 97 | 72 | 701 | 44 | 50 | 547 | 5 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 1.0 | 1.7 | 1.7 | 21.1 | 27.3 | 21.8 | 3.9 | 20.4 | 20.4 | 2.9 | 19.4 | 19.4 |
| Effective Green, g (s) | 1.0 | 1.7 | 1.7 | 21.1 | 27.3 | 21.8 | 3.9 | 20.4 | 20.4 | 2.9 | 19.4 | 19.4 |
| Actuated g/C Ratio | 0.02 | 0.03 | 0.03 | 0.33 | 0.43 | 0.34 | 0.06 | 0.32 | 0.32 | 0.05 | 0.30 | 0.30 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 27 | 49 | 41 | 553 | 657 | 538 | 107 | 1126 | 503 | 80 | 1071 | 479 |
| v/s Ratio Prot | 0.01 | 0.01 | | c0.12 | 0.10 | | c0.04 | c0.20 | | 0.03 | 0.15 | |
| v/s Ratio Perm | | | 0.00 | | c0.03 | 0.06 | | | 0.03 | | | 0.00 |
| v/c Ratio | 0.56 | 0.37 | 0.00 | 0.35 | 0.30 | 0.18 | 0.67 | 0.62 | 0.09 | 0.62 | 0.51 | 0.01 |
| Uniform Delay, d1 | 31.3 | 30.7 | 30.4 | 16.3 | 12.1 | 14.9 | 29.5 | 18.6 | 15.3 | 30.1 | 18.4 | 15.6 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 22.5 | 4.6 | 0.0 | 0.4 | 0.3 | 0.2 | 15.4 | 2.6 | 0.3 | 14.2 | 1.7 | 0.0 |
| Delay (s) | 53.8 | 35.3 | 30.4 | 16.7 | 12.4 | 15.0 | 44.9 | 21.2 | 15.7 | 44.3 | 20.2 | 15.7 |
| Level of Service | D | D | C | B | B | B | D | C | B | D | C | B |
| Approach Delay (s) | | 43.3 | | | 14.7 | | | 22.2 | | | 22.0 | |
| Approach LOS | | D | | | B | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 20.2 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 64.1 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 49.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 45 | 163 | 357 | 553 | 412 | 92 |
| Future Volume (vph) | 45 | 163 | 357 | 553 | 412 | 92 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 49 | 177 | 388 | 601 | 448 | 100 |
| RTOR Reduction (vph) | 0 | 157 | 0 | 0 | 0 | 65 |
| Lane Group Flow (vph) | 49 | 20 | 388 | 601 | 448 | 35 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 5.9 | 5.9 | 15.0 | 38.4 | 18.9 | 18.9 |
| Effective Green, g (s) | 5.9 | 5.9 | 15.0 | 38.4 | 18.9 | 18.9 |
| Actuated g/C Ratio | 0.11 | 0.11 | 0.28 | 0.72 | 0.35 | 0.35 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 195 | 175 | 498 | 2549 | 1254 | 561 |
| v/s Ratio Prot | c0.03 | | c0.22 | 0.17 | c0.13 | |
| v/s Ratio Perm | | 0.01 | | | | 0.02 |
| v/c Ratio | 0.25 | 0.11 | 0.78 | 0.24 | 0.36 | 0.06 |
| Uniform Delay, d1 | 21.7 | 21.3 | 17.6 | 2.5 | 12.7 | 11.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.7 | 0.3 | 7.6 | 0.2 | 0.8 | 0.2 |
| Delay (s) | 22.4 | 21.6 | 25.2 | 2.7 | 13.5 | 11.6 |
| Level of Service | C | C | C | A | B | B |
| Approach Delay (s) | 21.8 | | | 11.5 | 13.2 | |
| Approach LOS | C | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 13.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 53.3 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 46.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 17 | 47 | 2 | 1 | 10 | 2 | 9 | 2 | 5 | 4 | 5 | 50 |
| Future Volume (Veh/h) | 17 | 47 | 2 | 1 | 10 | 2 | 9 | 2 | 5 | 4 | 5 | 50 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 18 | 51 | 2 | 1 | 11 | 2 | 10 | 2 | 5 | 4 | 5 | 54 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 13 | | | 53 | | | 130 | 103 | 52 | 107 | 103 | 12 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 13 | | | 53 | | | 130 | 103 | 52 | 107 | 103 | 12 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 99 | 100 | 100 | 100 | 99 | 95 |
| cM capacity (veh/h) | 1606 | | | 1553 | | | 788 | 778 | 1016 | 858 | 778 | 1069 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 18 | 53 | 1 | 13 | 17 | 63 |
| Volume Left | 18 | 0 | 1 | 0 | 10 | 4 |
| Volume Right | 0 | 2 | 0 | 2 | 5 | 54 |
| cSH | 1606 | 1700 | 1553 | 1700 | 842 | 1247 |
| Volume to Capacity | 0.01 | 0.03 | 0.00 | 0.01 | 0.02 | 0.05 |
| Queue Length 95th (ft) | 1 | 0 | 0 | 0 | 2 | 4 |
| Control Delay (s) | 7.3 | 0.0 | 7.3 | 0.0 | 9.4 | 8.7 |
| Lane LOS | A | | A | | A | A |
| Approach Delay (s) | 1.8 | | 0.5 | | 9.4 | 8.7 |
| Approach LOS | | | | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 5.1 | | |
| Intersection Capacity Utilization | 21.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 12 | 6 | 0 | 124 | 12 | 100 | 34 | 582 | 129 | 60 | 578 | 6 |
| Future Volume (vph) | 12 | 6 | 0 | 124 | 12 | 100 | 34 | 582 | 129 | 60 | 578 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | | 1681 | 1700 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 0.78 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | | 1681 | 1381 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 13 | 7 | 0 | 135 | 13 | 109 | 37 | 633 | 140 | 65 | 628 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 84 | 0 | 0 | 4 |
| Lane Group Flow (vph) | 13 | 7 | 0 | 74 | 74 | 26 | 37 | 633 | 56 | 65 | 628 | 3 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 0.8 | 7.1 | | 7.8 | 19.4 | 14.1 | 1.7 | 24.0 | 24.0 | 2.7 | 25.0 | 25.0 |
| Effective Green, g (s) | 0.8 | 7.1 | | 7.8 | 19.4 | 14.1 | 1.7 | 24.0 | 24.0 | 2.7 | 25.0 | 25.0 |
| Actuated g/C Ratio | 0.01 | 0.12 | | 0.13 | 0.33 | 0.24 | 0.03 | 0.40 | 0.40 | 0.05 | 0.42 | 0.42 |
| Clearance Time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 23 | 221 | | 219 | 491 | 374 | 50 | 1425 | 637 | 80 | 1484 | 664 |
| v/s Ratio Prot | 0.01 | 0.00 | | c0.04 | 0.02 | | 0.02 | c0.18 | | c0.04 | 0.18 | |
| v/s Ratio Perm | | | | | c0.03 | 0.02 | | | 0.04 | | | 0.00 |
| v/c Ratio | 0.57 | 0.03 | | 0.34 | 0.15 | 0.07 | 0.74 | 0.44 | 0.09 | 0.81 | 0.42 | 0.00 |
| Uniform Delay, d1 | 29.2 | 23.2 | | 23.6 | 14.3 | 17.7 | 28.7 | 12.9 | 11.0 | 28.2 | 12.2 | 10.1 |
| Progression Factor | 1.02 | 1.03 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 28.1 | 0.1 | | 0.9 | 0.1 | 0.1 | 43.5 | 1.0 | 0.3 | 44.4 | 0.9 | 0.0 |
| Delay (s) | 57.9 | 24.0 | | 24.5 | 14.4 | 17.7 | 72.2 | 14.0 | 11.3 | 72.6 | 13.1 | 10.1 |
| Level of Service | E | C | | C | B | B | E | B | B | E | B | B |
| Approach Delay (s) | | 46.0 | | | 18.7 | | | 16.2 | | | 18.6 | |
| Approach LOS | | D | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 17.8 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.41 | | |
| Actuated Cycle Length (s) | 59.6 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 41.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 64 | 168 | 275 | 380 | 426 | 100 |
| Future Volume (vph) | 64 | 168 | 275 | 380 | 426 | 100 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 70 | 183 | 299 | 413 | 463 | 109 |
| RTOR Reduction (vph) | 0 | 160 | 0 | 0 | 0 | 68 |
| Lane Group Flow (vph) | 70 | 23 | 299 | 413 | 463 | 41 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 6.1 | 6.1 | 10.6 | 33.5 | 18.4 | 18.4 |
| Effective Green, g (s) | 6.1 | 6.1 | 10.6 | 33.5 | 18.4 | 18.4 |
| Actuated g/C Ratio | 0.13 | 0.13 | 0.22 | 0.69 | 0.38 | 0.38 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 222 | 198 | 386 | 2439 | 1339 | 599 |
| v/s Ratio Prot | c0.04 | | c0.17 | 0.12 | c0.13 | |
| v/s Ratio Perm | | 0.01 | | | | 0.03 |
| v/c Ratio | 0.32 | 0.12 | 0.77 | 0.17 | 0.35 | 0.07 |
| Uniform Delay, d1 | 19.3 | 18.9 | 17.9 | 2.7 | 10.8 | 9.6 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 0.3 | 9.4 | 0.2 | 0.7 | 0.2 |
| Delay (s) | 20.2 | 19.1 | 27.2 | 2.8 | 11.5 | 9.9 |
| Level of Service | C | B | C | A | B | A |
| Approach Delay (s) | 19.4 | | | 13.1 | 11.2 | |
| Approach LOS | B | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 13.4 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.47 | | |
| Actuated Cycle Length (s) | 48.6 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 42.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 23 | 29 | 2 | 17 | 38 | 3 | 47 | 26 | 30 | 44 | 21 | 28 |
| Future Volume (Veh/h) | 23 | 29 | 2 | 17 | 38 | 3 | 47 | 26 | 30 | 44 | 21 | 28 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 25 | 32 | 2 | 18 | 41 | 3 | 51 | 28 | 33 | 48 | 23 | 30 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 44 | | | 34 | | | 186 | 163 | 33 | 208 | 162 | 42 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 44 | | | 34 | | | 186 | 163 | 33 | 208 | 162 | 42 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 98 | | | 99 | | | 93 | 96 | 97 | 93 | 97 | 97 |
| cM capacity (veh/h) | 1564 | | | 1578 | | | 718 | 710 | 1041 | 690 | 710 | 1028 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 25 | 34 | 18 | 44 | 112 | 101 |
| Volume Left | 25 | 0 | 18 | 0 | 51 | 48 |
| Volume Right | 0 | 2 | 0 | 3 | 33 | 30 |
| cSH | 1564 | 1700 | 1578 | 1700 | 787 | 991 |
| Volume to Capacity | 0.02 | 0.02 | 0.01 | 0.03 | 0.14 | 0.10 |
| Queue Length 95th (ft) | 1 | 0 | 1 | 0 | 12 | 8 |
| Control Delay (s) | 7.3 | 0.0 | 7.3 | 0.0 | 10.3 | 10.1 |
| Lane LOS | A | | A | | B | B |
| Approach Delay (s) | 3.1 | | 2.1 | | 10.3 | 10.1 |
| Approach LOS | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.5 | | |
| Intersection Capacity Utilization | 27.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 22 | 34 | 0 | 96 | 96 | 144 | 37 | 734 | 245 | 282 | 627 | 91 |
| Future Volume (vph) | 22 | 34 | 0 | 96 | 96 | 144 | 37 | 734 | 245 | 282 | 627 | 91 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | | 1681 | 1762 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | | 1681 | 1764 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 24 | 37 | 0 | 104 | 104 | 157 | 40 | 798 | 266 | 307 | 682 | 99 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 118 | 0 | 0 | 187 | 0 | 0 | 54 |
| Lane Group Flow (vph) | 24 | 37 | 0 | 94 | 114 | 39 | 40 | 798 | 79 | 307 | 682 | 45 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 1.9 | 10.8 | | 10.4 | 25.7 | 19.3 | 3.5 | 23.0 | 23.0 | 15.7 | 35.2 | 35.2 |
| Effective Green, g (s) | 1.9 | 10.8 | | 10.4 | 25.7 | 19.3 | 3.5 | 23.0 | 23.0 | 15.7 | 35.2 | 35.2 |
| Actuated g/C Ratio | 0.02 | 0.14 | | 0.13 | 0.33 | 0.25 | 0.04 | 0.30 | 0.30 | 0.20 | 0.45 | 0.45 |
| Clearance Time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 43 | 258 | | 224 | 581 | 392 | 79 | 1044 | 467 | 356 | 1599 | 715 |
| v/s Ratio Prot | 0.01 | 0.02 | | c0.06 | 0.03 | | 0.02 | c0.23 | | c0.17 | 0.19 | |
| v/s Ratio Perm | | | | | c0.04 | 0.02 | | | 0.05 | | | 0.03 |
| v/c Ratio | 0.56 | 0.14 | | 0.42 | 0.20 | 0.10 | 0.51 | 0.76 | 0.17 | 0.86 | 0.43 | 0.06 |
| Uniform Delay, d1 | 37.6 | 29.5 | | 31.0 | 18.7 | 22.6 | 36.4 | 25.0 | 20.4 | 30.1 | 14.5 | 12.0 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 14.8 | 0.3 | | 1.3 | 0.2 | 0.1 | 5.0 | 5.3 | 0.8 | 18.8 | 0.8 | 0.2 |
| Delay (s) | 52.4 | 29.7 | | 32.3 | 18.9 | 22.7 | 41.4 | 30.3 | 21.1 | 48.9 | 15.3 | 12.2 |
| Level of Service | D | C | | C | B | C | D | C | C | D | B | B |
| Approach Delay (s) | | 38.6 | | | 24.0 | | | 28.5 | | | 24.5 | |
| Approach LOS | | D | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 26.4 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.64 | | |
| Actuated Cycle Length (s) | 77.9 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 59.0% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 105 | 381 | 299 | 526 | 480 | 99 |
| Future Volume (vph) | 105 | 381 | 299 | 526 | 480 | 99 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 114 | 414 | 325 | 572 | 522 | 108 |
| RTOR Reduction (vph) | 0 | 344 | 0 | 0 | 0 | 71 |
| Lane Group Flow (vph) | 114 | 70 | 325 | 572 | 522 | 37 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 9.6 | 9.6 | 14.0 | 38.1 | 19.6 | 19.6 |
| Effective Green, g (s) | 9.6 | 9.6 | 14.0 | 38.1 | 19.6 | 19.6 |
| Actuated g/C Ratio | 0.17 | 0.17 | 0.25 | 0.67 | 0.35 | 0.35 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 299 | 268 | 437 | 2378 | 1223 | 547 |
| v/s Ratio Prot | c0.06 | | c0.18 | 0.16 | c0.15 | |
| v/s Ratio Perm | | 0.04 | | | | 0.02 |
| v/c Ratio | 0.38 | 0.26 | 0.74 | 0.24 | 0.43 | 0.07 |
| Uniform Delay, d1 | 20.9 | 20.5 | 19.7 | 3.6 | 14.2 | 12.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 0.5 | 6.7 | 0.2 | 1.1 | 0.2 |
| Delay (s) | 21.7 | 21.0 | 26.4 | 3.9 | 15.3 | 12.7 |
| Level of Service | C | C | C | A | B | B |
| Approach Delay (s) | 21.2 | | | 12.0 | 14.9 | |
| Approach LOS | C | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 15.3 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 56.7 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 46.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 7 | 14 | 1 | 2 | 5 | 0 | 3 | 5 | 17 | 2 | 41 | 64 |
| Future Volume (Veh/h) | 7 | 14 | 1 | 2 | 5 | 0 | 3 | 5 | 17 | 2 | 41 | 64 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 8 | 15 | 1 | 2 | 5 | 0 | 3 | 5 | 18 | 2 | 45 | 70 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 5 | | | 16 | | | 98 | 40 | 16 | 60 | 41 | 5 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 5 | | | 16 | | | 98 | 40 | 16 | 60 | 41 | 5 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 100 | 99 | 98 | 100 | 95 | 94 |
| cM capacity (veh/h) | 1616 | | | 1602 | | | 789 | 846 | 1064 | 911 | 846 | 1078 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 8 | 16 | 2 | 5 | 26 | 117 |
| Volume Left | 8 | 0 | 2 | 0 | 3 | 2 |
| Volume Right | 0 | 1 | 0 | 0 | 18 | 70 |
| cSH | 1616 | 1700 | 1602 | 1700 | 976 | 1802 |
| Volume to Capacity | 0.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.06 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 | 2 | 5 |
| Control Delay (s) | 7.2 | 0.0 | 7.3 | 0.0 | 8.8 | 8.9 |
| Lane LOS | A | | A | | A | A |
| Approach Delay (s) | 2.4 | | 2.1 | | 8.8 | 8.9 |
| Approach LOS | | | | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.7 | | |
| Intersection Capacity Utilization | 20.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 15 | 18 | 1 | 326 | 55 | 275 | 69 | 676 | 134 | 48 | 528 | 16 |
| Future Volume (vph) | 15 | 18 | 1 | 326 | 55 | 275 | 69 | 676 | 134 | 48 | 528 | 16 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1681 | 1709 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 0.48 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 1681 | 854 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 16 | 20 | 1 | 354 | 60 | 299 | 75 | 735 | 146 | 52 | 574 | 17 |
| RTOR Reduction (vph) | 0 | 0 | 1 | 0 | 0 | 192 | 0 | 0 | 100 | 0 | 0 | 12 |
| Lane Group Flow (vph) | 16 | 20 | 0 | 205 | 209 | 107 | 75 | 735 | 46 | 52 | 574 | 5 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 0.9 | 3.1 | 3.1 | 21.5 | 29.1 | 23.7 | 3.9 | 20.6 | 20.6 | 2.9 | 19.6 | 19.6 |
| Effective Green, g (s) | 0.9 | 3.1 | 3.1 | 21.5 | 29.1 | 23.7 | 3.9 | 20.6 | 20.6 | 2.9 | 19.6 | 19.6 |
| Actuated g/C Ratio | 0.01 | 0.05 | 0.05 | 0.33 | 0.44 | 0.36 | 0.06 | 0.31 | 0.31 | 0.04 | 0.30 | 0.30 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 24 | 87 | 74 | 546 | 654 | 567 | 104 | 1102 | 493 | 77 | 1049 | 469 |
| v/s Ratio Prot | 0.01 | 0.01 | | c0.12 | 0.10 | | c0.04 | c0.21 | | 0.03 | 0.16 | |
| v/s Ratio Perm | | | 0.00 | | c0.04 | 0.07 | | | 0.03 | | | 0.00 |
| v/c Ratio | 0.67 | 0.23 | 0.00 | 0.38 | 0.32 | 0.19 | 0.72 | 0.67 | 0.09 | 0.68 | 0.55 | 0.01 |
| Uniform Delay, d1 | 32.5 | 30.3 | 30.0 | 17.1 | 12.1 | 14.6 | 30.6 | 19.8 | 16.1 | 31.1 | 19.5 | 16.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 52.8 | 1.4 | 0.0 | 0.4 | 0.3 | 0.2 | 21.7 | 3.2 | 0.4 | 20.9 | 2.1 | 0.0 |
| Delay (s) | 85.3 | 31.7 | 30.0 | 17.6 | 12.3 | 14.8 | 52.2 | 23.0 | 16.5 | 52.1 | 21.6 | 16.4 |
| Level of Service | F | C | C | B | B | B | D | C | B | D | C | B |
| Approach Delay (s) | | 54.8 | | | 14.9 | | | 24.3 | | | 23.9 | |
| Approach LOS | | D | | | B | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 21.8 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.55 | | |
| Actuated Cycle Length (s) | 66.1 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 51.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 47 | 171 | 374 | 580 | 432 | 96 |
| Future Volume (vph) | 47 | 171 | 374 | 580 | 432 | 96 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 186 | 407 | 630 | 470 | 104 |
| RTOR Reduction (vph) | 0 | 161 | 0 | 0 | 0 | 70 |
| Lane Group Flow (vph) | 51 | 25 | 407 | 630 | 470 | 34 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 7.3 | 7.3 | 15.5 | 38.0 | 18.0 | 18.0 |
| Effective Green, g (s) | 7.3 | 7.3 | 15.5 | 38.0 | 18.0 | 18.0 |
| Actuated g/C Ratio | 0.13 | 0.13 | 0.29 | 0.70 | 0.33 | 0.33 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 237 | 212 | 505 | 2476 | 1173 | 524 |
| v/s Ratio Prot | c0.03 | | c0.23 | 0.18 | c0.13 | |
| v/s Ratio Perm | | 0.02 | | | | 0.02 |
| v/c Ratio | 0.22 | 0.12 | 0.81 | 0.25 | 0.40 | 0.07 |
| Uniform Delay, d1 | 20.9 | 20.7 | 18.0 | 3.0 | 14.0 | 12.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.5 | 0.2 | 9.1 | 0.2 | 1.0 | 0.2 |
| Delay (s) | 21.4 | 20.9 | 27.1 | 3.2 | 15.0 | 12.6 |
| Level of Service | C | C | C | A | B | B |
| Approach Delay (s) | 21.0 | | | 12.6 | 14.6 | |
| Approach LOS | C | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 14.3 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 54.3 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 48.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 18 | 49 | 2 | 1 | 10 | 2 | 9 | 2 | 5 | 4 | 5 | 52 |
| Future Volume (Veh/h) | 18 | 49 | 2 | 1 | 10 | 2 | 9 | 2 | 5 | 4 | 5 | 52 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 20 | 53 | 2 | 1 | 11 | 2 | 10 | 2 | 5 | 4 | 5 | 57 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 13 | | | 55 | | | 138 | 109 | 54 | 113 | 109 | 12 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 13 | | | 55 | | | 138 | 109 | 54 | 113 | 109 | 12 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 99 | 100 | 100 | 100 | 99 | 95 |
| cM capacity (veh/h) | 1606 | | | 1550 | | | 776 | 771 | 1013 | 850 | 771 | 1069 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 20 | 55 | 1 | 13 | 17 | 66 |
| Volume Left | 20 | 0 | 1 | 0 | 10 | 4 |
| Volume Right | 0 | 2 | 0 | 2 | 5 | 57 |
| cSH | 1606 | 1700 | 1550 | 1700 | 833 | 1237 |
| Volume to Capacity | 0.01 | 0.03 | 0.00 | 0.01 | 0.02 | 0.05 |
| Queue Length 95th (ft) | 1 | 0 | 0 | 0 | 2 | 4 |
| Control Delay (s) | 7.3 | 0.0 | 7.3 | 0.0 | 9.4 | 8.7 |
| Lane LOS | A | | A | | A | A |
| Approach Delay (s) | 1.9 | | 0.5 | | 9.4 | 8.7 |
| Approach LOS | | | | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 5.2 | | |
| Intersection Capacity Utilization | 21.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 13 | 6 | 0 | 130 | 13 | 105 | 36 | 610 | 135 | 63 | 606 | 6 |
| Future Volume (vph) | 13 | 6 | 0 | 130 | 13 | 105 | 36 | 610 | 135 | 63 | 606 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | | 1681 | 1700 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 0.77 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | | 1681 | 1361 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 14 | 7 | 0 | 141 | 14 | 114 | 39 | 663 | 147 | 68 | 659 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 87 | 0 | 0 | 88 | 0 | 0 | 4 |
| Lane Group Flow (vph) | 14 | 7 | 0 | 78 | 77 | 27 | 39 | 663 | 59 | 68 | 659 | 3 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 0.8 | 7.1 | | 7.8 | 19.4 | 14.1 | 1.7 | 24.0 | 24.0 | 2.7 | 25.0 | 25.0 |
| Effective Green, g (s) | 0.8 | 7.1 | | 7.8 | 19.4 | 14.1 | 1.7 | 24.0 | 24.0 | 2.7 | 25.0 | 25.0 |
| Actuated g/C Ratio | 0.01 | 0.12 | | 0.13 | 0.33 | 0.24 | 0.03 | 0.40 | 0.40 | 0.05 | 0.42 | 0.42 |
| Clearance Time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 23 | 221 | | 219 | 487 | 374 | 50 | 1425 | 637 | 80 | 1484 | 664 |
| v/s Ratio Prot | 0.01 | 0.00 | | c0.05 | 0.02 | | 0.02 | c0.19 | | c0.04 | 0.19 | |
| v/s Ratio Perm | | | | | c0.03 | 0.02 | | | 0.04 | | | 0.00 |
| v/c Ratio | 0.61 | 0.03 | | 0.36 | 0.16 | 0.07 | 0.78 | 0.47 | 0.09 | 0.85 | 0.44 | 0.00 |
| Uniform Delay, d1 | 29.2 | 23.2 | | 23.6 | 14.3 | 17.7 | 28.8 | 13.1 | 11.0 | 28.2 | 12.3 | 10.1 |
| Progression Factor | 1.01 | 1.01 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 38.0 | 0.1 | | 1.0 | 0.2 | 0.1 | 53.9 | 1.1 | 0.3 | 53.1 | 1.0 | 0.0 |
| Delay (s) | 67.6 | 23.6 | | 24.6 | 14.4 | 17.8 | 82.7 | 14.2 | 11.3 | 81.3 | 13.3 | 10.1 |
| Level of Service | E | C | | C | B | B | F | B | B | F | B | B |
| Approach Delay (s) | | 52.9 | | | 18.8 | | | 16.8 | | | 19.6 | |
| Approach LOS | | D | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 18.6 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 59.6 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 42.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 67 | 176 | 288 | 399 | 447 | 105 |
| Future Volume (vph) | 67 | 176 | 288 | 399 | 447 | 105 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 73 | 191 | 313 | 434 | 486 | 114 |
| RTOR Reduction (vph) | 0 | 167 | 0 | 0 | 0 | 71 |
| Lane Group Flow (vph) | 73 | 24 | 313 | 434 | 486 | 43 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 6.1 | 6.1 | 10.6 | 33.5 | 18.4 | 18.4 |
| Effective Green, g (s) | 6.1 | 6.1 | 10.6 | 33.5 | 18.4 | 18.4 |
| Actuated g/C Ratio | 0.13 | 0.13 | 0.22 | 0.69 | 0.38 | 0.38 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 222 | 198 | 386 | 2439 | 1339 | 599 |
| v/s Ratio Prot | c0.04 | | c0.18 | 0.12 | c0.14 | |
| v/s Ratio Perm | | 0.02 | | | | 0.03 |
| v/c Ratio | 0.33 | 0.12 | 0.81 | 0.18 | 0.36 | 0.07 |
| Uniform Delay, d1 | 19.4 | 18.9 | 18.0 | 2.7 | 10.9 | 9.6 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.9 | 0.3 | 12.2 | 0.2 | 0.8 | 0.2 |
| Delay (s) | 20.3 | 19.1 | 30.2 | 2.8 | 11.6 | 9.9 |
| Level of Service | C | B | C | A | B | A |
| Approach Delay (s) | 19.5 | | | 14.3 | 11.3 | |
| Approach LOS | B | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 14.0 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 48.6 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 43.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 24 | 30 | 2 | 18 | 40 | 3 | 49 | 27 | 31 | 46 | 22 | 29 |
| Future Volume (Veh/h) | 24 | 30 | 2 | 18 | 40 | 3 | 49 | 27 | 31 | 46 | 22 | 29 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 26 | 33 | 2 | 20 | 43 | 3 | 53 | 29 | 34 | 50 | 24 | 32 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 46 | | | 35 | | | 197 | 172 | 34 | 218 | 172 | 44 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 46 | | | 35 | | | 197 | 172 | 34 | 218 | 172 | 44 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 98 | | | 99 | | | 92 | 96 | 97 | 93 | 97 | 97 |
| cM capacity (veh/h) | 1562 | | | 1576 | | | 703 | 700 | 1039 | 676 | 701 | 1025 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 26 | 35 | 20 | 46 | 116 | 106 |
| Volume Left | 26 | 0 | 20 | 0 | 53 | 50 |
| Volume Right | 0 | 2 | 0 | 3 | 34 | 32 |
| cSH | 1562 | 1700 | 1576 | 1700 | 776 | 980 |
| Volume to Capacity | 0.02 | 0.02 | 0.01 | 0.03 | 0.15 | 0.11 |
| Queue Length 95th (ft) | 1 | 0 | 1 | 0 | 13 | 9 |
| Control Delay (s) | 7.3 | 0.0 | 7.3 | 0.0 | 10.5 | 10.2 |
| Lane LOS | A | | A | | B | B |
| Approach Delay (s) | 3.1 | | 2.2 | | 10.5 | 10.2 |
| Approach LOS | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.5 | | |
| Intersection Capacity Utilization | 27.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 23 | 36 | 0 | 101 | 101 | 151 | 39 | 770 | 257 | 296 | 658 | 95 |
| Future Volume (vph) | 23 | 36 | 0 | 101 | 101 | 151 | 39 | 770 | 257 | 296 | 658 | 95 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | | 1681 | 1762 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | | 1681 | 1766 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 25 | 39 | 0 | 110 | 110 | 164 | 42 | 837 | 279 | 322 | 715 | 103 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 125 | 0 | 0 | 194 | 0 | 0 | 55 |
| Lane Group Flow (vph) | 25 | 39 | 0 | 99 | 121 | 39 | 42 | 837 | 85 | 322 | 715 | 48 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 2.0 | 9.3 | | 11.1 | 24.9 | 18.4 | 3.6 | 23.9 | 23.9 | 15.9 | 36.2 | 36.2 |
| Effective Green, g (s) | 2.0 | 9.3 | | 11.1 | 24.9 | 18.4 | 3.6 | 23.9 | 23.9 | 15.9 | 36.2 | 36.2 |
| Actuated g/C Ratio | 0.03 | 0.12 | | 0.14 | 0.32 | 0.24 | 0.05 | 0.31 | 0.31 | 0.20 | 0.46 | 0.46 |
| Clearance Time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 45 | 221 | | 238 | 561 | 372 | 81 | 1081 | 483 | 359 | 1638 | 732 |
| v/s Ratio Prot | 0.01 | 0.02 | | c0.06 | 0.03 | | 0.02 | c0.24 | | c0.18 | 0.20 | |
| v/s Ratio Perm | | | | | c0.04 | 0.02 | | | 0.05 | | | 0.03 |
| v/c Ratio | 0.56 | 0.18 | | 0.42 | 0.22 | 0.10 | 0.52 | 0.77 | 0.18 | 0.90 | 0.44 | 0.07 |
| Uniform Delay, d1 | 37.7 | 31.0 | | 30.6 | 19.5 | 23.4 | 36.5 | 24.7 | 19.9 | 30.4 | 14.1 | 11.6 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 14.0 | 0.4 | | 1.2 | 0.2 | 0.1 | 5.5 | 5.4 | 0.8 | 23.8 | 0.8 | 0.2 |
| Delay (s) | 51.7 | 31.4 | | 31.8 | 19.7 | 23.6 | 42.0 | 30.1 | 20.7 | 54.1 | 15.0 | 11.8 |
| Level of Service | D | C | | C | B | C | D | C | C | D | B | B |
| Approach Delay (s) | | 39.3 | | | 24.5 | | | 28.3 | | | 25.8 | |
| Approach LOS | | D | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 27.0 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.66 | | |
| Actuated Cycle Length (s) | 78.2 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 61.1% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 110 | 400 | 314 | 552 | 503 | 104 |
| Future Volume (vph) | 110 | 400 | 314 | 552 | 503 | 104 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 120 | 435 | 341 | 600 | 547 | 113 |
| RTOR Reduction (vph) | 0 | 360 | 0 | 0 | 0 | 75 |
| Lane Group Flow (vph) | 120 | 75 | 341 | 600 | 547 | 38 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 9.8 | 9.8 | 14.3 | 38.2 | 19.4 | 19.4 |
| Effective Green, g (s) | 9.8 | 9.8 | 14.3 | 38.2 | 19.4 | 19.4 |
| Actuated g/C Ratio | 0.17 | 0.17 | 0.25 | 0.67 | 0.34 | 0.34 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 304 | 272 | 444 | 2371 | 1204 | 538 |
| v/s Ratio Prot | c0.07 | | c0.19 | 0.17 | c0.15 | |
| v/s Ratio Perm | | 0.05 | | | | 0.02 |
| v/c Ratio | 0.39 | 0.27 | 0.77 | 0.25 | 0.45 | 0.07 |
| Uniform Delay, d1 | 21.0 | 20.5 | 19.8 | 3.7 | 14.7 | 12.7 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 0.6 | 7.8 | 0.3 | 1.2 | 0.3 |
| Delay (s) | 21.8 | 21.1 | 27.6 | 4.0 | 15.9 | 13.0 |
| Level of Service | C | C | C | A | B | B |
| Approach Delay (s) | 21.2 | | | 12.5 | 15.4 | |
| Approach LOS | C | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 15.7 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.54 | | |
| Actuated Cycle Length (s) | 57.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 48.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 11 | 22 | 2 | 2 | 8 | 0 | 4 | 5 | 17 | 2 | 41 | 98 |
| Future Volume (Veh/h) | 11 | 22 | 2 | 2 | 8 | 0 | 4 | 5 | 17 | 2 | 41 | 98 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 12 | 24 | 2 | 2 | 9 | 0 | 4 | 5 | 18 | 2 | 45 | 107 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 9 | | | 26 | | | 138 | 62 | 25 | 82 | 63 | 9 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 9 | | | 26 | | | 138 | 62 | 25 | 82 | 63 | 9 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 99 | | | 100 | | | 99 | 99 | 98 | 100 | 95 | 90 |
| cM capacity (veh/h) | 1611 | | | 1588 | | | 713 | 822 | 1051 | 881 | 821 | 1073 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 12 | 26 | 2 | 9 | 27 | 154 |
| Volume Left | 12 | 0 | 2 | 0 | 4 | 2 |
| Volume Right | 0 | 2 | 0 | 0 | 18 | 107 |
| cSH | 1611 | 1700 | 1588 | 1700 | 937 | 1544 |
| Volume to Capacity | 0.01 | 0.02 | 0.00 | 0.01 | 0.03 | 0.10 |
| Queue Length 95th (ft) | 1 | 0 | 0 | 0 | 2 | 8 |
| Control Delay (s) | 7.3 | 0.0 | 7.3 | 0.0 | 9.0 | 9.0 |
| Lane LOS | A | | A | | A | A |
| Approach Delay (s) | 2.3 | | 1.3 | | 9.0 | 9.0 |
| Approach LOS | | | | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.5 | | |
| Intersection Capacity Utilization | 22.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 17 | 20 | 1 | 327 | 68 | 275 | 86 | 676 | 134 | 48 | 530 | 20 |
| Future Volume (vph) | 17 | 20 | 1 | 327 | 68 | 275 | 86 | 676 | 134 | 48 | 530 | 20 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 1681 | 1713 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 0.59 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 1681 | 1048 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 18 | 22 | 1 | 355 | 74 | 299 | 93 | 735 | 146 | 52 | 576 | 22 |
| RTOR Reduction (vph) | 0 | 0 | 1 | 0 | 0 | 192 | 0 | 0 | 100 | 0 | 0 | 15 |
| Lane Group Flow (vph) | 18 | 22 | 0 | 213 | 216 | 107 | 93 | 735 | 46 | 52 | 576 | 7 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 0.9 | 5.7 | 5.7 | 18.9 | 29.1 | 23.7 | 3.9 | 20.6 | 20.6 | 2.9 | 19.6 | 19.6 |
| Effective Green, g (s) | 0.9 | 5.7 | 5.7 | 18.9 | 29.1 | 23.7 | 3.9 | 20.6 | 20.6 | 2.9 | 19.6 | 19.6 |
| Actuated g/C Ratio | 0.01 | 0.09 | 0.09 | 0.29 | 0.44 | 0.36 | 0.06 | 0.31 | 0.31 | 0.04 | 0.30 | 0.30 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 24 | 160 | 136 | 480 | 651 | 567 | 104 | 1102 | 493 | 77 | 1049 | 469 |
| v/s Ratio Prot | 0.01 | 0.01 | | c0.13 | 0.09 | | c0.05 | c0.21 | | 0.03 | 0.16 | |
| v/s Ratio Perm | | | 0.00 | | c0.05 | 0.07 | | | 0.03 | | | 0.00 |
| v/c Ratio | 0.75 | 0.14 | 0.00 | 0.44 | 0.33 | 0.19 | 0.89 | 0.67 | 0.09 | 0.68 | 0.55 | 0.01 |
| Uniform Delay, d1 | 32.5 | 27.9 | 27.6 | 19.3 | 12.1 | 14.6 | 30.9 | 19.8 | 16.1 | 31.1 | 19.5 | 16.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 80.1 | 0.4 | 0.0 | 0.7 | 0.3 | 0.2 | 55.6 | 3.2 | 0.4 | 20.9 | 2.1 | 0.1 |
| Delay (s) | 112.6 | 28.3 | 27.6 | 20.0 | 12.4 | 14.8 | 86.5 | 23.0 | 16.5 | 52.1 | 21.6 | 16.5 |
| Level of Service | F | C | C | B | B | B | F | C | B | D | C | B |
| Approach Delay (s) | | 65.3 | | | 15.6 | | | 28.1 | | | 23.9 | |
| Approach LOS | | E | | | B | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 23.8 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 66.1 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 51.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 47 | 173 | 375 | 581 | 436 | 96 |
| Future Volume (vph) | 47 | 173 | 375 | 581 | 436 | 96 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 188 | 408 | 632 | 474 | 104 |
| RTOR Reduction (vph) | 0 | 163 | 0 | 0 | 0 | 70 |
| Lane Group Flow (vph) | 51 | 25 | 408 | 632 | 474 | 34 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 7.3 | 7.3 | 15.5 | 38.0 | 18.0 | 18.0 |
| Effective Green, g (s) | 7.3 | 7.3 | 15.5 | 38.0 | 18.0 | 18.0 |
| Actuated g/C Ratio | 0.13 | 0.13 | 0.29 | 0.70 | 0.33 | 0.33 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 237 | 212 | 505 | 2476 | 1173 | 524 |
| v/s Ratio Prot | c0.03 | | c0.23 | 0.18 | c0.13 | |
| v/s Ratio Perm | | 0.02 | | | | 0.02 |
| v/c Ratio | 0.22 | 0.12 | 0.81 | 0.26 | 0.40 | 0.07 |
| Uniform Delay, d1 | 20.9 | 20.7 | 18.0 | 3.0 | 14.0 | 12.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.5 | 0.3 | 9.2 | 0.2 | 1.0 | 0.2 |
| Delay (s) | 21.4 | 20.9 | 27.2 | 3.2 | 15.0 | 12.6 |
| Level of Service | C | C | C | A | B | B |
| Approach Delay (s) | 21.0 | | | 12.6 | 14.6 | |
| Approach LOS | C | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 14.3 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 54.3 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 48.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 24 | 65 | 3 | 1 | 20 | 2 | 11 | 2 | 5 | 4 | 5 | 84 |
| Future Volume (Veh/h) | 24 | 65 | 3 | 1 | 20 | 2 | 11 | 2 | 5 | 4 | 5 | 84 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 26 | 71 | 3 | 1 | 22 | 2 | 12 | 2 | 5 | 4 | 5 | 91 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 24 | | | 74 | | | 196 | 150 | 72 | 154 | 151 | 23 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 24 | | | 74 | | | 196 | 150 | 72 | 154 | 151 | 23 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 98 | | | 100 | | | 98 | 100 | 99 | 99 | 99 | 91 |
| cM capacity (veh/h) | 1591 | | | 1526 | | | 684 | 729 | 990 | 797 | 728 | 1054 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 26 | 74 | 1 | 24 | 19 | 100 |
| Volume Left | 26 | 0 | 1 | 0 | 12 | 4 |
| Volume Right | 0 | 3 | 0 | 2 | 5 | 91 |
| cSH | 1591 | 1700 | 1526 | 1700 | 750 | 1158 |
| Volume to Capacity | 0.02 | 0.04 | 0.00 | 0.01 | 0.03 | 0.09 |
| Queue Length 95th (ft) | 1 | 0 | 0 | 0 | 2 | 7 |
| Control Delay (s) | 7.3 | 0.0 | 7.4 | 0.0 | 9.9 | 8.8 |
| Lane LOS | A | | A | | A | A |
| Approach Delay (s) | 1.9 | | 0.3 | | 9.9 | 8.8 |
| Approach LOS | | | | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 5.2 | | |
| Intersection Capacity Utilization | 22.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 17 | 8 | 0 | 132 | 20 | 105 | 57 | 610 | 135 | 63 | 614 | 10 |
| Future Volume (vph) | 17 | 8 | 0 | 132 | 20 | 105 | 57 | 610 | 135 | 63 | 614 | 10 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | | 1681 | 1707 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 0.80 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | | 1681 | 1411 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 18 | 9 | 0 | 143 | 22 | 114 | 62 | 663 | 147 | 68 | 667 | 11 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 87 | 0 | 0 | 89 | 0 | 0 | 7 |
| Lane Group Flow (vph) | 18 | 9 | 0 | 82 | 83 | 27 | 62 | 663 | 58 | 68 | 667 | 4 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 0.8 | 7.1 | | 7.8 | 19.4 | 14.1 | 2.7 | 23.2 | 23.2 | 2.7 | 23.2 | 23.2 |
| Effective Green, g (s) | 0.8 | 7.1 | | 7.8 | 19.4 | 14.1 | 2.7 | 23.2 | 23.2 | 2.7 | 23.2 | 23.2 |
| Actuated g/C Ratio | 0.01 | 0.12 | | 0.13 | 0.33 | 0.24 | 0.05 | 0.39 | 0.39 | 0.05 | 0.39 | 0.39 |
| Clearance Time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 24 | 224 | | 222 | 504 | 379 | 81 | 1396 | 624 | 81 | 1396 | 624 |
| v/s Ratio Prot | 0.01 | 0.00 | | c0.05 | 0.02 | | 0.04 | 0.19 | | c0.04 | c0.19 | |
| v/s Ratio Perm | | | | | c0.03 | 0.02 | | | 0.04 | | | 0.00 |
| v/c Ratio | 0.75 | 0.04 | | 0.37 | 0.16 | 0.07 | 0.77 | 0.47 | 0.09 | 0.84 | 0.48 | 0.01 |
| Uniform Delay, d1 | 28.9 | 22.8 | | 23.3 | 14.0 | 17.3 | 27.7 | 13.3 | 11.2 | 27.8 | 13.3 | 10.8 |
| Progression Factor | 1.02 | 1.01 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 80.1 | 0.1 | | 1.0 | 0.2 | 0.1 | 34.2 | 1.2 | 0.3 | 50.0 | 1.2 | 0.0 |
| Delay (s) | 109.5 | 23.1 | | 24.3 | 14.1 | 17.4 | 61.9 | 14.4 | 11.5 | 77.8 | 14.5 | 10.8 |
| Level of Service | F | C | | C | B | B | E | B | B | E | B | B |
| Approach Delay (s) | | 80.7 | | | 18.4 | | | 17.3 | | | 20.2 | |
| Approach LOS | | F | | | B | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 19.5 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.44 | | |
| Actuated Cycle Length (s) | 58.8 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 43.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 67 | 179 | 290 | 401 | 456 | 105 |
| Future Volume (vph) | 67 | 179 | 290 | 401 | 456 | 105 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 73 | 195 | 315 | 436 | 496 | 114 |
| RTOR Reduction (vph) | 0 | 171 | 0 | 0 | 0 | 71 |
| Lane Group Flow (vph) | 73 | 24 | 315 | 436 | 496 | 43 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 6.1 | 6.1 | 10.6 | 33.5 | 18.4 | 18.4 |
| Effective Green, g (s) | 6.1 | 6.1 | 10.6 | 33.5 | 18.4 | 18.4 |
| Actuated g/C Ratio | 0.13 | 0.13 | 0.22 | 0.69 | 0.38 | 0.38 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 222 | 198 | 386 | 2439 | 1339 | 599 |
| v/s Ratio Prot | c0.04 | | c0.18 | 0.12 | c0.14 | |
| v/s Ratio Perm | | 0.02 | | | | 0.03 |
| v/c Ratio | 0.33 | 0.12 | 0.82 | 0.18 | 0.37 | 0.07 |
| Uniform Delay, d1 | 19.4 | 18.9 | 18.1 | 2.7 | 10.9 | 9.6 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.9 | 0.3 | 12.5 | 0.2 | 0.8 | 0.2 |
| Delay (s) | 20.3 | 19.2 | 30.6 | 2.8 | 11.7 | 9.9 |
| Level of Service | C | B | C | A | B | A |
| Approach Delay (s) | 19.5 | | | 14.5 | 11.4 | |
| Approach LOS | B | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 14.1 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 48.6 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 44.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (veh/h) | 78 | 96 | 5 | 18 | 54 | 3 | 51 | 27 | 31 | 46 | 22 | 41 |
| Future Volume (Veh/h) | 78 | 96 | 5 | 18 | 54 | 3 | 51 | 27 | 31 | 46 | 22 | 41 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 85 | 104 | 5 | 20 | 59 | 3 | 55 | 29 | 34 | 50 | 24 | 45 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 3 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 62 | | | 109 | | | 410 | 378 | 106 | 423 | 380 | 60 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 62 | | | 109 | | | 410 | 378 | 106 | 423 | 380 | 60 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 94 | | | 99 | | | 89 | 94 | 96 | 89 | 95 | 96 |
| cM capacity (veh/h) | 1541 | | | 1481 | | | 482 | 516 | 948 | 474 | 515 | 1005 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | WB 2 | NB 1 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total | 85 | 109 | 20 | 62 | 118 | 119 |
| Volume Left | 85 | 0 | 20 | 0 | 55 | 50 |
| Volume Right | 0 | 5 | 0 | 3 | 34 | 45 |
| cSH | 1541 | 1700 | 1481 | 1700 | 572 | 783 |
| Volume to Capacity | 0.06 | 0.06 | 0.01 | 0.04 | 0.21 | 0.15 |
| Queue Length 95th (ft) | 4 | 0 | 1 | 0 | 19 | 13 |
| Control Delay (s) | 7.5 | 0.0 | 7.5 | 0.0 | 12.9 | 11.8 |
| Lane LOS | A | | A | | B | B |
| Approach Delay (s) | 3.3 | | 1.8 | | 12.9 | 11.8 |
| Approach LOS | | | | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.2 | | |
| Intersection Capacity Utilization | 30.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 44 | 69 | 0 | 103 | 106 | 151 | 41 | 770 | 257 | 296 | 670 | 100 |
| Future Volume (vph) | 44 | 69 | 0 | 103 | 106 | 151 | 41 | 770 | 257 | 296 | 670 | 100 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | | 0.95 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | | 1681 | 1762 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | | 0.95 | 0.99 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | | 1681 | 1745 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 48 | 75 | 0 | 112 | 115 | 164 | 45 | 837 | 279 | 322 | 728 | 109 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 128 | 0 | 0 | 189 | 0 | 0 | 55 |
| Lane Group Flow (vph) | 48 | 75 | 0 | 101 | 126 | 36 | 45 | 837 | 90 | 322 | 728 | 54 |
| Turn Type | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm | Prot | NA | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 3.7 | 17.0 | | 5.8 | 24.9 | 19.1 | 3.6 | 28.3 | 28.3 | 18.2 | 42.9 | 42.9 |
| Effective Green, g (s) | 3.7 | 17.0 | | 5.8 | 24.9 | 19.1 | 3.6 | 28.3 | 28.3 | 18.2 | 42.9 | 42.9 |
| Actuated g/C Ratio | 0.04 | 0.19 | | 0.07 | 0.29 | 0.22 | 0.04 | 0.32 | 0.32 | 0.21 | 0.49 | 0.49 |
| Clearance Time (s) | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 75 | 362 | | 111 | 498 | 346 | 72 | 1147 | 513 | 369 | 1739 | 777 |
| v/s Ratio Prot | 0.03 | 0.04 | | c0.06 | c0.02 | | 0.03 | c0.24 | | c0.18 | 0.21 | |
| v/s Ratio Perm | | | | | c0.06 | 0.02 | | | 0.06 | | | 0.03 |
| v/c Ratio | 0.64 | 0.21 | | 0.91 | 0.25 | 0.10 | 0.62 | 0.73 | 0.18 | 0.87 | 0.42 | 0.07 |
| Uniform Delay, d1 | 41.1 | 29.5 | | 40.5 | 24.0 | 27.3 | 41.2 | 26.1 | 21.1 | 33.4 | 14.2 | 11.7 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 17.1 | 0.3 | | 57.1 | 0.3 | 0.1 | 15.7 | 4.1 | 0.7 | 19.7 | 0.7 | 0.2 |
| Delay (s) | 58.3 | 29.8 | | 97.6 | 24.3 | 27.4 | 56.9 | 30.2 | 21.9 | 53.1 | 15.0 | 11.9 |
| Level of Service | E | C | | F | C | C | E | C | C | D | B | B |
| Approach Delay (s) | | 40.9 | | | 44.5 | | | 29.2 | | | 25.3 | |
| Approach LOS | | D | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 30.2 | HCM 2000 Level of Service | C |
| HCM 2000 Volume to Capacity ratio | 0.67 | | |
| Actuated Cycle Length (s) | 87.3 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 61.2% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 110 | 408 | 322 | 565 | 512 | 104 |
| Future Volume (vph) | 110 | 408 | 322 | 565 | 512 | 104 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 120 | 443 | 350 | 614 | 557 | 113 |
| RTOR Reduction (vph) | 0 | 367 | 0 | 0 | 0 | 75 |
| Lane Group Flow (vph) | 120 | 76 | 350 | 614 | 557 | 38 |
| Turn Type | Prot | Perm | Prot | NA | NA | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | 4 | | | | 6 |
| Actuated Green, G (s) | 9.8 | 9.8 | 14.5 | 38.2 | 19.2 | 19.2 |
| Effective Green, g (s) | 9.8 | 9.8 | 14.5 | 38.2 | 19.2 | 19.2 |
| Actuated g/C Ratio | 0.17 | 0.17 | 0.25 | 0.67 | 0.34 | 0.34 |
| Clearance Time (s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Vehicle Extension (s) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 304 | 272 | 450 | 2371 | 1192 | 533 |
| v/s Ratio Prot | c0.07 | | c0.20 | 0.17 | c0.16 | |
| v/s Ratio Perm | | 0.05 | | | | 0.02 |
| v/c Ratio | 0.39 | 0.28 | 0.78 | 0.26 | 0.47 | 0.07 |
| Uniform Delay, d1 | 21.0 | 20.5 | 19.8 | 3.8 | 14.9 | 12.8 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 0.6 | 8.3 | 0.3 | 1.3 | 0.3 |
| Delay (s) | 21.8 | 21.1 | 28.0 | 4.0 | 16.2 | 13.1 |
| Level of Service | C | C | C | A | B | B |
| Approach Delay (s) | 21.2 | | | 12.7 | 15.7 | |
| Approach LOS | C | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM 2000 Control Delay | 15.8 | HCM 2000 Level of Service | B |
| HCM 2000 Volume to Capacity ratio | 0.55 | | |
| Actuated Cycle Length (s) | 57.0 | Sum of lost time (s) | 13.5 |
| Intersection Capacity Utilization | 49.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group