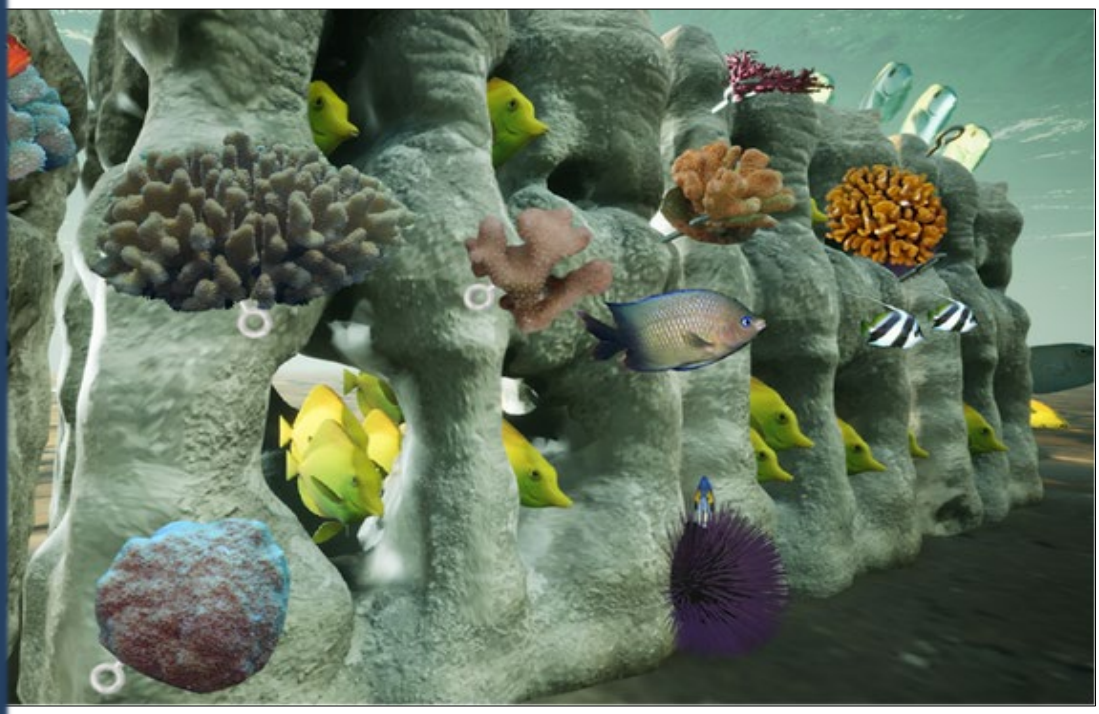
DRAFT
ENVIRONMENT ASSESSMENT

REEFrame
Restoration of Severely Degraded Coral Reefs in Hawai'i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks

NOAA Award Number: 23NMF4630084-T1-01



Prepared for
Conservation International Foundation

Prepared by
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828 Fort Street Mall, Suite 600
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April 2026

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CONTENT CHECKLIST

	HAR §11-200.1 EA Content Requirements	**Draft EA Compliance**
	Subchapter 8: Preparation	
(d)	The draft EA shall contain, but not be limited to, the following information	
(1)	Identification of the applicant or proposing agency	Summary Sheet Section 1, Introduction Section 2, Project Description and Alternatives
(2)	For applicant actions, identification of the approving agency	Summary Sheet
(3)	List of all required permits and approvals (state, federal, and county) and, for applicants, identification of which approval necessitates chapter 343, HRS, environmental review	Section 4.4, List of Permits and Approvals
(4)	Identification of agencies, citizen groups, and individuals consulted in preparing the draft EA	Section 5, Consultation
(5)	General description of the action's technical, economic, social, cultural, historical, and environmental characteristics	Executive Summary
(6)	Summary description of the affected environment, including suitable and adequate regional, location, and site maps such as Flood Insurance Rate Maps, Floodway Boundary Maps, United States Geological Survey topographic maps, or state sea level rise exposure area maps	Section 3, Description of Existing Environment, Impacts and Proposed Mitigation Measures
(7)	Identification and analysis of impacts and alternatives considered	Section 3, Description of Existing Environment, Impacts and Proposed Mitigation Measures
(8)	Proposed mitigation measures	Section 3, Description of Existing Environment, Impacts and Proposed Mitigation Measures
(9)	Proposing agency or approving agency anticipated determination, including findings and reasons supporting the anticipated Finding of No Significant Impact (FONSI), if applicable	Section 6, Findings and Reasons Supporting Anticipated Determination
(10)	Written comments, if any, and responses to the comments received, if any, and made pursuant to the early consultation provisions of subsection (a) and statutorily prescribed public review periods	Appendix F, Draft EA Pre-Consultation Correspondence

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APPENDIX B: REQUIRED BEST MANAGEMENT PRACTICES (BMPS) FROM THE RC-PI PROGRAMMATIC CONSULTATIONS REEFRAME CULTURAL IMPACT ASSESSMENT

APPENDIX C: ARCHAEOLOGICAL LITERATURE REVIEW IN SUPPORT OF REEFRAME: RESTORATION OF SEVERELY DEGRADED CORAL REEFS IN HAWAI'I VIA PERMANENT CORAL NURSERIES ON 3D PRINTED CONCRETE REEF FRAMEWORKS, WAIKIKI AHUPUA'A, KONA MOKU ISLAND OF O'AHU, STATE OF HAWAI'I; TMK: (1) 2-6 (OFFSHORE); DATED JANUARY 2026

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APPENDIX E: PRE-CONSULTATION PACKAGE; DATED OCTOBER 2025

APPENDIX F DRAFT EA PRE-CONSULTATION CORRESPONDENCE

SUMMARY SHEET

Type of Document	Draft Environmental Assessment (EA)
Project Name	REEFrame: Restoration of Severely Degraded Coral Reefs in Hawai‘i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks NOAA Award Number: NA23NMF4630084-T1-01
Applicant/Approving Agency	State of Hawai‘i Board of Land and Natural Resources
Project Location	Latitude: 21d 16’ 11.61”N Longitude: 157d 50’ 23.18”W 0.52 to 0.75 miles offshore off Waikīkī Beach in water depths between 40 and 60 feet.
Tax Map Key (TMK)	The nearest landside TMKs are the strip of shoreline properties along Kālia Road in Waikīkī, including Halekulani Hotel, and include: (1) 2-6-005:001 (1) 2-6-004:012 (1) 2-6-004:010 (1) 2-6-004:009 (1) 2-6-004:008 (1) 2-6-004:007 (1) 2-6-004:006 (1) 2-6-004:005 (1) 2-6-002:026 (1) 2-6-002:006
Land Area	Not applicable
Ocean Area	11.4 acres
State Land Use District (SLUD)	Conservation
State Land Use Conservation District	Resource Subzone
Special Management Area	Not applicable
County Zoning Designation	Not applicable
Project Summary	REEFrame is a habitat restoration project intended to restore Waikīkī’s coral reefs by creating and installing permanent naturally shaped concrete modules designed to enhance coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, artificial reefs. REEFrame aims to support coral growth and restore functional reef habitat, improve ecosystem health, support marine life, and reinforce the coastal

	benefits the reef provides to the Waikīkī community. REEFrame location is 0.52 to 0.75 miles offshore in water depths between 40 and 60 feet (ft). This $9 million project is funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Habitat Conservation.
Regulatory Context	Chapters 343 and 344, Hawai‘i Revised Statutes (HRS) and Chapter 11-200.1, Hawai‘i Administrative Rules (HAR)
Triggers for the EA	Use of state or county land or the use of state or county funds Use within Conservation District
Anticipated Determination	Finding of No Significant Impact (FONSI)
Estimated Cost	$9,027,618
Time Frame	Construction completion anticipated in late 2026/early 2027
Consultant	Oceanit 828 Fort Street Mall, Suite 600 Honolulu, HI, 96813 Reeframe@oceanit.com

ACRONYMS AND ABBREVIATIONS

%	Percent
§	Section
°F	Degree(s) Fahrenheit
AFNSI	Anticipated Finding of No Significant Impact
AFRC	Ānuenue Fisheries Research Center
AHPA	Archaeological and Historic Preservation Act
ALR	Archaeological Literature Review
ALRFI	Archaeological Literature Review and Field Inspection Report
AQS	Air Quality System
AUD INJ	Auditory Injury
BLNR	Board of Land and Natural Resources
BMP(s)	Best Management Practice(s)
BPBM	Bernice Pauahi Bishop Museum
BS	Beaches
CAA	Clean Air Act
CCH	City and County of Honolulu
CDP	Census Designated Place
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
cm	Centimeter(s)
CoOs	Corals of Opportunity
CI	Conservation International
CIA	Cultural Impact Assessment
CReME	Coral Resilience Module Experiment
CWA	Clean Water Act
CWB	Clean Water Branch, DOH
CWRM	Commission on Water Resource Management
CZARA	Coastal Zone Act Reauthorization Amendments
CZM	Coastal Zone Management
DAR	Division of Aquatic Resources, DLNR
dBA	Decibels
DBEDT	State of Hawai‘i Department of Business, Economic Development and Tourism
DLNR	State of Hawai‘i Department of Land and Natural Resources

DLIR	State of Hawai‘i Department of Labor and Industrial Relations
DOBOR	Division of Boating and Ocean Recreation, DLNR
DOFAW	Division of Forestry and Wildlife, DLNR
DOCARE	Division of Conservation and Resources Enforcement, DLNR
DOH	State of Hawai‘i Department of Health
DP	Dynamic Positioning
DPP	Department of Planning and Permitting, CCH
DPR	Department of Parks and Recreation, CCH
DPS	Distinct Population Segment
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENV	Department of Environmental Services, CCH
EPA	Environmental Protection Agency
ERP	Environmental Review Program, OPSD
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FEP(s)	Fishery Ecosystem Plan(s)
FIRM	Flood Insurance Rate Map
FMP	Fisheries Management Plan
FONSI	Finding of No Significant Impacts
ft	Foot or feet
FWCA	Fish and Wildlife Coordination Act
FWS	Fishers Working Group
GDP	Gross Domestic Product
GPS	Global Positioning System
HAPC	Habitat Areas of Particular Concern
HAR	Hawai‘i Administrative Rules
HCRN	Hawai‘i Coral Restoration Nursery
HDPE	High-density polyethylene
HECO	Hawaiian Electric Company
Hg	Mercury
HHA	Hawai‘i Hotel Alliance
HICRIS	Hawai‘i Cultural Resource Information System
HIHWNMS	Hawaiian Islands Humpback Whale National Marine Sanctuary

HIOSH	Hawai‘i Occupational Safety and Health Division, DLIR
HMPS	Hawaiian Music Perpetuation Society
HOST	Hawai‘i Ocean Safety Team
HPD	Honolulu Police Department
HRS	Hawai‘i Revised Statutes
HST	Hawai‘i Standard Time
HVBC	Hawai‘i Visitors and Convention Bureau
IPCC	Intergovernmental Panel on Climate Change
IPaC	Information for Planning and Consultation tool operated by U.S. Fish and Wildlife Service
JaC	Jaucas
LAND	Land Division, DLNR
LUC	Land Use Commission
M	Million
m	Meter(s)
MBTA	Migratory Bird Treaty Act
mg/L	Milligrams per Liter
mm	Millimeter(s)
MMPA	Marine Mammal Protection Act
mph	Miles per Hour
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MUS	Management Unit Species
NAAQS	National Ambient Air Quality Standards
NHPA	National Historic Preservation Act
No.	Number
NOAA	National Oceanic and Atmospheric Administration
NOAA NMFS	NOAA National Marine Fisheries Service
NOAA OHC	NOAA Office of Habitat Conservation
NOAA PIRO	NOAA Pacific Islands Regional Office
NOAA RC	NOAA Fisheries Service Office of Habitat Conservation’s Restoration Center
NWP	Nationwide Permit
OCCL	Office of Conservation and Coastal Lands, DLNR
OPSD	State of Hawai‘i Office of Planning and Sustainable Development

PacIOOS	Pacific Islands Ocean Observing System
PEIS	Programmatic Environmental Impact Statement
PIFWSO	Pacific Islands Fish and Wildlife Service Office, USFWS
PM	Particulate Matter
Qty	Quantity
RC-PI	Restoration Center - Pacific Islands, NOAA OHC
ROH	Revised Ordinances of Honolulu
RTE	Rare, Threatened, and Endangered
Scuba	Self Contained Underwater Breathing Apparatus
SFHA	Special Flood Hazard Area
SHPD	State Historic Preservation Division, DLNR
SIHP	State Inventory of Historic Places
SLOPES	Standard Local Operating Procedures for Endangered Species
SLR	Sea Level Rise
SLR-XA	Sea Level Rise Exposure Area
SLUD	State Land Use District
SMA	Special Management Area
SSE	South-Southeast
SWAN	Simulating Waves Nearshore
TEZ	Tsunami Evacuation Zone
TMDL	Total Maximum Daily Load
TMK	Tax Map Key
TSS	Total Suspended Solids
UHM	University of Hawai‘i at Mānoa
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	Ultraviolet
WIA	Waikīkī Improvement Association
WBSIDA	Waikīkī Beach Special Improvement District Association
WPRFMC	Western Pacific Regional Fishery Management Council
WQC	Water Quality Certification

WQS	Water Quality Standards

EXECUTIVE SUMMARY

REEFrame is a habitat restoration project intended to restore Waikīkī's coral reefs by creating and installing permanent naturally shaped concrete modules designed to enhance coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. This $9 million project is funded by the National Oceanic and Atmospheric Administration Office of Habitat Conservation (NOAA OHC).

Urbanization, pollution, fishing impacts, and climate change have accelerated the decline of Waikīkī's coral reef ecosystem. Today, this ecosystem is among the most degraded in Hawai'i with the lowest herbivorous fish density in Hawai'i.[1] REEFrame is a proactive step towards restoring this degraded Waikīkī coral reef ecosystem. The project area is located near the 'Āpuakēhau Channel 0.52 to 0.75 miles offshore in water depths between 40 and 60 feet (ft).

The EA includes a discussion of the No Action alternative and the following alternatives:

- *Location Alternatives*

  Eight potential sites between Kewalo Basin and Diamond Head were evaluated for feasibility to meet the project objectives. The alternative sites were divided into two distinct groups: shallow sandy sites and deeper sites. Two sites, Halekulani Dagger and Halekulani East, were combined as "Halekulani" and selected as the preferred location to install the REEFrame modules. The preferred location is centrally located, dominantly sandy bottom type, offshore of the popular commercial dive spot Turtle Canyon, near a natural spur and grove reef, and been previously studied in the CReME project. Further, it is located at depths feasible for restoration work by scuba (Self Contained Underwater Breathing Apparatus) divers.

- *Coral Reef Restoration Alternatives*

  The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Office of Habitat Conservation's Restoration Center (NOAA RC) prepared a Programmatic Environmental Impact Statement (PEIS) to evaluate coastal habitat restoration activities through its existing programmatic framework and related procedures. The PEIS identified a range of physical and biological coral restoration techniques for shallow benthic coral communities, specifically coral communities characterized by consolidated hard substrates. A range of six coral techniques were identified, of which two techniques align with the preferred REEFrame alternative. These include 1) transplanting (outplanting) coral fragments from a nursery or an impacted location to appropriate targeted locations, and 2) re-attaching or moving broken corals or stabilizing rubble substrates in areas impacted by events

[1] Donovan et al. (2023). Evidence for managing herbivores for reef resilience. *Proceedings of the Royal Society B: Biological Sciences, 290*(2012), 2023-2101. https://doi.org/10.1098/rspb.2023.2101

such as vessel groundings or storms, sometimes in conjunction with proactively relocating corals to more appropriate locations, which may include a coral nursery. The proposed REEFrame project aligns with these alternatives.

- *No-Action Alternative*

  The No-Action Alternative will allow the continuation of significant losses of coral reefs and, if unchecked, the degradation of the overall health of the benthic environment along the Waikīkī coastline. Coral restoration is relevant to both the aquatic ecosystem and the uniquely diverse culture of Waikīkī. In the long term, the No-Action Alternative has a poor detrimental effect on future measures to restore healthy reefs throughout the Hawaiian Islands and delays a significant crucial step in restoring function to the marine environment.

The following potentially impacted environments were evaluated in this Draft Environmental Assessment (EA):

- Climate and topography
- Geology and soils
- Hydrogeology and water resources
- Ocean water quality
- Air and noise quality
- Climate change and sea level rise
- Flood, tsunami and hurricane hazards
- Terrestrial biological resources
- Marine biological resources
- Demographics and the economy
- Archaeological and cultural resources
- Public services and facilities

Overall, the Proposed Action will not cause significant negative impacts and mitigates potential negative impacts. Short-term negative impacts are related to deployment and construction activities, and, as discussed in this Draft EA, Best Management Practices (BMPs) will be strictly followed to avoid, minimize, or mitigate impacts on ocean water quality, air and noise quality, and marine biological resources.

Over the long term, the project is anticipated to result in net ecological benefits by introducing durable reef-like substrate in an area with limited complex natural structure, supporting Corals of Opportunity (CoO) outplants, enhancing habitat for reef-associated fishes and invertebrates, and broadening the State's coral restoration objectives.

Hawai'i Administrative Rule (HAR) Section (§) 11-200.1 establishes procedures for determining if a Finding of No Significant Impact (FONSI) is warranted. In accordance with the provisions set forth in Chapter 343, Hawai'i Revised Statutes (HRS), and HAR §11-200.1, this Draft EA has preliminarily determined that the Proposed Action will not have significant adverse impacts on the environment. As such, a FONSI is anticipated.

1. STATEMENT OF PURPOSE AND NEED

1.1 Background

REEFrame is a habitat restoration project intended to enhance Waikīkī's coral reefs by creating and installing permanent modules that mimic the structure of a naturally occurring reef. The project will function as a structure for coral outplanting, as well as a habitat for naturally colonizing corals and ecologically important reef species.

Today, coral reefs face increasing stress from sources such as land-based pollution, ocean acidification, overfishing, warming ocean temperatures, and frequent extreme weather events.[2] These combined pressures all significantly degrade coral resilience, leaving corals susceptible to bleaching events and coral death.[3] Coral mortality exposes the reef to erosion, reducing habitat availability in the natural reef system[4] and resulting in lower numbers and biodiversity of reef species such as fishes.[5] Coral decline also reduces coastal protection[6] and can lead to the limitation of cultural practices such as fishing, loss of tourism-related income, and general negative impacts on recreational ocean use.[7]

In a healthy coral reef ecosystem, herbivorous reef fishes and invertebrates feed upon marine flora, regulating algae that can smother living coral tissue. Over the past few decades, unsustainable fishing practices and land-based pollution such as urban runoff have negatively impacted this balance, favoring algal growth.[8] Algal growth over coral tissues restricts larval settlement increases colony

[2] Hughes et al. (2003). Climate change, human impacts, and the resilience of coral reefs. *Science*, *301*(5635), 929-933. https://doi.org/10.1126/science.1085046

[3] Hoegh-Guldberg et al. (2007). Coral reefs under rapid climate change and ocean acidification. *Science, 318*(5857), 1737-1742. https://doi.org/10.1126/science.1152509

[4] Alvarez-Filip et al. (2009). Flattening of Caribbean coral reefs: region-wide declines in architectural complexity. *Proceedings of the Royal Society B: Biological Sciences*, *276*(1669), 3019-3025. https://doi.org/10.1098/rspb.2009.0339

[5] Pratchett, M. S., Hoey, A. S., & Wilson, S. K. (2014). Reef degradation and the loss of critical ecosystem goods and services provided by coral reef fishes. *Current Opinion in Environmental Sustainability, 7*, 37-43. https://doi.org/10.1016/j.cosust.2013.11.022

[6] Carlot et al. (2023). Coral reef structural complexity loss exposes coastlines to waves. *Scientific Reports*, *13*(1), 1683. https://doi.org/10.1038/s41598-023-28945-x

[7] Eddy et al. (2021). Global decline in capacity of coral reefs to provide ecosystem services. *One Earth*, *4*(9), 1278-1285. https://doi.org/10.1016/j.oneear.2021.08.016

[8] Donovan et al. (2023). Evidence for managing herbivores for reef resilience. *Proceedings of the Royal Society B: Biological Sciences, 290*(2012), 2023-2101. https://doi.org/10.1098/rspb.2023.2101

susceptibility to disease, prevents coral growth, and inhibits colony survival rates.[9] Studies indicate that coral reefs with robust herbivore populations are associated with lower levels of macroalgae and turf algae[10] as well as increased larval recruitment, juvenile survivorship, and overall colony growth.[11] Herbivore protection has been projected to delay rates of coral loss during extreme bleaching and other disturbance events.[12] Within a reef ecosystem, species diversity among herbivores is particularly crucial for mitigating algal overgrowth.[13] Therefore, maintaining a stable herbivorous fish population is a priority for coral reef management.

The REEFrame module design supports many species of marine herbivores that each differ in feeding preferences, life histories, and habitat preferences (see more on module design elements in Section 2.3.3). Structural complexity within a reef system provides important refuge for juvenile and adult herbivores and is necessary to support biodiversity.[14] The size and distribution of shelter space within a reef is ecologically significant in the context of predator-prey interactions and is a determining factor in the types and sizes of species that are supported by the reef ecosystem.[15]

1.2 Purpose and Project Need

Urbanization, pollution, fishing impacts, and ocean warming have accelerated the decline of Waikīkī's coral reef ecosystem. Today, this ecosystem is among the most degraded in Hawai'i with the lowest

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[9] Birrell, C. L., McCook, L. J., Willis, B. L., & Diaz-Pulido, G. A. (2008). Effects of benthic algae on the replenishment of corals and the implications for the resilience of coral reefs. *Oceanography and Marine Biology* (pp. 31-70). CRC Press. https://doi.org/10.1201/9781420065756-4

[10] Heenan, A., & Williams, I. D. (2013). Monitoring herbivorous fishes as indicators of coral reef resilience in American Samoa. *PloS one, 8*(11), e79604. https://doi.org/10.1371/journal.pone.0079604

[11] Idjadi et al. (2010). Recovery of the sea urchin Diadema antillarum promotes scleractinian coral growth and survivorship on shallow Jamaican reefs. *Marine Ecology Progress Series*, 403, 91-100. https://doi.org/10.3354/meps08463

[12] Chung et al. (2019). Building coral reef resilience through spatial herbivore management. *Frontiers in Marine Science*, 6. https://doi.org/10.3389/fmars.2019.00098

[13] Hixon, M. A. (2015). Reef fishes, seaweeds, and corals: a complex triangle. In C. Birkeland (Ed.), *Coral reefs in the Anthropocene* (pp. 195-215). Springer. https://doi.org/10.1007/978-94-017-7249-5_10

[14] Moustaka et al. (2024). Local habitat composition and complexity outweigh seascape effects on fish distributions across a tropical seascape. *Landscape Ecology*, *39*(2), 28. https://doi.org/10.1007/s10980-024-01814-2

[15] Hixon, M. A., & Beets, J. P. (1993). Predation, prey refuges, and the structure of coral-reef fish assemblages. *Ecological Monographs 63*(1), 77-101. https://doi.org/10.2307/2937124

herbivorous fish density in Hawai‘i.[16] REEFrame is a proactive step towards restoring a robust Waikīkī coral reef ecosystem.

REEFrame is a restoration project serving to promote coral reef resilience (resistance and recovery) and revitalize Waikīkī's degraded reef ecosystem. Beyond Waikīkī, this project serves as a template for future reef restoration efforts throughout Hawai‘i. Coral reefs are foundational to the deeply rooted culture and history of Hawai‘i. In this project, restoration applies to both the marine ecosystem and the uniquely diverse culture of Waikīkī. REEFrame seeks to revitalize the historic significance and cultural practices that are inhibited due to continuing ecosystem degradation. Restoring coral reefs is the first step in supporting the greater marine environment, which extends to the social and cultural environments that make Hawai‘i unique.

The reefs in Waikīkī are the target for this reef restoration project because they are among the most degraded in the state. Reports indicate that Waikīkī yields some of the lowest resource fish biomass in the state, which translates to low herbivorous fish populations.[17] These ecological conditions create an unsuitable habitat for corals and reef species. Without a healthy and stable herbivorous fish population, coral will continue to decline.

1.3 Project Area

The REEFrame Project Area is located at the mouth of the ‘Āpuakēhau Channel along the coast of Waikīkī in Honolulu, Hawai‘i on the island of O‘ahu as depicted in Figure 1. The Project Area is 0.52 to 0.75 miles off Waikīkī Beach in water depths between 40 and 60 ft and covers approximately 11.4 acres. At these depths, REEFrame will avoid high wave energy, minimize effects on surf sites, and enable feasible underwater restoration activities.

1.4 Scope and Authority

This Draft Environmental Assessment (EA) was prepared for the proposed REEFrame project in accordance with Hawai‘i Revised Statutes (HRS) Chapter 343 relating to Environmental Impacts Statements (EIS), Hawai‘i Administrative Rules (HAR) Chapter 11-200.1 Environmental Impact Statement Rules, and HAR Title 13, Chapter 5, which specifies procedures for projects located in the State Conservation District.

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[16] Donovan et al. (2023). Evidence for managing herbivores for reef resilience. *Proceedings of the Royal Society B: Biological Sciences*, *290*(2012), 2023-2101. https://doi.org/10.1098/rspb.2023.2101

[17] Friedlander et al. (2018). Human-induced gradients of reef fish declines in the Hawaiian Archipelago viewed through the lens of traditional management boundaries. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *28*(1), 146-157. https://doi.org/10.1002/aqc.2832

HRS Chapter 343 is triggered by the use of state or county land or the use of state or county funds and project location within the conservation district. HAR §13-5-31 requires a draft or final EA as part of the application for a Conservation District Use Permit (CDUP).

This Draft EA is prepared to determine impacts associated with a proposed action, to develop mitigation measures for adverse impacts, and to determine whether any of the impacts are significant according to thirteen (13) criteria. If the approving agency confirms that no significant impacts are expected after considering comments made regarding the Draft EA, then the agency would issue a Finding of No Significant Impact (FONSI) and the action would be allowed to seek applicable permits. This Draft EA examines potential environmental impacts of the Proposed Action and seeks agency and public comments on subject areas that should be addressed. Preparation of this Draft EA is in accordance with HAR Chapter 11-200.1.

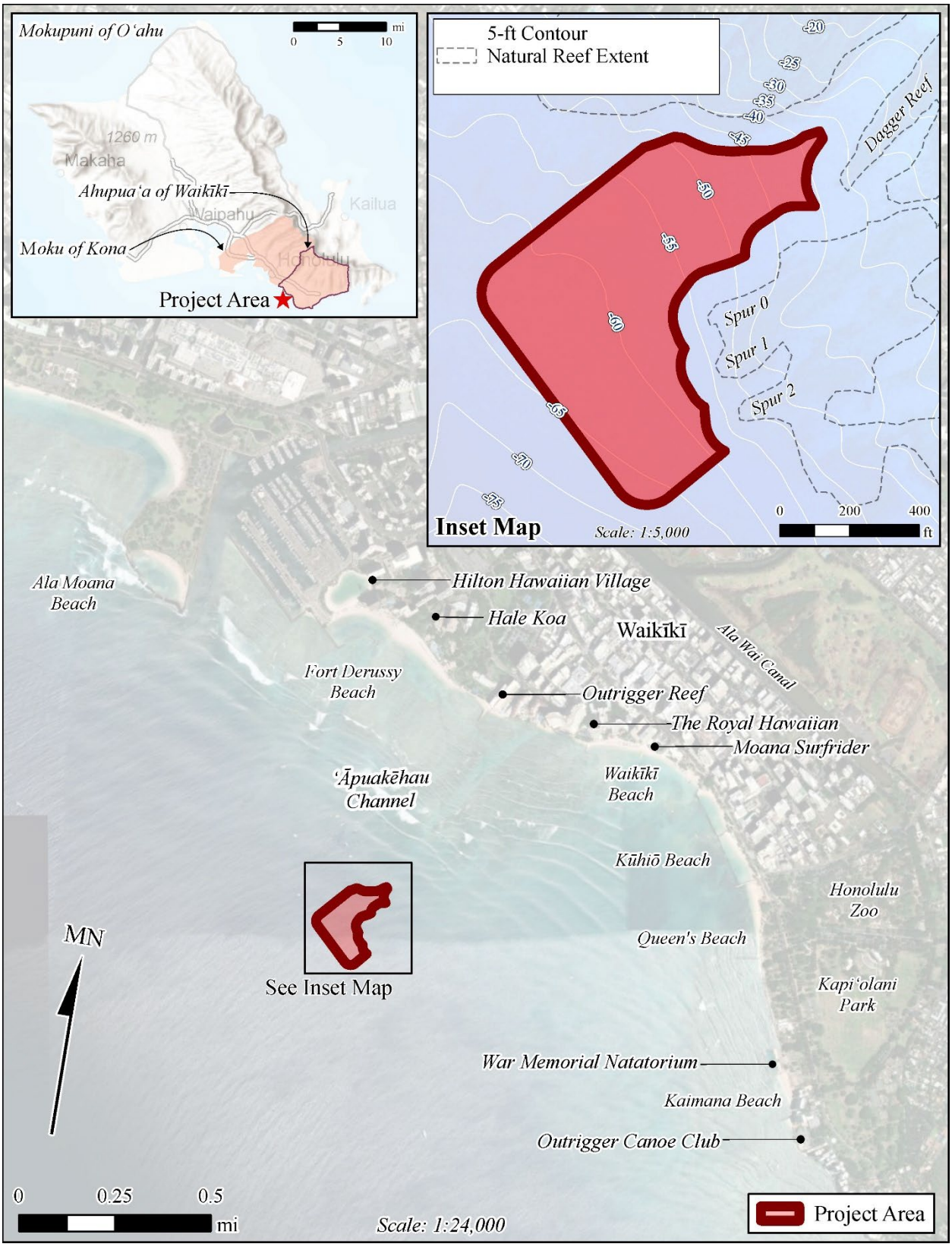


Figure 1: Project Vicinity Map

2. PROPOSED ACTION AND PROJECT ALTERNATIVES

2.1 Project Overview

The REEFrame project is intended to establish permanent coral nurseries off Waikīkī Beach comprising naturally shaped concrete modules. These structures will act both as nurseries and permanent reefs and will be 0.52 to 0.75 miles offshore at a depth of 40 to 60 ft. The modules will contain holes, crevices, ledges and other intentional design elements to help mimic a natural reef structure while providing shelter space for colonizing fishes and marine invertebrates.

The REEFrame modules have attachment points for Coral of Opportunity (CoOs), which are healthy coral fragments that have been dislodged by storms or human activity and are a cost-effective option for reef restoration. CoOs are a valuable resource for nurseries and outplanting to boost coral resilience (resistance and recovery) by providing coral pieces that can quickly return ecological services. CoOs are used in coral restoration projects across Hawai‘i by multiple organizations and restoration practitioners.

The REEFrame modules are intended ultimately to serve as permanent ecologically functional reefs that are colonized by naturally occurring coral larvae and other marine life, as well as serve as a nursery for corals that may be used in future restoration efforts. The modules are designed to withstand wave forces and have multiple levels of complexity to provide shelter for species that benefit coral. The habitat features (surface texture, grooves, holes, and overhangs) are created using innovative Natrx DryForming™ technology and will enhance biodiversity and provide ecosystem services to benefit CoOs, natural coral recruitment, and fish habitat. This ecosystem-based approach is an example of how habitat enhancement features can play a critical role in coral restoration efforts. Table 1 lists project team members and their roles.

Table 1: REEFrame Team Members

Team Partner	Role
Conservation International	Project management and administration
NOAA Office of Habitat Conservation	Technical assistance and environmental compliance
Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR)	State partner
University of Hawai‘i at Mānoa	Scientific lead
Natrx	Design and production of concrete modules
Oceanit	Marine engineering and permits / approvals
Pacific Consulting Services, Inc.	Archaeological and cultural studies
ClimbHI	Public engagement, outreach, and education
Hawaiian Music Perpetuation Society	Cultural and community engagement guidance

2.2 Pilot Study: Coral Resilience Module Experiment (CReME)

The foundation of REEFrame is based on the Coral Resilience Module Experiment (CReME) feasibility study conducted by the University of Hawai'i. In 2016, the CReME project began as an artificial reef pilot study with six units deployed at each of two sites: Hanauma Bay and Waikīkī. Six one cubic-meter (m^3) concrete modules were deployed offshore of Waikīkī at depths ranging from 40 to 60 ft on the primarily sandy ocean floor, the same location as the preferred site for REEFrame.

The CReME project tested whether concrete modules providing shelter holes would enhance the local abundance of herbivorous fishes and sea urchins. The modules were subsequently used to test the survival and growth of attached CoOs. CReME aimed to attract and support herbivores to heighten control of benthic algae that would otherwise inhibit coral colonization.[18]

2.2.1 CReME Description and Methodology

Each CReME module comprises 48 standard concrete blocks with dimensions of 40 x 19 x 19 centimeters (cm) and a volume of 0.71 m^3. Following deployment, the units were monitored every quarter over four years.

As reported by Dilley et al. (2026), corals were censused quarterly starting in May 2017, when coral colonization was first detectable, until the start of the COVID pandemic in early 2020. Juvenile coral demography was quantified, accounting for all individual coral colonies, which include small colonies and even individual primary polyps that settled on the CReME modules. To properly visualize and count corals, scuba divers used ultraviolet (UV) lights to make colonies and polyps fluoresce, making it easier to count small individuals. All new corals measuring less than or equal to 5 mm in greatest diameter length were counted and then divided by the total settlement area to describe the density of new coral colonies per square-meter (m^2).[19]

[18] Dilley, E.R., Brush, E.G., Jones, R.N., & Hixon, M.A. (2026). Coral Restoration: Roles of shelter for herbivores and reef state in early recruitment success. *PeerJ* 14:e20891. https://doi.org/10.7717/peerj.20891

[19] Dilley, E.R., Brush, E.G., Jones, R.N., & Hixon, M.A. (2026). Coral Restoration: Roles of shelter for herbivores and reef state in early recruitment success. *PeerJ* 14:e20891. https://doi.org/10.7717/peerj.20891

Coral growth was monitored by measuring the changes in planar surface area of colonies between the beginnings of sequential quarters. Analyses did not include coral colonies that experienced fragmentation, fusion or had shrunk. All fish associated with the modules were sized and counted, and size was then converted into biomass following published weight and length relationships. Algal overgrowth was measured by visually estimating the percent cover of benthic algae. Finally, sea urchin and other large macroinvertebrate abundances were measured for each module.[20]

2.2.2 CReME Findings and Status

Natural coral recruitment was first detected in 2017, and individuals grew to about two cm in diameter by the end of the year. Common reef building corals were observed on the modules, with *Pocillopora, Porites,* and *Montipora* being the dominant genera.[21] During the second phase of the project, the modules were seeded with 47 *Pocillopora grandis* and 8 *Pocillopora meandrina* CoOs. Large (>30cm) CoOs demonstrated the highest survivorship; 34 out of 35 large *P. grandis* and 6 out of 8 large *P. meandrina* CoOs successfully attached to the modules and continued growing throughout the study period.

The second phase of the project also included seeding the structures with hatchery-raised juvenile urchins (*Tripneustes gratilla*). The urchins failed to transplant successfully due to an inability to maintain attachment to the modules even under mild wave conditions. However, several species of urchins were observed to naturally colonize the modules successfully. Urchin as well as fish species colonizing the modules were found to be representative of the surrounding natural reefs, indicating immigration from those reefs.

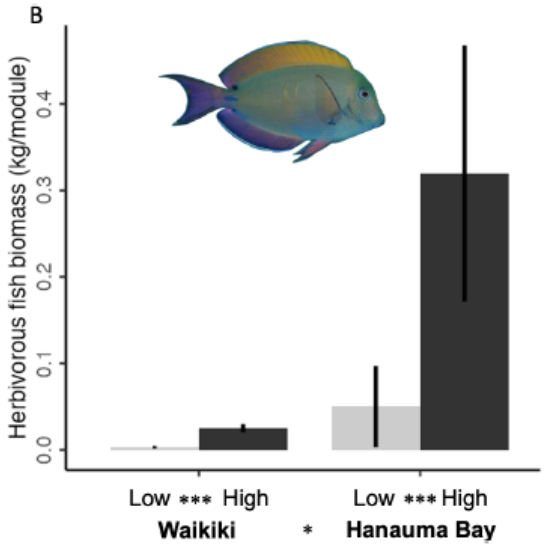
Data from the CReME study were used to inform the REEFrame design features such as surface textures, grooves, holes, and overhangs which provide effective shelter for a diverse assemblage of reef species. This pilot study demonstrated that outplanted CoOs and naturally recruiting corals can grow and develop on concrete structures installed offshore of Waikīkī, which supports the concept for REEFrame to function as a structure for coral outplanting as well as a habitat for naturally colonizing corals. Moreover, the CReME project supports the prospect that the REEFrame project will enhance the surrounding natural environment by serving as high-shelter habitat for reef-associated invertebrates and fishes found in the nearby reef habitat.

Figure 2 highlights the success of high shelter structures with regards to increased colonization by fishes and Figure 3 details the natural coral recruitment on these concrete structures.

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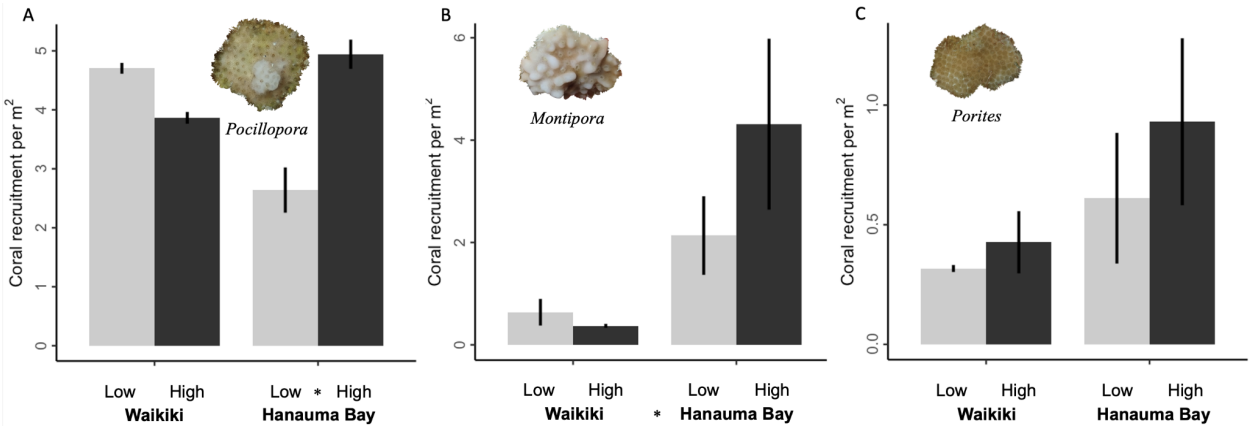
[20] Dilley, E.R., Brush, E.G., Jones, R.N., & Hixon, M.A. (2026). Coral Restoration: Roles of shelter for herbivores and reef state in early recruitment success. *PeerJ* 14:e20891. https://doi.org/10.7717/peerj.20891

[21] Dilley, E.R., Brush, E.G., Jones, R.N., & Hixon, M.A. (2026). Coral Restoration: Roles of shelter for herbivores and reef state in early recruitment success. *PeerJ* 14:e20891. https://doi.org/10.7717/peerj.20891



Source: Hixon et al., 2026. CReME: Coral Resilience Module Experiment.

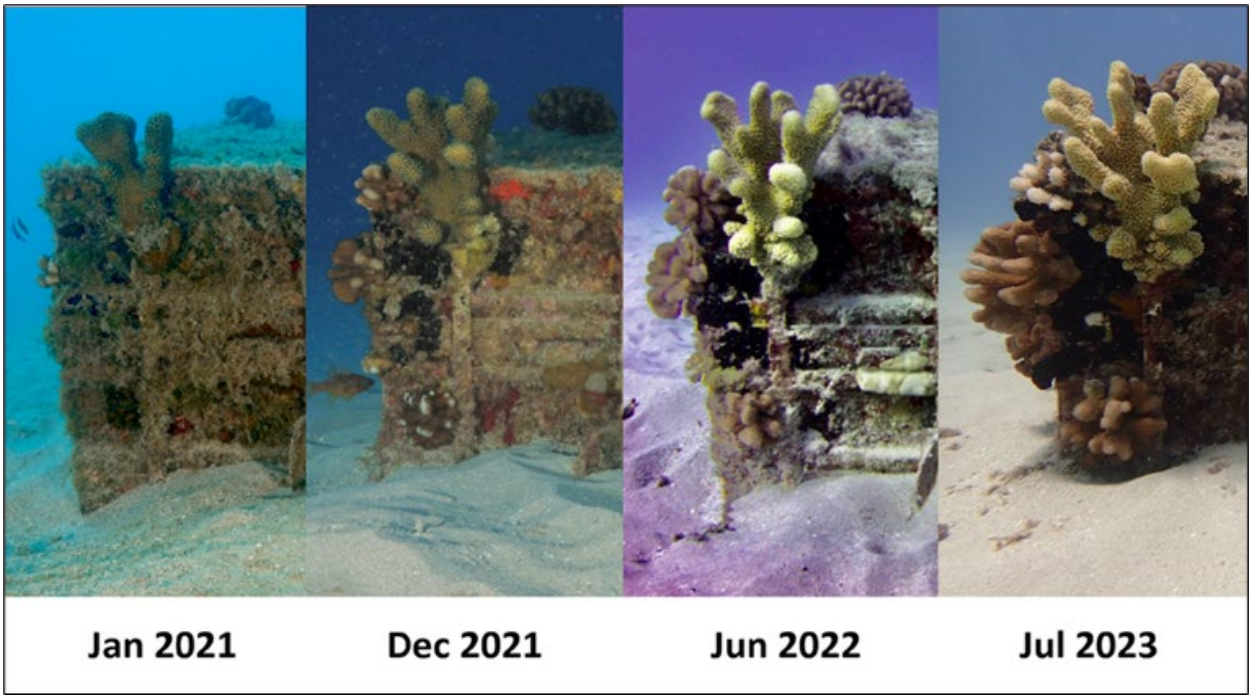
Figure 2: Mean Herbivorous Fish Biomass Recorded at Low and High shelter CReME Modules Between 2017 and 2023



Source: Hixon et al., 2026. CReME: Coral Resilience Module Experiment.

Figure 3: Number of Coral Recruits Across Low and High Shelter CReME Modules Between 2017 and 2020

Figure 4 illustrates the success of CReME in fostering coral growth. In this sequence, the largest colony is an attached CoO fragment of antler coral (*Pocillopora grandis*), and the other colonies are naturally recruited cauliflower coral (*P. meandrina*).



Source: CReME Special Activity Permit.

Figure 4: Waikīkī CReME Modules from 2021 to 2023

2.3 Description of the Proposed Action

2.3.1 Objectives of the Proposed Action

The Proposed Action is designed to achieve the following objectives:

1) Provide an accessible structure for outplanting coral fragments and serve as habitat for naturally spawning, reef-building corals, juvenile and adult fish, crustose coralline algae, macroinvertebrates, and other ecologically associated reef organisms.

2) Support the initial recruitment and continued growth of the organisms listed above.

3) Control species that outcompete corals, such as dense turf and macroalgal mats, until the ecological community is self-sustaining.

The REEFrame team is dedicated to collaborating with the stewards, users and traditional and cultural practitioners in Waikīkī. Through shared kuleana, the community works to honor the legacy of the ʻōpū aliʻi (servant leaders) who have called Waikīkī home. For generations, Hawaiʻi's servant leaders cared for the Waikīkī ahupuaʻa, recognizing the vast importance of our actions on this delicate ecosystem. Building permanent coral nurseries off Waikīkī Beach is a critical step for maintaining the deeply connected culture while restoring the ecosystem and the important species that inhabit the reef. REEFrame has engaged with community stakeholders since the project began and will continue to proactively connect through project implementation, with stakeholders who include but are not limited to:

Resource management agencies
Waikīkī residents
Cultural groups and kūpuna
Surfing community
Fishers
Scuba dive tour companies
Waʻa (canoe) clubs
Youth / schools
Visitor industry
Scientific community

2.3.2 Project Area

Site selection was based on the following criteria:

1. **Proximity to Restorable Coral Reef:** The REEFrame project should be adjacent to an area suitable for coral reef restoration. The adjacent reefs were surveyed for indications that transplanted corals from the REEFrame modules would have suitable conditions for coral growth. Additionally, the CReME project discussed in Section 2.2 is a proof-of-concept project in the vicinity that has shown success.

2. **Water Depth**: Water depth at the REEFrame site needs to meet criteria to avoid impacts to surf sites and optimize project efficiency. To balance depth considerations, REEFrame was designed to be installed at a depth of 40 to 60 ft. Shallower water (less than 60 ft deep) makes coral nurseries more accessible and practical for restoration and monitoring activities via scuba. Greater water depth (greater than 40 ft deep) helps to accomplish the following:

    - Reduce the likelihood that wave forces will cause damage to the nursery.
    - Reduce the likelihood that the project will cause changes to nearby surf sites and impact safe navigation by ocean vessels.

3. **Seafloor Composition**: Selecting a site consisting primarily of sand ensures that no existing corals are affected by the project. To reduce negative impacts on wildlife, the chosen deployment area consists of unconsolidated sand and sediments with minimal algal cover and maintains a 100 ft buffer between the REEFrame Project Area and existing reef.

Section 2.4.1, Location Alternatives, discusses the site selection process that resulted in the current Project Area.

The REEFrame Project Area is located at the mouth of the ʻĀpuakēhau Channel along the coast of Waikīkī in Honolulu, Hawaiʻi and depicted in Figure 1. The Project Area is 0.52 to 0.75 miles offshore in water depths between 40 and 60 ft.

At these depths, REEFrame will avoid damage from high wave energy (as demonstrated by the CReME project), avoid potential effects on surf sites, and allow for underwater restoration activities. In the proposed location, the seafloor composition is generally unconsolidated, primarily consisting of sand and rubble. Existing coral coverage is low, so the placement of the REEFrame structures will not negatively impact key biological resources such as corals, endemic algae, and other mobile invertebrates. Additionally, the identified REEFrame site is adjacent to a natural reef, which will provide CoOs to seed the REEFrame structures and increase the potential for natural coral recruitment. Finally, this REEFrame site is optimal because it is in a central location that is accessible for future coral restoration.

2.3.3 REEFrame Technology

The REEFrame modules are manufactured using Natrx's DryForming™ process, which enables the creation of naturalistic features to foster coral growth. The modules have holes of varying sizes, crevices, ledges, and other intentional design elements that mimic a natural reef structure. These texture features vary between modules to provide a complex habitat for coral, fish, and other marine organisms. The modules are a concrete material with steel hardware. Steel is covered in concrete coatings. There are five interlocking units per module. Each module measures six feet wide by six feet tall and weighs an average of five tons. The modules are designed to withstand a 50-year southern swell storm event where wave heights reach or exceed 18 ft with a sustained 18 second period.

Intentional variation is part of the REEFrame design and exists to accommodate ecological features and mimic natural coral reef formation. The minimum weight for stability and bottom footprint will be uniform across all REEFrame modules. Examples of planned variations include:

- Dome or sloping sides
- Rugous surfaces
- Varying hole sizes (2 to 8 inches in diameter)
- Ledges/overhangs 1 to 2 ft off the bottom (5 to 8 inches high by 18-33 inches across)

Permanent coral attachment points will be incorporated on the REEFrame modules (i.e., one flat corner per module to accommodate affixing DAR's coral pyramids, and pin holes on modules to allow for outplanting CoOs). Figure 5 shows a typical REEFrame module.



Figure 5: Typical REEFrame Module

2.3.4 Construction

The Area of Potential Effects (APE) encompasses approximately 11.4 acres (496,584 square ft). Current funding supports the deployment of an initial 150 reef modules, representing a meaningful scale of restoration. These modules would occupy approximately 5,400 square feet, or about 1.1 percent of the APE seafloor. Figure 6 contains a potential site plan. The exact module layout is subject to change within the Project Area.

This assessment also evaluates the APE with flexibility to accommodate additional modules, and future expansion may occur within the APE subject to additional funding. Any such expansion would use the same materials, installation methods, and placement criteria evaluated in this assessment, and would be consistent with the module size, configuration, and impact mechanisms analyzed herein.

The placement of the REEFrame modules will require construction barges with heavy equipment to place the modules on the sandy sea floor. To help control the risks of inadvertently placing a structure on the natural reef, construction will proceed only during fair weather conditions at the site (preferable waves, currents and winds). The placement locations of each module will be confirmed by the selected construction company. To help control the short-term risks of the construction activities on ocean water quality and the benthic environment, Best Management Practices (BMPs) will be established prior to the deployment of REEFrame.

Construction activities will commence upon obtaining permits and approvals, which is estimated to be in late 2026/early 2027, avoiding large summer swells. Once approvals are issued and the construction company is contracted, on-site construction activities (deployment) are expected to take two to four weeks.

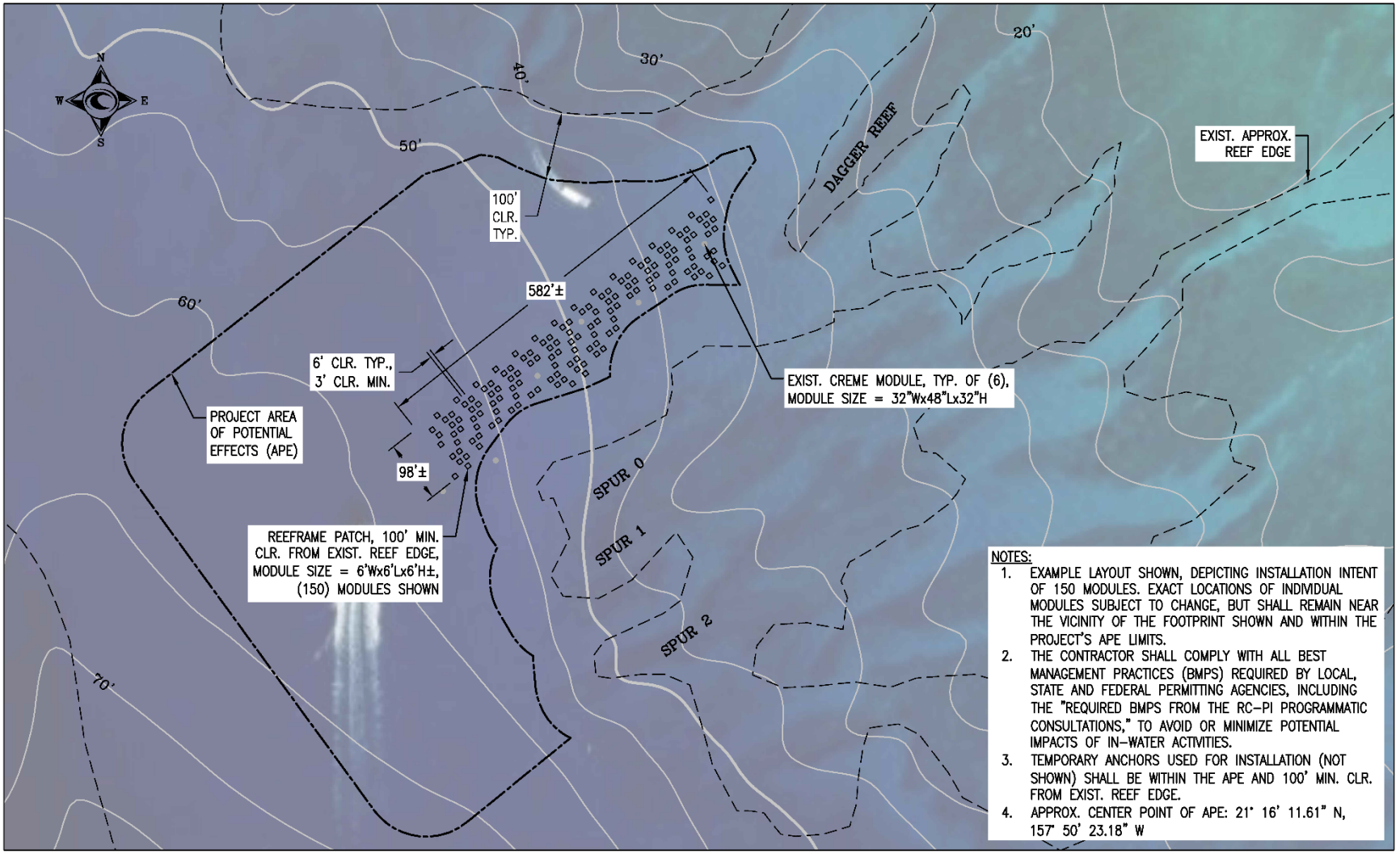


Figure 6: Potential REEFrame Site Plan

2.4 Project Alternatives

2.4.1 Location Alternatives

To select a preferred site for REEFrame, the project team (1) evaluated available geospatial data spanning an area from Kewalo Basin (offshore of Kewalo Harbor) to Kaimana (offshore of Diamond Head), (2) identified eight candidate sites for consideration, and (3) physically inspected candidate sites located in areas suitable for construction of the nursery and adjacent to natural reefs suitable for coral restoration activities.

The geospatial analysis included the following data layers: depth and bathymetry, bottom type, benthic habitat, wave climate, water quality classification and vessel traffic, as well as proximity to marine managed areas, ahupua'a boundaries, and bodysurfing, surfing, and dive sites. Eight candidate sites were identified from this initial geospatial analysis: five deep water (50-60 ft) and three shallow water (40-50 ft). From west to east, the candidate sites included Kewalo Basin, Magic Island, Rockpiles, Halekulani West, Halekulani East, Halekulani Dagger, Castles, and Kaimana. See Figure 7 for a map of the candidate sites and chosen location. All candidate locations adhered to the three essential criteria discussed in Section 2.3.2, Project Area, but required in-water surveys to ground truth the geospatial data.

Exploratory dives were conducted at each of the eight candidate sites to evaluate the physical and biological characteristics at each location to determine which site provides the most optimal conditions. Two sites, Halekulani Dagger and Halekulani East, were combined as "Halekulani" and selected as the preferred location to install the REEFrame modules. The preferred location was selected because it exhibits several high-preference features including sandy, unconsolidated seafloor, low biological cover, proximity to a reef with high restoration potential, has been previously studied in the CReME project, is centrally located in the Waikīkī region, and is at depths ideal for coral restoration activities without affecting nearby surf spots and other human activities.

While the other sites had some of the benefits mentioned above, the tradeoffs with conflicting conditions such as higher boat traffic, heavy recreational use such as surfing and paddling, low proximity to coral cover, and/or high abundance of algal beds lowered their restoration suitability.

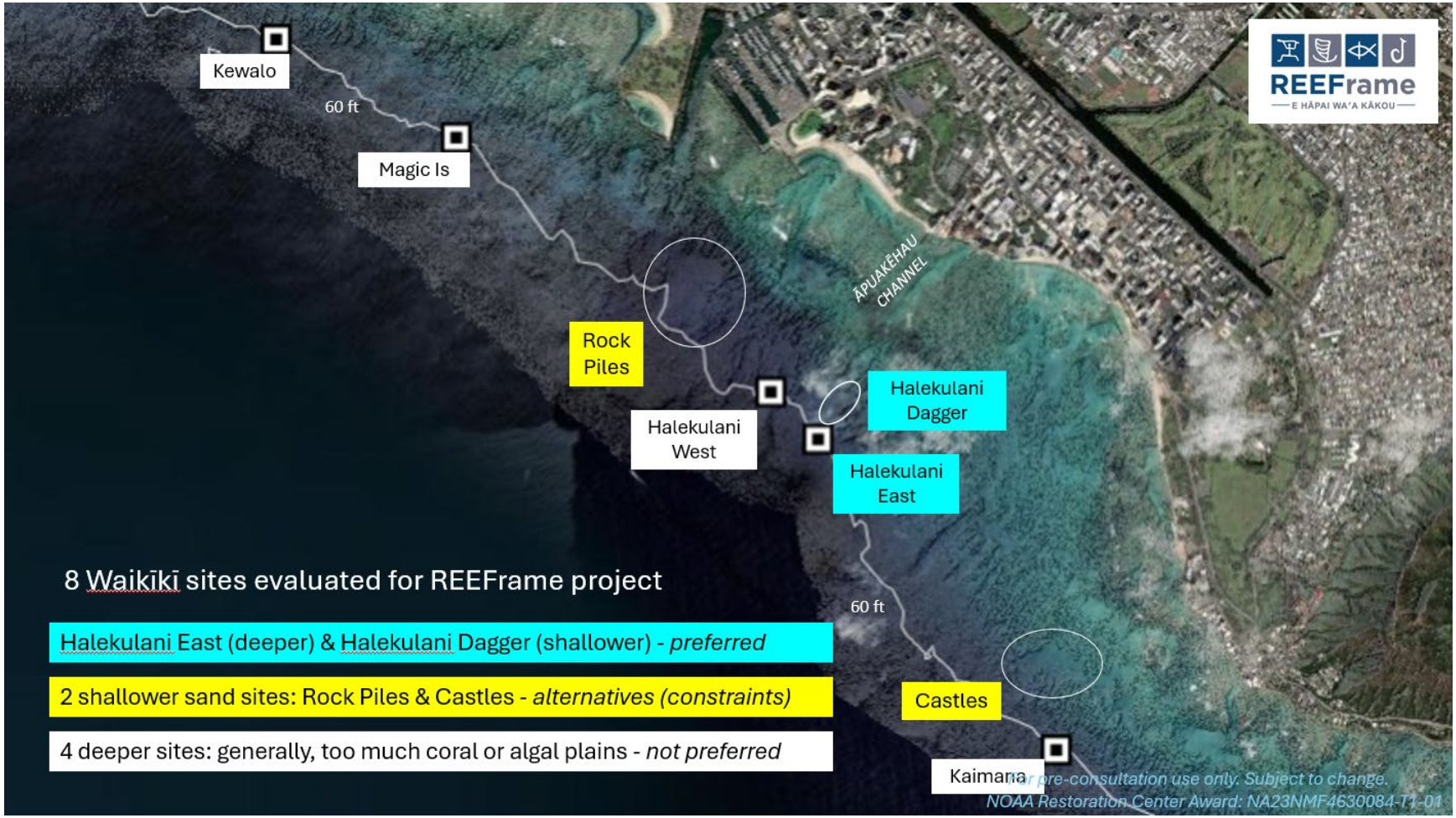


Figure 7: Preferred, Alternative, and Not Preferred Sites

2.4.2 Coral Reef Restoration Alternatives

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Office of Habitat Conservation's Restoration Center (NOAA RC) prepared a Programmatic Environmental Impact Statement (PEIS) to evaluate coastal habitat restoration activities through its existing programmatic framework and related procedures. Projects implemented by NOAA RC vary in terms of their size, complexity, geographic location, and NOAA involvement, and they often benefit from a wide range of habitat types and affect several different species. NOAA RC project types include fish passage, hydrologic/tidal reconnection, shellfish restoration, coral recovery, salt marsh and barrier island restoration, erosion prevention, debris removal, and invasive species removal.[22]

The PEIS identified a range of physical and biological coral restoration techniques for shallow benthic coral communities, specifically coral communities characterized by consolidated hard substrates. A range of six coral techniques are listed below. The two techniques that align with the preferred REEFrame alternative are italicized.

- Propagating a genetically and species-rich collection of coral fragments in nurseries, with an emphasis on threatened and endangered species
- Implementing erosion control techniques to stabilize sediment
- Managing invasive species (invasive fish and algae) through removal and appropriate maintenance techniques
- Improving infrastructure such as aids to navigation or mooring buoys, or enhancements to piloting operational capabilities
- *Transplanting (outplanting) coral fragments from nursery or an impacted location to appropriate targeted locations*
- *Re-attaching or moving broken corals or stabilizing rubble substrates in areas impacted by events such as vessel groundings or storms, sometimes in conjunction with proactively relocating corals to more appropriate locations, which may include a coral nursery.*[23]

[22] NOAA RC. (2015). *Final NOAA Restoration Center programmatic environmental impact statement.* https://www.fisheries.noaa.gov/resource/document/restoration-center-programmatic-environmental-impact-statement

[23] NOAA RC. (2015). *Final NOAA Restoration Center programmatic environmental impact statement.* https://www.fisheries.noaa.gov/resource/document/restoration-center-programmatic-environmental-impact-statement

The REEFrame project is closely aligned with the last two techniques, which describe coral reef restoration activities that include creating or re-creating reef relief through transplant and re-attachment of coral fragments. These activities restore the structure and favorable conditions that allow recruitment, growth, and survival of corals, sponges, live rock, and other reef organisms.

The other four alternative techniques do not meet project objectives or are not applicable to the project location or environment.

2.4.3 No-Action Alternative

The No-Action Alternative will allow the continuation of significant losses of coral reefs and thus unchecked degradation of the overall health of the benthic environment and associated species along the Waikīkī coastline. Coral restoration has a positive benefit on both the aquatic ecology and the uniquely diverse culture of Waikīkī. No-Action will inhibit the revitalization of historic meaning and cultural practices connected to reefs and the ocean environment.

In the long-term, the No-Action Alternative has a detrimental effect on future measures to restore healthy reefs throughout the Hawaiian Islands. The REEFrame project serves as an ecological template for future reef restoration efforts throughout Hawai‘i. The No-Action Alternative will delay a crucial step in supporting the greater marine ecosystem, which is a part of the social and cultural conditions that make Hawai‘i unique.

3. AFFECTED ENVIRONMENT, POTENTIAL IMPACTS, AND PROPOSED MITIGATION MEASURES

This section discusses existing conditions, potential impacts and proposed mitigation measures for the physical and natural environment, natural hazards, ecological resources, the human environment, and public services and facilities.

3.1 Physical and Natural Environment

3.1.1 Climate

3.1.1.1 Existing Conditions

The Hawaiian Island chain, located in the Pacific Ocean, is one of the most remote land masses on earth. Due to the stabilizing effects of the surrounding ocean and a relatively small seasonal variation in energy received from the sun, seasonal temperature variation at sea level tends to be less than 15 degrees Fahrenheit (°F).[24]

A large eastern Pacific semi-permanent high-pressure system north of Hawai‘i dictates much of the air circulation patterns and climate of the region. This high-pressure system produces northeasterly winds, called trade winds, over the Hawaiian Islands. Trade winds are most prevalent between May to September.[25] From October through April, the high-pressure system moves south, and the prevalence of the trade winds decreases.[26] During these months, storm systems often pull winds from all directions, and Kona (southwest) wind inversions bring southwesterly winds to the islands.

Hawai‘i’s complex topography drives localized wind interactions, making Hawai‘i one of the most highly spatially diverse climate patterns on the planet. Hawai‘i is divided into twelve distinct climate regions, two of which are found on O‘ahu – the Wai‘anae and Ko‘olau climate divisions.[27] Each region is distinguished by differing rainfall patterns and seasonality, as well as interannual and decadal

[24] Western Regional Climate Center. (n.d.). *Honolulu Intl AP, Hawaii - Climate summary.* Retrieved March 8, 2026, from https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?hi1919

[25] City and County of Honolulu. (2025). *2025 Local Hazard Mitigation Plan,* Chapter 20: Windstorm. https://www.honolulu.gov/dem/wp-content/uploads/sites/64/2025/07/Chapter-20.pdf

[26] City and County of Honolulu. (2025). *2025 Local Hazard Mitigation Plan,* Chapter 20: Windstorm. https://www.honolulu.gov/dem/wp-content/uploads/sites/64/2025/07/Chapter-20.pdf

[27] Luo et al. (2024). Routine climate monitoring in the state of Hawai‘i: establishment of state climate divisions. *Bulletin of the American Meteorological Society, 105*, E1049. https://doi.org/10.1175/BAMS-D-23-0236.1

variability. Hawai‘i’s climate tends to have two 6-month seasons: a cooler wet season (November – April) and a warmer dry season (May – October).

The project area, located offshore of Honolulu on the Leeward side of O‘ahu, is located within the Wai‘anae climate division.[28] The average annual rainfall at the project area is approximately 23.5 inches per year, with the most rain occurring between November and March. In Honolulu, relative humidity is approximately 70%,[29] with an average temperature of 74.7°F that remains relatively stable throughout the year.[30]

3.1.1.2 Potential Impacts and Proposed Mitigation Measures

The Proposed Action will not impact climate in the area and no mitigation is required.

3.1.2 Geology and Soils

3.1.2.1 Existing Conditions

The island of O‘ahu was formed by basaltic lava flows from the Wai‘anae and Ko‘olau shield volcanoes that erupted 4.3 to 1.78 million (M) years ago.[31] The Ko‘olau lavas are divided into Ko‘olau Basalt and Honolulu Volcanics. The Ko‘olau Basalt primarily consists of Pliocene-aged shield stage

[28] Luo et al. (2024). Routine climate monitoring in the state of Hawai‘i: establishment of state climate divisions. *Bulletin of the American Meteorological Society, 105*, E1049. https://doi.org/10.1175/BAMS-D-23-0236.1

[29] Giambelluca, T. W. et al. (2014). *Evapotranspiration of Hawai‘i.* [Final report submitted to the U.S. Army Corps of Engineers – Honolulu District and the Commission on Water Resource Management, State of Hawai‘i]. University of Hawai‘i at Mānoa. https://www.hawaii.edu/climate-data-portal/evapotranspiration-atlas/

[30] Giambelluca, T. W. et al. (2014). *Evapotranspiration of Hawai‘i.* [Final report submitted to the U.S. Army Corps of Engineers – Honolulu District and the Commission on Water Resource Management, State of Hawai‘i]. University of Hawai‘i at Mānoa. https://www.hawaii.edu/climate-data-portal/evapotranspiration-atlas/

[31] Sherrod, D. R. et al. (2021). *Geologic Map of the State of Hawai‘i* (Scientific Investigations Map 3143, Sheet 2). U.S. Geological Survey. https://doi.org/10.3133/sim3143

tholeiitic basalt. This is what underlies the project area, topped by terrestrial and marine deposits which form a dense caprock layer.[32] Figure 8 presents a geologic map of O'ahu.[33]

The REEFrame project will be deployed offshore of Waikīkī, O'ahu. The seafloor in the area is composed of limestone pavement, formed by the fossilization of coral reefs during the Pleistocene epoch.[34] This limestone pavement substrate is covered by patches of marine carbonate sand interspersed with coral rubble. Halekulani, the planned project site, is located where unconsolidated sand has accumulated at the mouth of the 'Āpuakēhau Channel that was dredged through the limestone pavement.[35]

Additional geologic resources in the surrounding area include living coral reefs, coral fragments, and gravel to boulder-sized rock formations.

3.1.2.2 Potential Impacts and Proposed Mitigation Measures

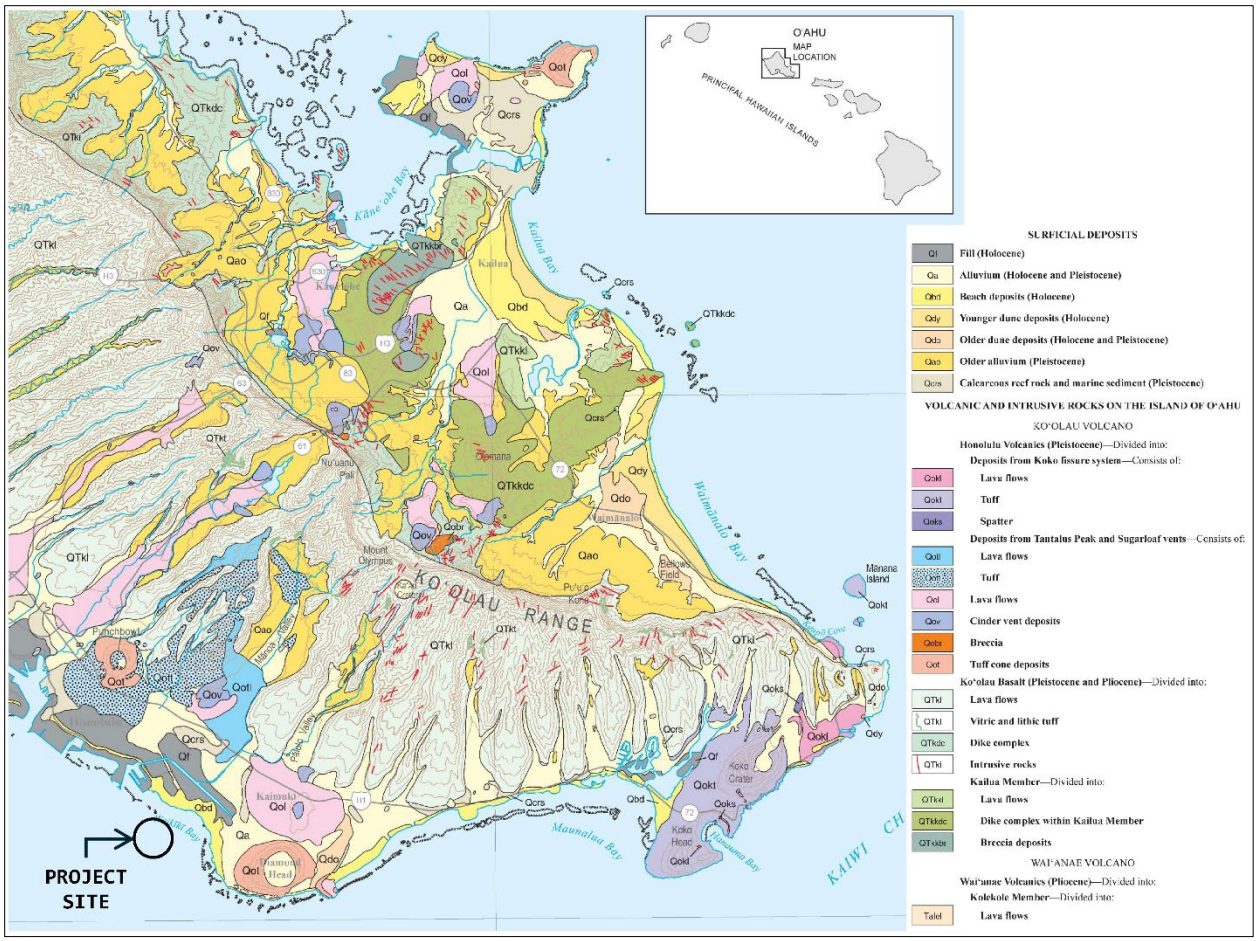
During deployment, REEFrame modules will be lowered in a controlled manner onto unconsolidated carbonate sand sediment where other geologic resources are absent. Long-term impacts to these resources will be limited to the project footprint area. Larger geological resources such as rocks, boulders, and non-living corals are not present within the selected project site, and no impacts to these resources are expected to occur.

[32] Stearns, H. T. (1939). *Geologic map and guide of the island of Oahu, Hawaii* (Bulletin 2). Hawai'i Division of Hydrography. https://pubs.usgs.gov/unnumbered/70099108/report.pdf

[33] Sherrod, D. R. et al. (2021). *Geologic Map of the State of Hawai'i* (Scientific Investigations Map 3143, Sheet 2). U.S. Geological Survey. https://doi.org/10.3133/sim3143

[34] Stearns, H. T. (1935). Pleistocene Shore Lines on the Islands of Oahu and Maui, Hawaii. *GSA Bulletin* 46(12), 1927-56. https://doi.org/10.1130/GSAB-46-1927

[35] Coastal Geology Group, University of Hawai'i at Mānoa. (2013). *Royal Hawaiian Beach: Replenishment, Monitoring, and History of Engineering, interim report year 1* (University of Hawai'i). https://dlnr.hawaii.gov/occl/files/2013/08/REPORT-Royal-Hawaiian-Beach-6_13.pdf



Source: Sherrod et al., 2021. https://doi.org/10.3133/sim3143

Figure 8: Geologic Map of O'ahu

3.1.3 Hydrogeology and Water Resources

3.1.3.1 Existing Conditions

The hydraulic properties of aquifers in Hawai'i are determined by the lava flows that formed them. Layers of volcanic rock with varying permeability and geometry cause water to move through the ground in a highly localized fashion.[36] On O'ahu, aquifers contain shallow freshwater and deep saltwater, which mix at their boundary layer. Freshwater generally flows through the aquifer with gravity, from higher inland elevations to lower coastal elevations. Saltwater flow into the aquifer is driven by the hydraulic gradient, which is affected by changes in sea level and the volume of overlying freshwater.

[36] Hunt, C. D., Jr. (1996). *Geohydrology of the island of Oahu, Hawaii.* (U.S. Geological Survey Professional Paper 1412-B). U.S. Geological Survey. https://pubs.usgs.gov/pp/1412b/report.pdf

The project area is located offshore of southern O'ahu within the Honolulu sector of the Ko'olau Basalt regional aquifer system. The Ko'olau Basalt is a volcanic rock aquifer, which contains overlying deposits formed of weathered volcanic rocks, reef limestone deposits, and terrestrial and marine sediments in the Honolulu sector. These deposits form a dense caprock layer over 900 ft thick that impedes fresh groundwater discharge to the coast and drives the formation of a freshwater lens behind the Honolulu coastline.[37] Interactions between freshwater held within the lens, the caprock, and ocean depend on localized caprock permeability and how freshwater moves underneath the caprock layer. Freshwater leaves the aquifer as either subaerial (shoreline) or submarine discharge by traveling below the overlying caprock or can discharge as surface water by seeping into streams that meet the ocean.

The nearshore of Waikīkī comprises a fringing fossil limestone reef that extends offshore for about one mile and is intersected by several ancient stream channels.[38] During the construction of the Ala Wai Canal in the 1920s, freshwater streams that once flowed to the ocean at Waikīkī were permanently diverted to the Ala Wai Canal and springs in the surrounding wetlands of Honolulu were filled with material dredged during canal construction.[39] These actions significantly altered surface freshwater resources in the area.[40]

3.1.3.2 Potential Impacts and Proposed Mitigation Measures

Neither short- nor long-term impacts on hydrogeology and water resources are anticipated due to the Proposed Action. Project activities will involve placing reef modules on existing unconsolidated marine sediments in the project area. The modules resting on the seafloor are not expected to impact subaerial or submarine freshwater discharge at the project site. The Proposed Action does not involve drilling into or through the caprock layer and, thus, does not pose a risk of contaminating the underlying aquifer or increasing freshwater discharge from it. Since the project site is located offshore, there will be no impact on surface water resources.

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[37] Gingerich, S. B., & Oki, D. S. (2000). *Ground Water in Hawaii: U.S. Geological Survey Fact Sheet 126-00*. U.S. Geological Survey. https://pubs.usgs.gov/fs/2000/126/pdf/fs126-00.pdf

[38] Miller, T. L., & Fletcher, C. H. (2003). Waikiki: Historical analysis of an engineered shoreline. *Journal of Coastal Research*, *19*(4), 1026-1043. https://dlnr.hawaii.gov/occl/files/2013/08/Miller-2003-JCR-Waikiki-Historical.pdf

[39] Wiegel, R. L. (2008). Waikiki Beach, Oahu, Hawaii. *Shore & Beach*, *63*(4), 34-36. https://dlnr.hawaii.gov/occl/files/2013/08/Wiegel-2008-ShoreAndBeach-Waikiki-history.pdf

[40] Coastal Geology Group, University of Hawai'i at Mānoa. (2013). *Royal Hawaiian Beach: Replenishment, Monitoring, and History of Engineering, interim report year 1* (University of Hawai'i). https://dlnr.hawaii.gov/occl/files/2013/08/REPORT-Royal-Hawaiian-Beach-6_13.pdf

3.1.4 Ocean Water Quality

3.1.4.1 Existing Conditions

The United States (U.S.) Environmental Protection Agency (EPA) establishes pollutant control regulations under the Clean Water Act (CWA) to protect surface waters from contamination. Under the CWA, unpermitted discharge of point source pollution into navigable waters of the U.S. is unlawful. The EPA also requires states and territories to control nonpoint source pollution to coastal waters under the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990. In Hawai'i, compliance to and enforcement of the CWA is managed by the State.

Pursuant to CWA obligations, the Hawai'i State Department of Health (DOH) publishes a report on statewide water quality every two years. To inform the report, DOH conducts regular water quality testing at sites around the State and compares the results to numeric water quality criteria defined in HAR 11-54. Sites that regularly do not meet water quality criteria are defined as impaired water bodies. The project site is located offshore of the Gray's Beach Assessment Unit (HI941499). Gray's Beach is listed in the 2024 Water Quality Report as an impaired water body due to excess Total Nitrogen, Turbidity, and Chlorophyll a.[41] Based on an assessment by the DOH, Gray's Beach is also listed as a low priority site for Total Maximum Daily Load (TMDL) development to restore water quality.

The project area is classified as (a) Class A open coastal waters, and (b) Class II nearshore reef flat, as described in Chapter 11-54 of the Hawai'i Administrative Rules (HAR).[42] Figure 9 depicts the marine classification at the project site.[43] HAR 11-54-3 states that "it is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected".[44] Any other use is permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on the water. Class A waters may not act as receiving waters for any discharge which has not received the best degree of treatment or control. HAR 11-54-7 also

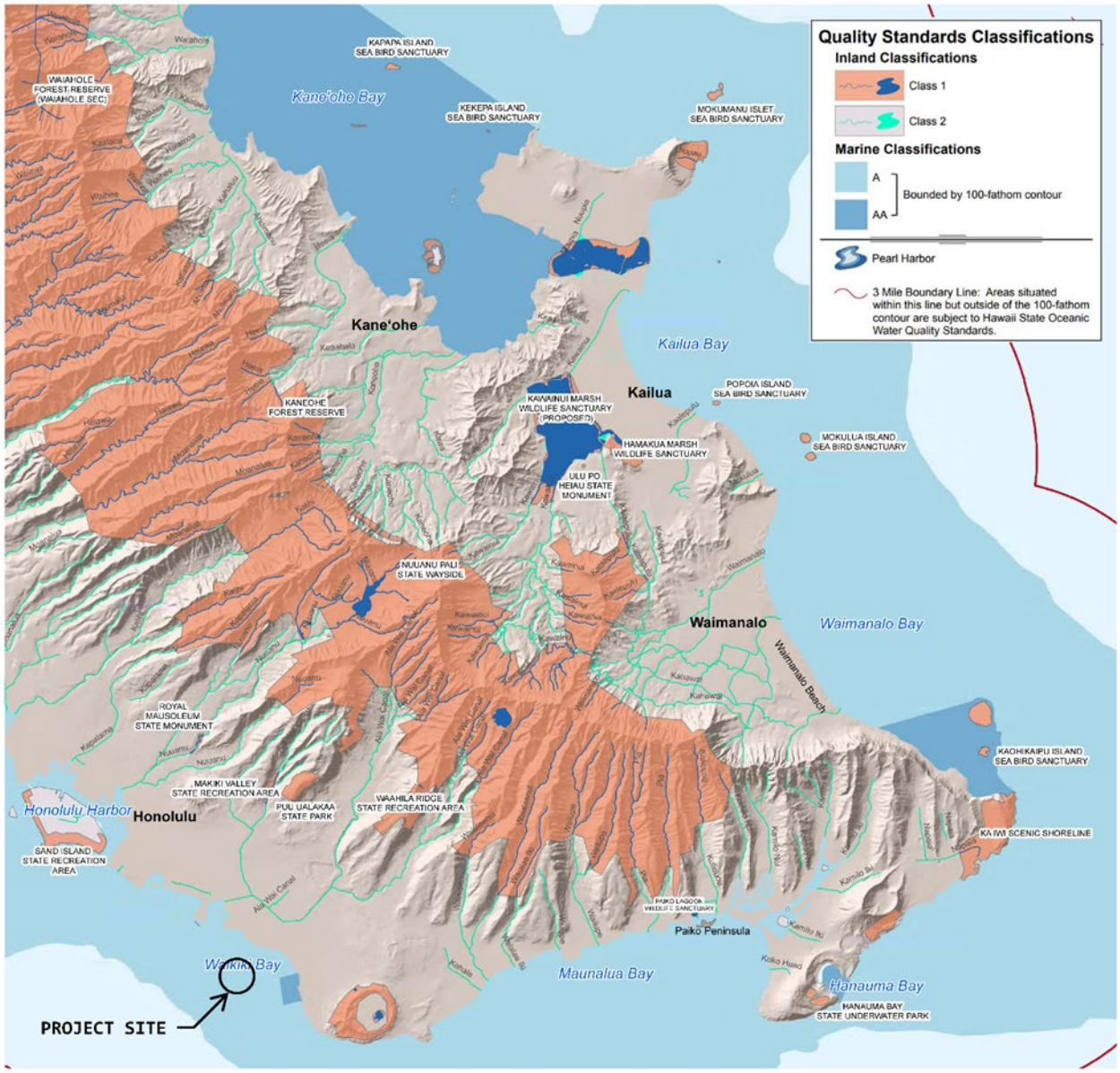
[41] DOH. (2024). *2024 State of Hawai'i water quality monitoring and assessment report: Draft* (Appendix C-15). Clean Water Branch. https://health.hawaii.gov/cwb/files/2024/02/IR-2024-public-comment-draft.pdf

[42] DOH. (2021). *Hawai'i Administrative Rules: Water Quality Standards* (Title 11, Chapter 54). https://health.hawaii.gov/cwb/files/2022/01/HAR-11-54-October-22-2021.pdf

[43] DOH. (2014). *Water Quality Standards Map of the Island of O'ahu: Draft* (p. 1). https://health.hawaii.gov/cwb/files/2013/05/WQS_20140708_Oahu_Reduced.pdf

[44] DOH. (2021). *Hawai'i Administrative Rules: Water Quality Standards* (Title 11, Chapter 54). https://health.hawaii.gov/cwb/files/2022/01/HAR-11-54-October-22-2021.pdf

establishes that no action may be taken that would substantially risk damage, impairment, or alteration of the biological characteristics of a reef flat.[45]



Source: DOH, 2014. https://health.hawaii.gov/cwb/files/2013/05/WQS_20140708_Oahu_Reduced.pdf

Figure 9: Water Quality

[45] DOH. (2021). *Hawai'i Administrative Rules: Water Quality Standards* (Title 11, Chapter 54). https://health.hawaii.gov/cwb/files/2022/01/HAR-11-54-October-22-2021.pdf

3.1.4.2 Potential Impacts and Proposed Mitigation Measures

Project activities will include transporting REEFrame modules to the site by barge, using heavy equipment to place the modules on the seafloor carefully, and periodically returning to the site to transplant and monitor corals. Effective BMPs will prevent and minimize short and long-term construction and maintenance-related impacts. The following applicable BMPs will be required, as advised through a Programmatic Consultation process completed by the NOAA Office of Habitat Conservation (NOAA OHC) with the NOAA Pacific Islands Reginal Office (NOAA PIRO):

General BMPs

- Fueling of land-based vehicles and equipment shall take place at least 50 meters (m) away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
- Chemicals that are toxic/not marine-safe are excluded from use under this programmatic BMP unless explicitly discussed and described in the activity descriptions in section 3.
- All required Federal, State, and local permits will be in place before implementation of any RC-PI activities.

Vessel Operations and Anchoring

- Vessels used in implementing activities must meet all EPA Vessel General Permit and Coast Guard requirements for the control of pollution from air emissions, vessel discharges, and trash.
- A contingency plan to control toxic materials will be required. A hard copy of the plan will be available on board the vessel and will be discussed with all personnel to ensure quick response in case of spills, fires or materials unintentionally entering the water column.
- Appropriate materials to contain and clean potential spills will be stored on the vessel or on the worksites and be readily available.
- Operations will only occur during preferable ocean conditions with contingency plans to cancel or delay the action for favorable weather conditions.
- No trash or debris will be thrown overboard.
- All objects and equipment will be lowered to the bottom in a controlled manner. This can include the use of equipment, divers, or buoyancy controls such as lift bags that affect positive control over the rate of descent.

Bottom Sediment Disturbing Activities

- Turbidity and siltation from project-related work shall be minimized and contained through the appropriate use of erosion control practices, effective silt containment devices, the curtailment of work during adverse weather and tidal/flow conditions, and slow, gentle deployment of structures onto the seafloor.

- If operations are anticipated to increase sedimentation or suspended material longer than 24 hours, a plan will need to be submitted outlining actions to avoid impacts to coral spawning and recruitment.

With appropriate adherence to these BMPs, any direct impacts to water quality arising from the Proposed Action are anticipated to be minimal and short-term. In the long term, coral reef restoration can improve water quality by fostering healthier ecosystems that act as natural filters and remove particulate matter and impurities from the surrounding water. In addition, rebuilding coral structures can help reduce nutrient pollution, trap sediment, and increase oxygenation in the water. Overall, the Proposed Action is not anticipated to directly impact water quality to a level that would harm marine life or endanger public health in the project site or surrounding area.

3.1.5 Ocean Currents

3.1.5.1 Existing Conditions

Offshore tidal currents in Waikīkī, including the REEFrame site, generally flow westward during rising tides and eastward during falling tides, often exceeding one knot. Inshore currents are weaker than currents occurring further offshore. These currents are part of a mixed tidal system with two daily highs and lows, and with spring tides rarely exceeding 3 ft. The surface currents are influenced by wind speed and direction, creating eddies when wind counters tidal flow and a smoother sea state when blowing in the same direction.

Wave-induced currents predominate inside the breaker zone. Nearshore currents inside the breaker zone at Waikīkī are primarily characterized by calm conditions, with localized, stronger rip currents during high surf. The preferred REEFrame site is outside the breaker zone.

3.1.5.2 Potential Impacts and Proposed Mitigation Measures

The REEFrame structures will be deployed at a depth of 40 to 60 ft, which is outside the breaker zone. The impact of REEFrame structures on tidal currents will not be significant, since the height of the structures is only about 6 ft above seafloor. The proposed project will not impact the mean currents in far fields or nearshore currents inside the breaker zone.

3.1.6 Bathymetry

3.1.6.1 Existing Conditions

The project area is adjacent to ʻĀpuakēhau Channel and seaward of what scientists call Dagger Reef. A bathymetric map of the project vicinity is shown in Figure 10. The elevation contours are generated from the 2013 U.S. Army Corps of Engineers (USACE) lidar data. The nearshore bathymetry at Waikīkī Beach features shallow fossil reef bisected by paleo stream channels, and water depth generally 5 ft or less. The seafloor gradually transitions to deeper water from seaward of the surf zone to a depth of 40 ft, with a slope less than 2%. Between the 40 and 60 ft depth contours, bottom slope increases, so the project site has a seafloor slope of about 4%.

3.1.6.2 Potential Impacts and Proposed Mitigation Measures

Long-term impacts to bathymetry and seafloor conditions will be limited to the actual footprint of the REEFrame structures. They will not alter the bathymetry of the surrounding seafloor and no mitigation is required.

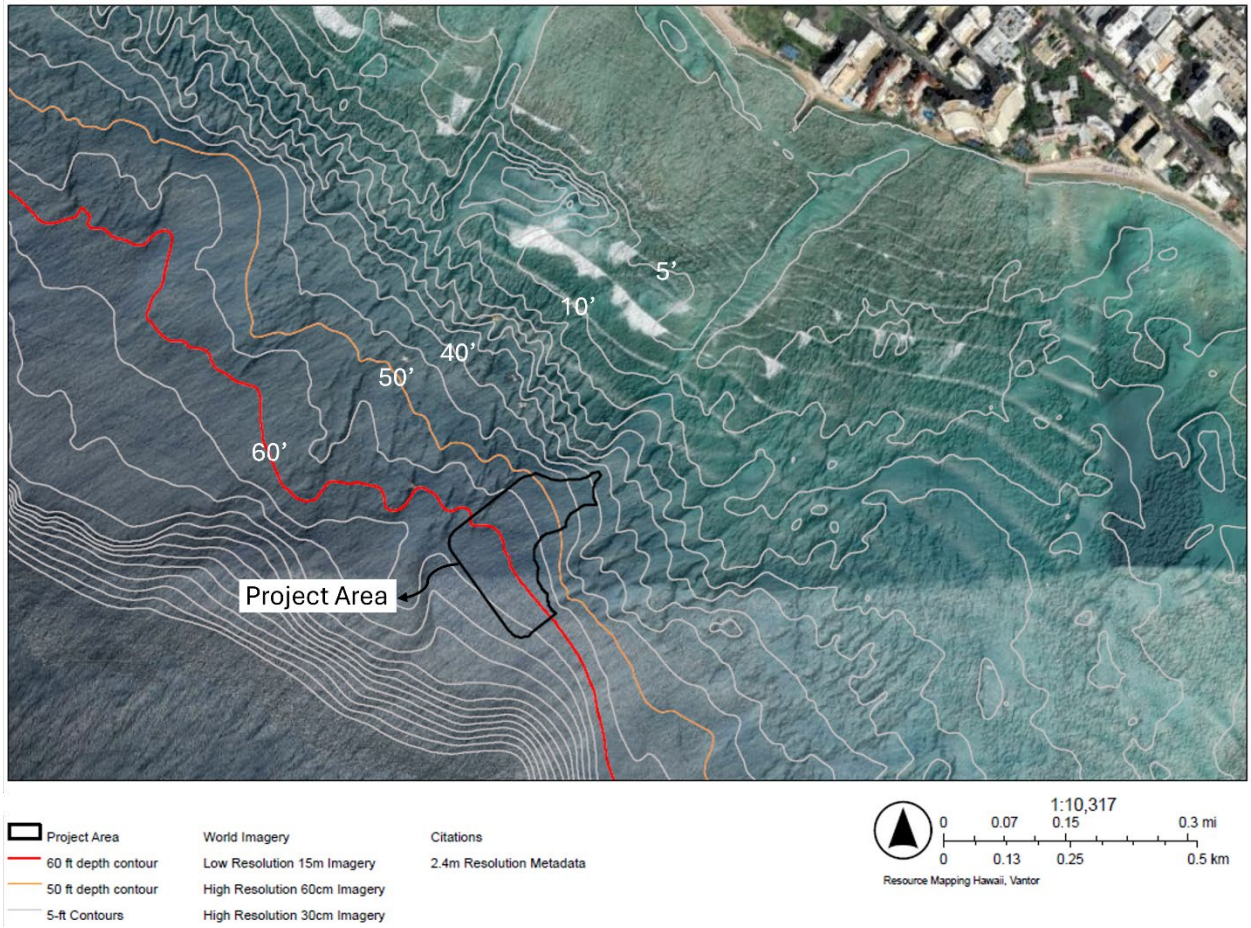


Figure 10: Bathymetry Map of Project Vicinity

3.1.7 Marine Biological Resources

3.1.7.1 CReME surveys

The REEFrame Project is grounded in the foundational research conducted by Dr. Mark Hixon and graduate students at the University of Hawai'i at Mānoa through the CReME project which is discussed in Section 2.2.

Concrete modules, each approximately one cubic yard in volume and fabricated in low and high-shelter configurations, were deployed offshore of Waikīkī Beach within the REEFrame APE in the summer of 2016. Between 2016 and 2023, the modules were monitored quarterly for marine resources including corals, algae, fishes, and benthic invertebrates. The CReME project provided a feasibility study that greatly increased our understanding of how reef nursery structures in the project area may support populations of marine resources.

Overall results demonstrated that the concrete modules provided suitable and durable settlement surfaces for corals, and that modules with high structural complexity supported greater biomass of fishes and sea urchins. Although overall herbivorous fish density was found to be low relative to healthier reef systems in Hawai'i, fish abundance and diversity was greater in areas where shelter was available. Benthic invertebrates were found to be diverse but low-density, and a higher biomass of sea urchins was recorded on high-shelter modules. Turf algae was observed to overgrow newly settled corals on the CReME modules, yet a substantial number of colonies survived and are now larger than and safe from the surrounding turf. There was a slight but insignificant decrease in algal overgrowth on the high-shelter modules at Waikīkī. Larger coral fragments (>30cm) exhibited high survivorship and grew successfully when attached to stable module substrate. Mortality of CoOs was primarily associated with predation by cushion stars (*Culcita novaeguineae*).

In summary, the CReME project demonstrates that outplanting CoOs in the project area is a viable coral reef restoration approach. It supports the expectation that the REEFrame project will enhance the surrounding natural environment by providing high-shelter habitat for reef-associated invertebrates and fish, while also acting as a platform for CoO seeding and natural coral recruitment.

3.1.7.2 REEFrame Benthic Survey

A benthic study was prepared for Conservation International (CI) and is contained in Appendix A. DAR personnel surveyed the REEFrame APE on October 22nd, 2025, for habitat type, complexity, and composition. Divers conducted roving 20-meter swath surveys along bearings crossing the APE, marking notable features such as coral colonies on Global Positioning System (GPS). Fish species observed within the 20-meter swaths were also recorded. A total of 23,020 m^2, or 50% of the APE, was surveyed.

Overall habitat complexity across the majority of the area was determined to be low. There was no evidence of continuous reef framework, high-relief substrate, or structurally complex benthic habitat within areas identified for potential module placement. The benthic habitat was found to be

dominated by unconsolidated sandy sediment, featuring small and isolated patches of coral structure. Sparse, patchy coverage of *Halimeda kanaloana* algae and occasional *Avrainvillea erecta* was noted. Six coral colonies belonging to two coral species (*Pocillopora meandrina* and *Porites lobata*) were observed within the APE, with overall coral cover measured at less than 1%. Of these six coral colonies, two were small (<20cm), one was medium (20-50cm) and two were large (>50cm). The two large colonies, both identified as *Porites lobata*, were about 1 meter in size and located near areas of relatively high coral cover. These locations were marked and are noted as areas to avoid for REEFrame module placement. A total of 12 fish species were observed during the survey and comprise common species that inhabit sandy bottom habitats across O'ahu.

3.1.7.3 ESA Section 7 and EFH Review

The Information for Planning and Consultation (IPaC) is a project planning tool provided by U.S. Fish and Wildlife Service (USFWS). The tool was applied to initially identify listed species, critical habitat, migratory birds and other natural resources managed by USFWS within the REEFrame project APE prior to a formal consultation process. Table 2 lists the IPaC findings accessed on April 10, 2026.

Table 2. IPaC Findings Within the REEFrame APE

	Scientific Name	Common Name	Listing Status
Birds	*Hydrobates castro*	Band-rumped Storm-petrel	Endangered
	Pterodroma sandwichensis	Hawaiian Petrel	Endangered
	Puffinus newelli	Newell's Shearwater	Threatened
	Phoebastria (=Diomedea) albatrus	Short-tailed Albatross	Endangered
Reptiles	*Eretmochelys imbricata*	Hawksbill Sea Turtle	Endangered
Critical Habitats	There are no critical habitats at this location		
National Wildlife Refuge Lands	There are no refuge lands at this location		
Fish Hatcheries	There are no fish hatcheries at this location		

It is noted that the species and critical habitats using IPaC solely refer to the species managed by USFWS and do not include the species and critical habitats managed by NOAA Fisheries

Listed Species Managed by NOAA Fisheries

In designated areas of the Main Hawaiian Islands, critical habitat for Hawaiian monk seals (*Neomonachus schauinslandi*) includes the marine environment with a seaward boundary that extends from the 200-meter depth contour line (relative to mean lower low water), including the seafloor and all subsurface waters and marine habitat within 10 meters of the seafloor, through the water's edge 5 meters into the terrestrial environment. Proposed critical habitat for green sea turtles (*Chelonia mydas*) includes the marine environment from the mean high water line to 20 m depth.

Table 3: Federally Listed Species Managed by NOAA Fisheries within the REEFrame APE

Species/Common Name	ESA Status	Effective Listing Date/Federal Register (FR) Notice	Critical Habitat
Chelonia mydas Central North Pacific Green Sea Turtle	Threatened	05/06/2016 81 FR 20057	Proposed 07/19/2023 88 FR 46572
Neomonachus schauinslandi Hawaiian Monk Seal	Endangered	11/23/1976 41 FR 51612	9/21/2015 (revised) 80 FR 50925
Eretmochelys imbricata Hawksbill Sea Turtle	Endangered	06/03/1970 35 FR 8491	-

Additional federally protected marine species known to occur in the region include spinner dolphins (*Stenella longirostris*). Coral species also occur in the area and are protected by Hawai'i State regulations, but no coral species that occur in the Main Hawaiian Islands are currently federally listed.

Essential Fish Habitat Designations

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (Section 305(b)(2)) mandates that federal agencies conduct an essential fish habitat (EFH) consultation with NOAA NMFS PIRO regarding any of their actions authorized, funded, or undertaken that may adversely affect EFH. An adverse effect refers to any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat wide impacts including individual, cumulative, or synergistic consequences of actions.

Under Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH conservation recommendations to federal and state agencies for actions that will adversely affect EFH. EFH is

defined as those waters and substrate necessary for federally managed species to spawn, breed, feed, and/or grow to maturity. In general, the life stages of Management Unit Species (MUS) found within the water column in the Pacific Region include eggs, larvae, juveniles, and adults of various MUS. EFH is described in detail in the Western Pacific Regional Fishery Management Council's (WPRFMC's) Fishery Ecosystem Plans (FEPs), available on their website.

While EFH is designated throughout a wide range of habitats that contain an extraordinary diversity of biological organisms, corals and submerged aquatic vegetation are particularly vulnerable to many types of adverse effects; and the habitats that they form (coral reefs and seagrass beds) are slow growing and hard-to-replace. In addition to being designated as EFH, these habitats are "special aquatic sites" (Clean Water Act in 40 CFR 230 Subpart E), and both habitats have widely known critical functions in many or various life stages of multiple MUS. Uncolonized hard bottoms and hard surfaces are also important for settlement of new corals, and artificial surfaces that occur in the marine environment as a result of man-made structures often function as a proxy for where coral reefs may have once existed. Due to the ecological functions of these EFH resources and their fragile nature, avoiding and minimizing adverse effects to corals and seagrass is a priority of the EFH Programmatic Consultation. This does not preclude the importance of other resources as important EFH, but they tend to be more tolerant of disturbances and/or recover more quickly. Additionally, the water column is the medium through which marine life processes occur and provides critical habitat functions.

Pursuant to requirements under the Endangered Species Act and the Magnuson-Stevens Act, NOAA's OHC consulted with the NOAA PIRO using the Programmatic Consultation. PIRO concurred that the REEFrame activities fit within the scope of the included activities. Appendix B contains the EFH Consultation Verification Form.

3.1.7.4 Project Impacts and Proposed Mitigation Measures

During project deployment, monitoring, and maintenance, boats may encounter ESA species visiting or transiting the site. To avoid disturbance impacts to listed species, the BMPs will be in place. Appendix B includes required BMPs established through Programmatic Consultations between the NOAA PIRO OHC and the NOAA RC-PI regarding ESA compliance for NMFS-managed species and EFH assessment. Additionally, the project will be placed at least 100ft from coral reef and large corals, including the two large (50 cm) *Porites lobata* colonies located during the DAR survey. If medium (20-50cm) or small (<20cm) live coral colonies are found in the deployment area where modules will be lowered to the bottom in a controlled manner, the team will work with DAR to secure a Special Activity Permit to relocate the corals.

Over the long term, the project is anticipated to provide net ecological benefits by creating reef habitat and providing dimensional structure in an area with limited natural structure, supporting CoO outplants, enhancing habitat for natural colonization by corals, reef-associated fishes, and invertebrates, and contributing to broaden coral restoration objectives.

3.1.8 Air Quality

3.1.8.1 Existing Conditions

The U.S. EPA has National Ambient Air Quality Standards (NAAQS) for ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), 2.5-micron and 10-micron particulate matter (PM) ($PM_{2.5}$ and PM_{10}), and airborne lead (Pb). These ambient air quality standards establish the maximum concentrations of pollution considered acceptable for public health and welfare. The State of Hawai'i also has its own set of ambient air quality standards for five of the six criteria pollutants (excluding $PM_{2.5}$) and an additional ambient air quality standard for hydrogen sulfide (H_2S).

The project area is in EPA attainment zones for CO, NO_2, O_3, $PM_{2.5}$, PM_{10}, SO_2, and Pb.[46] EPA attainment designations generally extend 25 miles seaward from a state's boundary. The DOH "State of Hawai'i Annual Summary 2024 Air Quality Data" report, published in September 2025, contains the most recent, publicly available air pollutant data collected at monitoring stations across the State. In 2024, the entire State of Hawai'i was in attainment with the annual NAAQS averages for $PM_{2.5}$, NO_2, SO_2, 24-hour NAAQS average for PM_{10}, 8-hour NAAQS averages for CO and O_3, 1-hour State standard for H_2S, and rolling 3-month NAAQS average for Pb, based on the 2024 average of annual mean values across all 17 air quality stations. There are four air quality stations on O'ahu, two on Maui, ten on Hawai'i Island, and one on Kaua'i, and they all measure different pollutants.

Of the four air quality stations on O'ahu, two are found in Honolulu. The closest air quality station to the project area is the Honolulu Station Air Quality System (AQS) (Number [no.] 150031001). This station is located approximately 2.8 miles northwest of the site on the roof of the State of Hawai'i Department of Health (DOH) building in downtown Honolulu, at an altitude of 20 m above Mean Sea Level (MSL), and measures CO, SO_2, $PM_{2.5}$, and PM_{10}. The tall, dense buildings in downtown Honolulu tend to create city pollution, warmer temperatures, and turbulent winds within the city center; however, these effects are minimized by trade winds. The annual averages from this air quality station during the 2024 calendar year did not exceed attainment, and no sites were in violation of the NAAQS.[47]

The second closest air quality station to the project area is the Sand Island Station (AQS no. 150031004), approximately 3.1 miles northwest of the site. This station is located near the entrance to the Sand Island Recreational Area at an altitude of 5.3 m above MSL, and measures O_3 and $PM_{2.5}$. The Sand Island Station is downwind of the downtown Honolulu Station and closer to the ocean than

[46] EPA. (2014). *Air Quality Analysis: EPA Region 9 Air Quality Maps and Geographic Information.* Retrieved February 2, 2026, from https://www3.epa.gov/region9/air/maps/#regional

[47] DOH. (2025). *State of Hawai'i Annual Summary 2024 Air Quality Data.* rep. State of Hawai'i Department of Health. health.hawaii.gov/cab/files/2025/09/2024_AQ_Databook_final.pdf

the Honolulu Station. Like the Honolulu Station, the annual averages from this air quality station during the 2024 calendar year did not exceed attainment.[48]

During winter months when trade winds are absent and "Kona" winds blow from the southeast, vog from Hawai'i Island can bring increased levels of SO_2 and $PM_{2.5}$ in the event of ongoing activity at Kīlauea volcano. Hawai'i's advisories for volcanic SO_2 and $PM_{2.5}$ have been customized for local conditions. Air monitoring stations in the vicinity of the active Kīlauea Volcano on Hawai'i Island often exceed the NAAQS for SO_2 and occasionally $PM_{2.5}$. The EPA considers activity from the volcano as a natural, uncontrollable event, and therefore, the State requests exclusion from these NAAQS exceedances for attainment/non-attainment determination. Shorter exposure time intervals have also been adopted due to variable wind conditions, which can cause volcanic gas concentrations to change rapidly.

DOH also regulates fugitive dust, which can be released during demolition activities and earth-moving activities, including removal of earth, excavation and fill, debris clearing, and vegetation grubbing.

3.1.8.2 Potential Impacts and Proposed Mitigation Measures

The Proposed Action will not involve any demolition or earth-moving activities, so minimal to no fugitive dust is expected to be generated by short-term construction activities. The contractor will comply with the provisions of HAR §11-60.1-33 on "Fugitive Dust" to keep dust to the lowest levels practicable. Temporary degradation in air quality (e.g., increased levels of CO, nitrogen oxides, volatile organic compounds [VOCs]), and $PM_{2.5}$ and PM_{10} in the immediate project area may occur during construction from emissions from construction equipment (e.g., barges, tugboats, vessels, barge cranes), but is not anticipated to be greater than that created by the existing heavy boat traffic in the area.

To minimize emissions, construction BMPs will be employed throughout the project. The construction contractor shall comply with all BMPs required by local, State and Federal permitting agencies, including the Required BMPs from the NOAA Restoration Center - Pacific Islands (RC-PI) Programmatic Consultations to avoid or minimize potential impacts of in-water activities (Appendix B). These include but are not limited to:

- Fueling of land-based vehicles and equipment shall take place at least 50 meters away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
- Chemicals that are toxic/not marine-safe are excluded from use.

[48] DOH. (2025). *State of Hawai'i Annual Summary 2024 Air Quality Data.* rep. State of Hawai'i Department of Health. health.hawaii.gov/cab/files/2025/09/2024_AQ_Databook_final.pdf

- Vessels used in implementing activities must meet all EPA Vessel General Permit and Coast Guard requirements for the control of pollution from air emissions, vessel discharges, and trash.

- Commercial vessels will be operated by experienced staff who have applicable training and certifications to do so.

- Operational and maintenance standards for vessels will be practiced.

- Operations will only occur during preferable ocean conditions with contingency plans to cancel or delay the action for favorable weather conditions.

- Vessels will follow established transportation channels whenever practicable.

- Fueling operations will be done internally or in designated refueling areas.

- A contingency plan to control toxic materials will be required. A hard copy of the plan will be available on board the vessel, and will be discussed with all personnel to ensure quick response in case of spills, fires or materials unintentionally entering the water column.

- Appropriate materials to contain and clean potential spills will be stored on the vessel or at the work site(s) and be readily available.

- The project manager and heavy equipment operators shall perform daily pre-work equipment inspections for cleanliness and leaks. All heavy equipment operations shall be postponed or halted should a leak be detected, and shall not proceed until the leak is repaired and equipment cleaned.

- All vehicles and other heavy equipment will be (a) operated in a safe manner; (b) stored, fueled and maintained in a vehicle staging area set back from any natural waterbody or wetland; and (c) inspected daily for fluid leaks before leaving the vehicle staging area.

- Generators, cranes, and any other stationary equipment operated within (50 meters of) any natural waterway or wetland will be maintained as necessary to prevent leaks and spills from entering the water.

- The contractor shall use procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities if a spill occurs. Heavy equipment can also leak oil and fluids. Equipment will always be refueled away from stream corridors, and operators will be required to have a spill response plan in place in case of a leak.

No long-term impacts on air quality are expected.

3.1.9 Noise

3.1.9.1 Existing Conditions

Existing ambient noise levels include boats, aircraft, surf, and wind. In proximity of significant construction activity, noise levels can intermittently reach 80 decibels (dBA). The DOH regulates noise per HAR Chapter 11-46, "Community Noise Control," which establishes maximum permissible sound levels shown in Table 4. The rules provide for the prevention, control, and abatement of noise pollution from stationary noise sources and from equipment related to agricultural, construction, and industrial activities. The standards are intended to protect public health and welfare and to prevent significant degradation of the environment and quality of life. The DOH establishes acceptable levels of noise based on the ambient conditions (Class A-C) that would be anticipated in differing land use situations (i.e., Zoning Districts) ranging from residential and business/resort, to industrial conditions.

Table 4: Maximum Permissible Sound Levels in dBA

Zoning Districts	Daytime (7am – 10pm)	Nighttime (10pm – 7am)
Class A	55	45
Class B	60	50
Class C	70	70

Notes:

1) *Class A zoning districts include all areas equivalent to lands zoned for residential, conservation, preservation, public space, open space, or similar type. Class B zoning districts include all areas equivalent to lands zoned for multi-family dwellings, apartment, business, commercial, hotel, resort, or similar type.*
2) *Class C zoning districts include all areas equivalent to lands zoned for agriculture, country, industrial, or similar type.*
3) *The maximum permissible sound levels apply to any excessive noise source emanating within the specified zoning district, and at any point at or beyond (past) the property line of the premises. Noise levels may exceed the limit up to 10% of the time within any 20-minute period. Higher noise levels are allowed only by permit or variance issued under HAR §11-46-7 and §11-46-8.*
4) *For mixed zoning districts, the primary land use designation is used to determine the applicable zoning district class and the maximum permissible sound level.*
5) *The maximum permissible sound level for impulsive noise is 10 dBA (as measured by the "Fast" meter response) above the maximum permissible sound levels shown.*

HAR §11-46-7 grants the Director of the DOH the authority to issue permits to operate a noise source which emits sound more than the maximum permissible levels specified in Table 4 if it is in the public interest and subject to any reasonable conditions. Those conditions can include requirements to employ the best available noise control technology.

While specific dBA levels for open ocean areas are not explicitly listed in general statutes, noise that acts as a public nuisance, or interferes with public rights, is prohibited. The State's Disorderly Conduct Law (HRS §711-1101) defines "unreasonable noise" as one that constitutes a "gross deviation from the standard of conduct that a law-abiding citizen would follow." Recent proposals (HI SB1147) seek

to amend the definition of "unreasonable noise" as sound exceeding 80 dBA when measured from 30 ft away.

Noise produced by vessels, including barges, is regulated by the Department of Land and Natural Resources (DLNR) through the Division of Boating and Ocean Recreation (DOBOR). While there are no specific dBA limits, vessels propelled by an internal combustion engine must be equipped with an efficient muffler, underwater exhaust, or other modern device that suppresses engine sound to prevent excessive or unusual noise. Operating a vessel in a manner that creates excessive noise or nuisance is prohibited.

In 2010, the NMFS established interim thresholds regarding the exposure of marine mammals to high-intensity noise that may be considered take under the Marine Mammal Protection Act (MMPA). Under this guidance, marine mammals exposed to underwater continuous noise (e.g., pre-drilling) or underwater impulse noise (e.g., impact pile-driving) of 180 dBA root mean square (RMS) or greater for cetaceans, and 190 dBA RMS or greater for pinnipeds, are considered to have been taken by Level A (i.e., injurious) harassment. Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to noise of 120 dBA RMS or greater for underwater continuous noise and 160 dBA RMS or greater for underwater impulse noise. For continuous noise, RMS levels are based on a time constant of 10 seconds, and those RMS levels should be averaged across the entire event. For impulse noise, the overall RMS level should be characterized by integrating sound energy for each acoustic pulse across 90% of the acoustic energy in each pulse, and averaging all the RMS levels for all pulses.

In 2024, NMFS released new guidance for the establishment of Level A harassment zones and replaced the flat, unweighted thresholds with more refined, frequency-dependent auditory weighting functions for five functional hearing groups: low-frequency, high-frequency, and very high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. Specifically, the new guidance "identifies the received levels and auditory weighting functions, or criteria, at which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) for acute (less than or equal to 24 hours), incidental exposure to underwater… anthropogenic sound sources based on updated information".[49] The new thresholds for identifying Level A harassment zones, or the onset of auditory injury (AUD INJ), are presented in Table 5. The 2010 thresholds for behavioral effects (120 dBA RMS for continuous noise and 160 dBA RMS for impulse noise) are still to be utilized as Level B harassment thresholds.

[49] National Marine Fisheries Service. (2024). 2024 update to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 3.0): Underwater and in-air criteria for onset of auditory injury and temporary threshold shifts (NOAA Technical Memorandum NMFS-OPR-71). U.S. Department of Commerce, National Oceanic and Atmospheric Administration. https://www.fisheries.noaa.gov/s3/2024-11/Tech_Memo-Guidance_-3.0-_OCT-2024-508_OPR1.pdf

Table 5: Thresholds Identifying the Onset of AUD INJ

Hearing Group	Impulsive AUD INJ Onset Acoustic Threshold (Received Level)	Non-impulsive AUD INJ Onset Acoustic Threshold (Received Level)
Low-Frequency Cetaceans (LF)	$L_{pk,flat}$: 222 dBA $L_{E,24h}$: 183 dBA	$L_{E,24h}$: 197 dBA
High-Frequency Cetaceans (HF)	$L_{pk,flat}$: 230 dBA $L_{E,24h}$: 193 dBA	$L_{E,24h}$: 201 dBA
Very High-Frequency Cetaceans (VHF)	$L_{pk,flat}$: 202 dBA $L_{E,24h}$: 159 dBA	$L_{E,24h}$: 181 dBA
Phocid Pinnipeds (PW) (Underwater)	$L_{pk,flat}$: 223 dBA $L_{E,24h}$: 185 dBA	$L_{E,24h}$: 195 dBA
Otariid Pinnipeds (OW) (Underwater)	$L_{pk,flat}$: 230 dBA $L_{E,24h}$: 185 dBA	$L_{E,24h}$: 199 dBA

Notes:

1) *Dual metric criteria for impulsive sounds: Use whichever criteria results in the larger isopleth for calculating AUD INJ onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level criteria associated with impulsive sounds, the peak sound pressure level criteria are recommended for consideration for non-impulsive sources.*
2) $L_{pk,flat}$ *= Unweighted peak sound pressure level*
   $L_{E,24h}$ *= Sound exposure level, cumulative 24 hours*

3.1.8.2. Potential Impacts and Proposed Mitigation Measures

Short-term noise impacts associated with construction are anticipated with the Proposed Action. Project activities would involve vessel transport and mooring, lowering modules into place using heavy equipment, monitoring activities using divers and/or snorkelers, and other related installation activities. No construction activities causing high-intensity noise underwater (e.g., drilling, pile-driving) are planned, and no harassment of marine mammals should occur. No disruption of behavioral patterns (Level B harassment) for or auditory injury (Level A harassment) to marine mammals is anticipated nor authorized. To mitigate noise emissions and community effects of noise emissions from construction activities, construction BMPs will be employed throughout the project. The contractor shall comply with all BMPs required by local, State and Federal permitting agencies, including the Required BMPs from the NOAA RC-PI Programmatic Consultations, to avoid or minimize potential impacts of in-water activities (Appendix B). These include but are not limited to:

- Commercial vessels will be operated by experienced staff who have applicable training and certifications to do so.
- Operational and maintenance standards for vessels will be practiced.
- Vessels will follow established transportation channels whenever practicable.

- Vessels will take reasonable steps to alert other vessels in the vicinity of whale(s).
- Vessels will not allow lines to remain in the water, and no trash or other debris will be thrown overboard, thereby reducing the potential for marine mammal entanglement.
- The transit route for the vessels will avoid designated critical habitat to the extent practicable.
- All objects and equipment will be lowered to the bottom in a controlled manner. This can include the use of equipment, divers, or buoyancy controls such as lift bags that affect positive control over the rate of descent.
- To minimize disturbances and damage (to animals and habitats), divers will use low-impact techniques, which include employing neutral buoyancy, point of entry/exit, the use of appropriate dive equipment and tools, expert boat anchoring (e.g., hand placement by divers/snorkelers or verified non-living bottom habitat before deployment), job-specific diver training, and diver awareness.
- An oversight vessel will be used to ensure no marine mammals or sea turtles are in the area during any buoy installation. If marine mammals or sea turtles are observed within 50 meters, operations will cease until the animal has left the area.
- If needed, directional echosounders with the smallest beam width practicable will be used, to concentrate noise directly under the vessel to the maximum extent practicable.
- The use of all active acoustic systems will be minimized (e.g., all non-navigational echosounders will be turned off when not actively mapping).
- Any mapping echosounders will be powered down or turned off if a marine mammal is observed closely approaching or within 100 meters of the vessel.
- Any lines associated with moored instruments shall be taut to avoid the possibility of entanglement of protected species.
- No attempt will be made to feed, touch, ride or otherwise intentionally interact with an ESA-listed marine species.
- Observers will report when motile ESA-listed marine species are within 50 meters of the proposed work and halt work, and work will only begin/resume after the animals have voluntarily departed the area.
- If ESA-listed motile marine species are noticed within 50 meters after work has already begun, that work may continue only if the activity will not adversely affect the animal(s).

- Constant vigilance will be kept for the presence of ESA- or MMPA-listed marine species during all aspects of the project, particularly in-water activities such as boat operations, diving, and deployment of anchors and mooring lines.

- When piloting vessels, vessel operators will alter course to remain at least 50 meters from marine mammals and sea turtles.

- Vessel speeds will be reduced to 10 knots or less when piloting vessels at or within the ranges described above from marine mammals and sea turtles. Operators will be particularly vigilant in watching for turtles at or near the surface, and if practicable, reduce vessel speed to 5 knots or less.

- Marine mammals and sea turtles will not be encircled or trapped between multiple vessels or between vessels and/or the shore.

- When whales are sighted, a distance of 100 meters or greater shall be maintained between the whale and the vessel.

- If a sea turtle or marine mammal is observed within 50 meters while using any DPVs or drills, the equipment will not be used until the animal has exited the area of its own accord.

No long-term noise related impacts from the Proposed Action are anticipated.

3.2 Natural Hazards

3.2.1 Climate Change and Sea Level Rise

3.2.1.1 Existing Conditions

The project site is located 0.52 to 0.75 miles offshore in water depths between 40 and 60 ft. Therefore, hazards related to sea level rise do not apply.

The Sea Level Rise (SLR) Exposure Area (SLR-XA) is a combination of three hazards including passive flooding, annual high wave flooding, and coastal erosion. Passive flooding modeling evaluates low-lying areas susceptible to flooding from the elevation of ocean water level or groundwater level by SLR. Annual high wave flooding captures the distance wave runup and over wash will travel across the shoreline under high wave conditions. With SLR and higher water levels, offshore reefs will be less effective at dissipating incoming wave energy, which in turn results in greater wave size and energy impacts on the shoreline. Finally, coastal erosion modeling depicts the areas threatened by landward recession of the shoreline based on historical data.

According to their fifth assessment report (AR5), the Intergovernmental Panel on Climate Change (IPCC) predicts a worldwide SLR of 0.9 ft to 3.2 ft by the year 2100, depending on future efforts to mitigate greenhouse gas emissions. The IPCC has outlined numerous impacts from this magnitude

of sea level rise on coastal communities, including beach erosion, inundation of land, increased flood and storm damage, saltwater intrusion into the freshwater lens aquifer, changes in precipitation, increased levels of land-based pollutants to coastal waters including sediments, nutrients and contaminants, and more frequent, longer, and more powerful El Niño and La Niña events.[50]

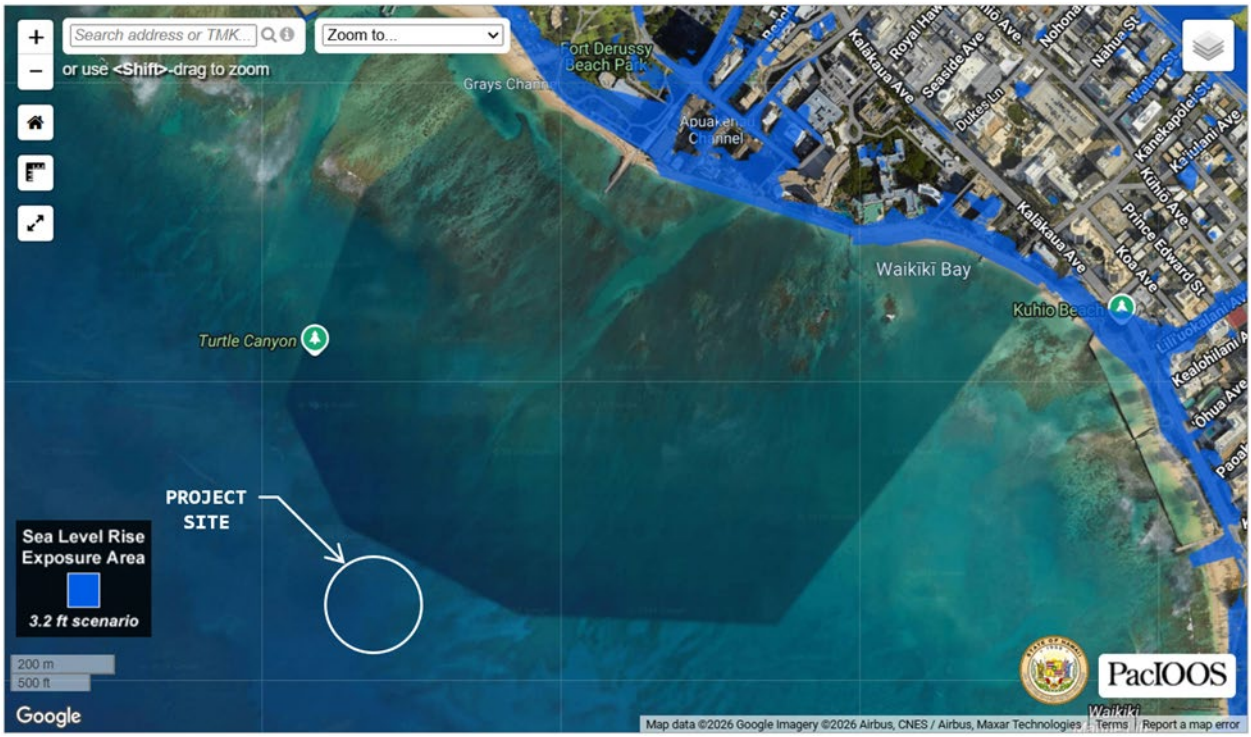
More recent studies by NOAA suggest that up to 3.2 ft of SLR could occur as early as the year 2060 under extreme scenarios. Under immediate scenarios, however, NOAA predicts 1.5 ft of rise as early as the 2060s, and 3.3 ft of rise by 2100[51]. With uncertainties on the exact projections of SLR associated with greenhouse gas emission trajectories and the behavior of Earth's cryosphere, the State of Hawai'i Sea Level Rise Report recommends the State to begin planning now for 3.2 ft of SLR.[52]

Since the project site is not a land area at risk of flooding or erosion, it is outside of the SLR-XA boundaries. The 3.2 ft SLR-XA for coastal areas landward of the project site are depicted in Figure 11.

[50] IPCC. (2014). AR5 IPCC Fifth Assessment Report. https://www.ipcc.ch/assessment-report/ar5/

[51] Sweet, W. V. et al. (2017). *Global and regional sea level rise scenarios for the United States* (NOAA Technical Report NOS CO-OPS 083). NOAA National Ocean Service. https://doi.org/10.7289/v5/tr-nos-coops-083

[52] Hawai'i Climate Change Mitigation and Adaptation Commission. (2017). *Hawai'i Sea Level Rise Vulnerability and Adaptation Report*. Prepared by Tetra Tech, Inc. and the State of Hawai'i Department of Land and Natural Resources, Office of Conservation and Coastal Lands. climate.hawaii.gov/wp-content/uploads/2019/02/SLR-Report_Dec2017-with-updated-disclaimer.pdf

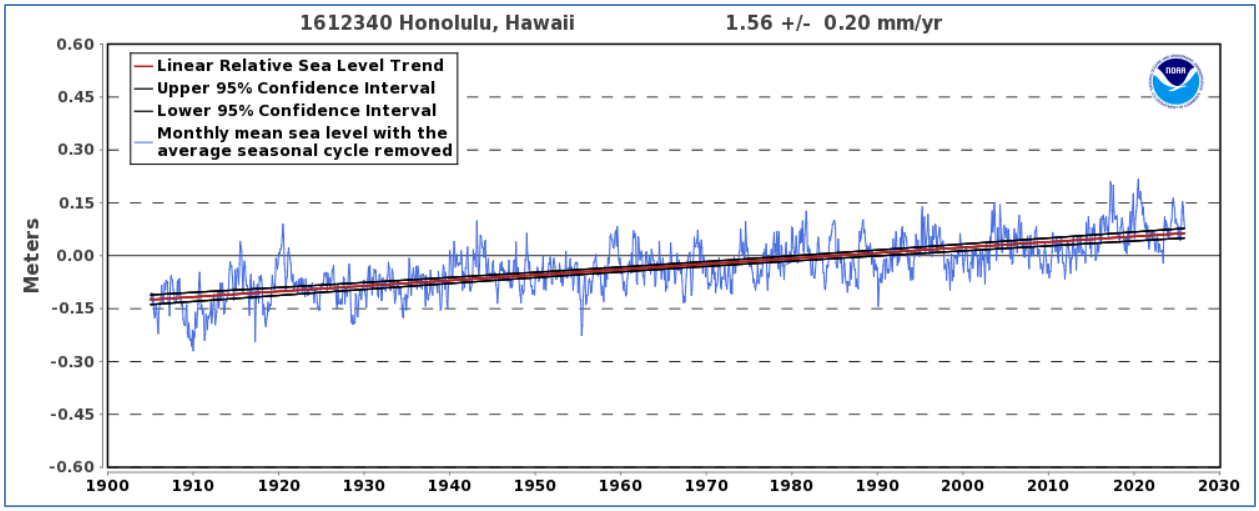


Source: PacIOOS, 2025. [State of Hawai'i Sea Level Rise Viewer | PacIOOS]

Figure 11: Map of Project Site Relative to the Nearest 3.2 ft SLR-XA

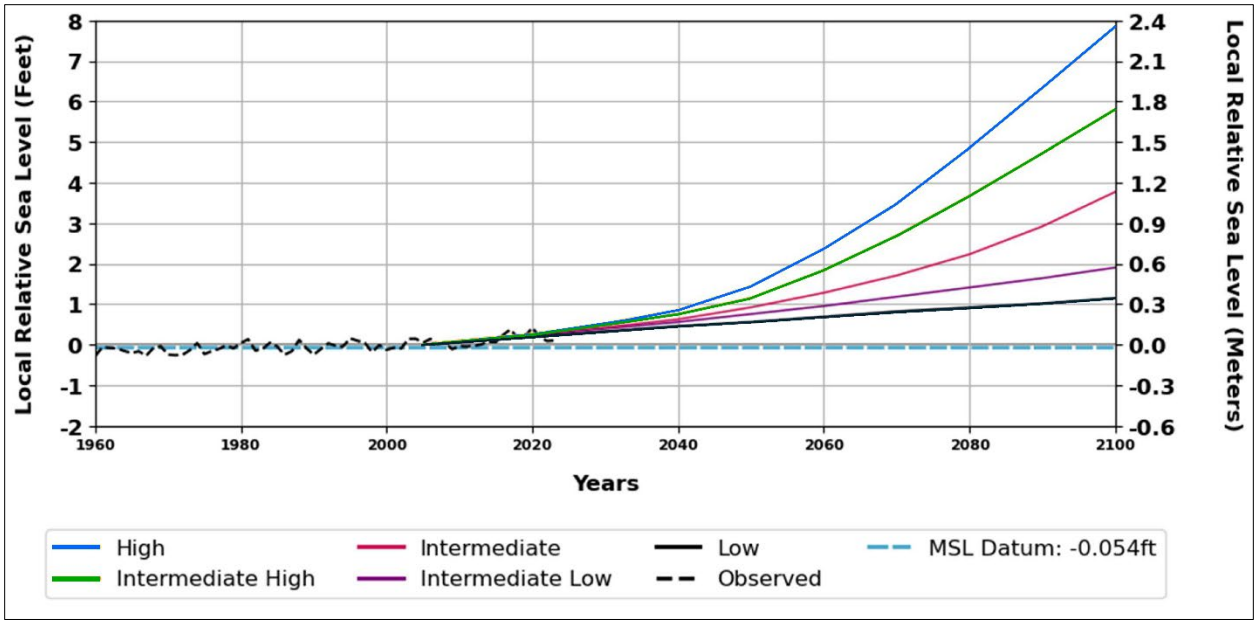
According to NOAA, based on MSL data from 1905 to 2024, the relative sea level trend from Honolulu Harbor (Station 1612340) is 1.56 mm/year with a 95% confidence interval of +/- 0.2 mm/year. This is equivalent to about a 0.51 ft-rise in 100 years (Figure 12).[53]

[53] National Oceanic and Atmospheric Administration. (2024). *Sea Level Trends: Relative Sea Level Trend.* NOAA Tides & Currents. NOAA NOS Center for Operational Oceanographic Product and Services. Retrieved February 6, 2026, from https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=1612340#tabmeantrend



Source: NOAA, 2024. https://tidesandcurrents.noaa.gov/stationhome.html?id=1612340

Figure 12: Relative Sea Level Trend, Station 1612340 Honolulu, HI



Source: NOAA, 2022. https://tidesandcurrents.noaa.gov/stationhome.html?id=1612340

Figure 13: Annual Mean Sea Level since 1960 at NOAA Tide Gauge 1612340 in Honolulu, HI with Five SLR Scenarios Plotted Relative to a 1996-2014 Baseline Period

3.2.1.2. Potential Impacts and Proposed Mitigation Measures

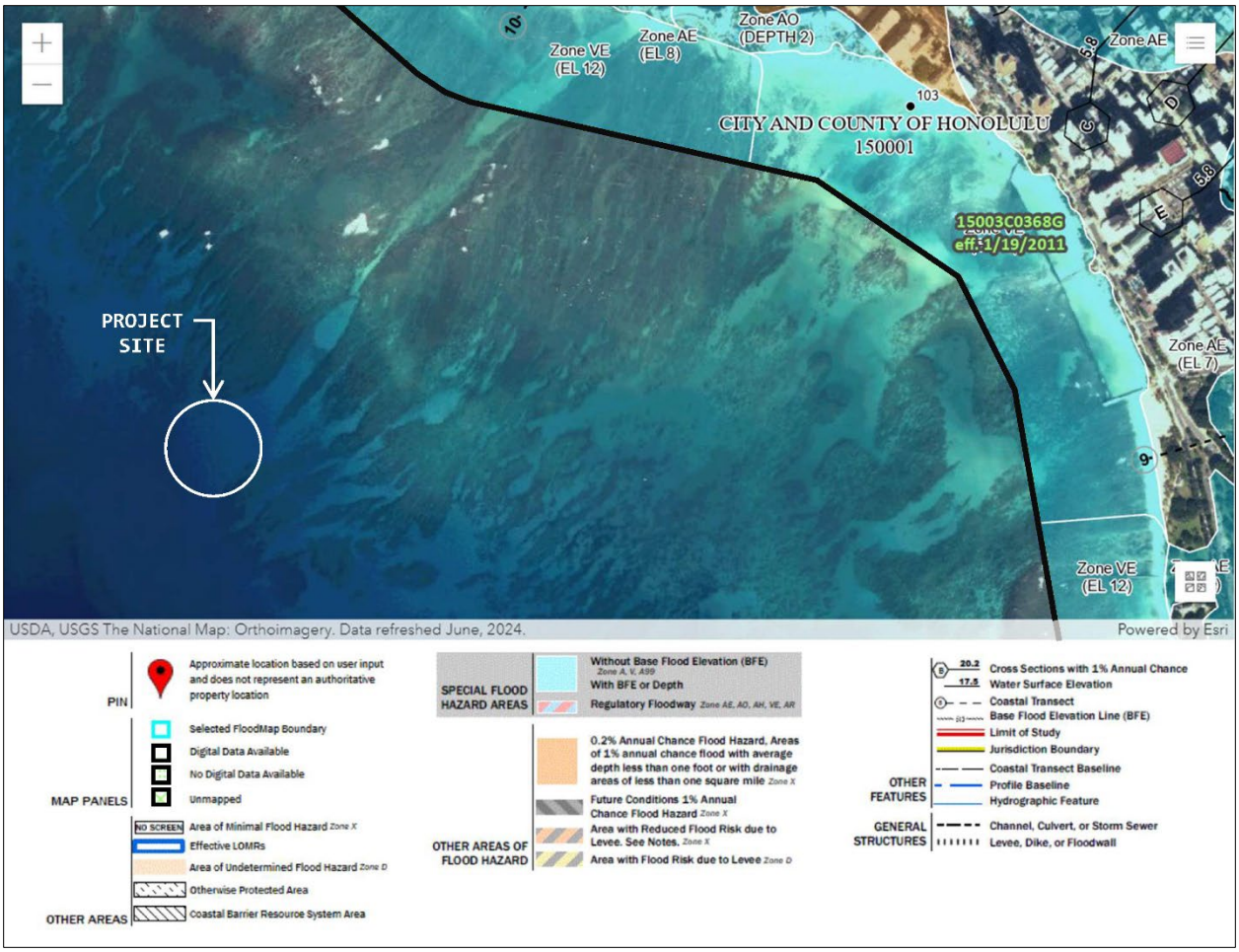
The Proposed Action will neither impact SLR nor increase the degree of risk and exposure to SLR for coastal areas landward of the project site.

3.2.2 Flood Hazards

3.2.2.1 Existing Conditions

The project site is located 0.52 to 0.75 miles offshore in water depths between 40 and 60 ft. Therefore, flood hazards do not apply.

Since the project site is not a land area at risk of flooding, it is outside of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) boundaries. Flood hazards for coastal areas landward of the project site are depicted on FIRM panel number 15003C0368G (effective date January 19, 2011). The closest Special Flood Hazard Area (SFHA) to the project site is Zone VE (base flood elevation +12 ft MSL), approximately 0.4 miles northeast (Figure 14). Areas within V-Zones are coastal high-hazard areas that are subject to a 1% or greater annual chance of flooding with high-velocity wave action of 3 ft or higher.



Source: FEMA, 2024. https://msc.fema.gov/portal/search

Figure 14: Map of Project Site Relative to the Nearest FEMA Flood Zones

3.2.2.2. Potential Impacts and Proposed Mitigation Measures

The Proposed Action will not change or impact flood zones of coastal areas landward of the project site.

3.2.3 Tsunami and Hurricane Hazards

3.2.3.1 Existing Conditions

The project site is located 0.52 to 0.75 miles off Waikīkī Beach in water depths between 40 and 60 ft. Therefore, tsunami and hurricane hazards do not apply.

Tsunami Evacuation Zones (TEZs) for coastal areas landward of the project site are depicted in Figure 15. Occupants within these zones are required to evacuate and move to a safe zone in the event of a tsunami warning. Hurricanes are classified as tropical cyclones with violent winds, heavy rains, and abnormally high waves and storm tides. Hurricane season in Hawai‘i occurs annually between the

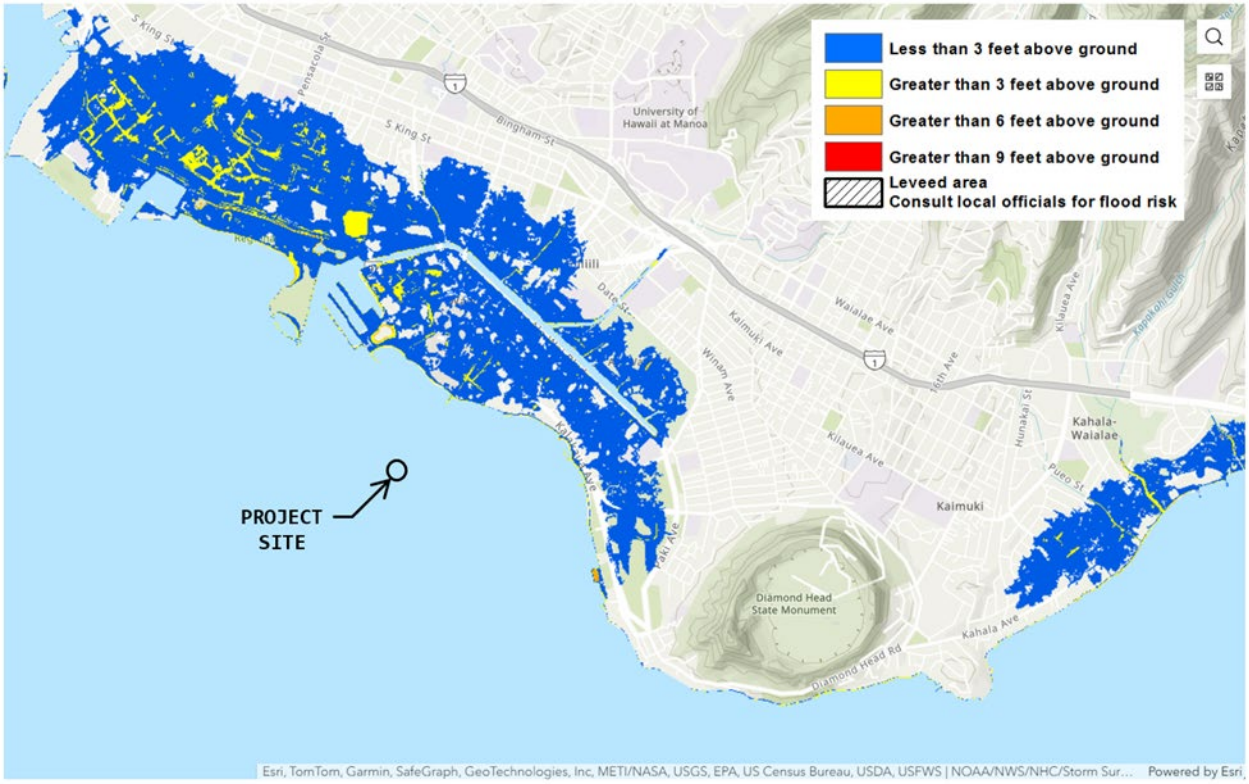
months of June through November, although large storms are rare. Hurricanes of note that have directly hit or caused great damage to the Hawaiian Islands include Hurricane Dot in 1959, Hurricane Iwa in 1982, and Hurricane Iniki in 1992. Although the occurrences of hurricanes in the islands are rare, storm surges and coastal flooding are expected to continue to become more severe and frequent with climate change predictions.



Source: City and County of Honolulu, 2015. https://dod.hawaii.gov/hiema/tsunami-evacuation-zones/

Figure 15: Map of Project Site Relative to the Nearest TEZs

Storm surge has the potential to extend miles inland from the immediate coastline. Based on NOAA National Hurricane Center Storm Surge Risk Maps, coastal areas landward of the project site are vulnerable to storm surge flooding. Given Category 1 hurricanes, storm surge flooding will inundate a majority of these mauka (landward) lands with water levels less than 3 ft above ground (Figure 16). A Category 1 hurricane represents the lowest level on the Saffir-Simpson scale, with maximum sustained wind speeds of 74 to 95 miles per hour (mph), causing damage primarily to shrubbery, tree foliage, poorly constructed items, and unanchored mobile homes.



Source: NOAA, 2025. National Storm Surge Risk Maps - Version 4

Figure 16: Map of Project Site Relative to the Nearest Storm Surge Flooding Vulnerability Areas, given a Category 1 Hurricane

3.2.3.2. Potential Impacts and Proposed Mitigation Measures

The Proposed Action will not alter flooding, tsunami or hurricane hazards of coastal areas landward of the project site.

3.3 Human Environment

3.3.1 Population

3.3.1.1 *Existing Conditions*

The REEFrame project site is located offshore of the Urban Honolulu Census Designated Place (CDP), which spans 68.4 square miles and contains a population of 344,977 people.[54] The median age in the Urban Honolulu CDP is 42.8 years old, with 4.7% of the population under 5 years old and 22.6% over 65 years old.[55] Nearly half of the population identifies as Asian, at 49.6% of the population, while 21.1% identify as two or more races, 16.8% identify as White, 8.9% identify as Native Hawaiian and Other Pacific Islander, 1.8% identify as Black or African American, 0.1% identify as American Indian and Alaska Native, and 1.6% identify as some other race. In 2024, the median household annual income was $86,169[56], and 10.5% of individuals live below the poverty line of $17,310[57] annual income for an individual.

3.3.1.2 *Potential Impacts and Proposed Mitigation Measures*

The Proposed Action will have no impact on Honolulu's population size, nor will it alter population demographics. No mitigation is required.

3.3.2 The Economy

3.3.2.1 *Existing Conditions*

The REEFrame Project Area is 0.52 to 0.75 miles off Waikīkī Beach. Waikīkī is bounded on the north and west by the Ala Wai, on the east by Kapahulu Avenue, and on the south by the shoreline. This region features hotels, restaurants, and retail operations that cater to the tourism industry and is recognized by the City and County of Honolulu (CCH) as the Waikīkī Beach Special Improvement

[54] U.S. Census Bureau. (n.d.). Age and Sex. *American Community Survey, ACS 1-Year Estimates Subject Tables, Table S0101*. Retrieved March 19, 2026, from https://data.census.gov/table/ACSST1Y2024.S0101?g=160XX00US1571550

[55] U.S. Census Bureau. (n.d.). ACS Demographic and Housing Estimates. *American Community Survey, ACS 1-Year Estimates Data Profiles, Table DP05*. Retrieved March 19, 2026, from https://data.census.gov/table/ACSDP1Y2024.DP05?g=160XX00US1571550

[56] U.S. Census Bureau. (2024). Comparative Economic Characteristics. *American Community Survey, ACS 1-Year Estimates Comparison Profiles, Table CP03*. https://data.census.gov/table/ACSCP1Y2024.CP03?q=honolulu+CDP+median+household+income+poverty&g=160XX00US1571550

[57] Office of the Assistant Secretary for Planning and Evaluation. (2024). *Poverty guidelines*. U.S. Department of Health and Human Services. https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines

District (including coastal waters 150 ft makai [seaward] of the shoreline). Waikīkī attracted 5,794,854 visitors arriving by air in 2024, directly and indirectly sustaining 6.9% of civilian jobs, making up 6% of the State's GDP, and contributing $798.6 million to Hawai'i State taxes.

The offshore area of Waikīkī is fundamental to its economic health by contributing to the aesthetic value and attracting both residents and visitors to recreational activities such as swimming, surfing, boating, paddleboarding. This offshore area is not included in the Waikīkī Beach Special Improvement District.

3.3.2.2 *Potential Impacts and Proposed Mitigation Measures*

REEFrame will have a positive short-term impact by creating direct and indirect employment related to construction. The new coral nursery will have a positive long-term impact by increasing recreational potential for scuba divers and freedivers to visit the new healthy marine ecosystem. The Project Area has no overlap with popular surf sites or boating channels and will have no other impacts on the economy. No mitigation is required.

3.3.3 Archeological Resources

An "Archaeological Literature Review in Support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawai'i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupua'a, Kona Moku, Island of O'ahu, State of Hawai'i" was prepared for this project and is contained in Appendix C. This section summarizes the report. Refer to Appendix C for specific references.

3.3.3.1 Pre-Contact Periods

Early Pre-Contact Period:

Over the last two decades, analysis and reanalysis of paleoenvironmental and archaeological chronometric data have shown that the earliest settlement of the Hawaiian Islands occurred between AD 1000 and 1100. There is only sparse evidence of the earliest human occupation in the Hawaiian Islands, and, in most cases, the radiocarbon data and the contexts from which they were derived have been debated. By the thirteenth century, the unique aspects of Hawaiian culture had developed, indicating a rapid adaptation to a new environment. Adaptations included the expansion of population inland and the exploitation of leeward resources such as salt, wood, grasses, lithic raw materials, birds, and marine life by windward inhabitants. Along with the rising population, there was increasing political and social complexity. By the 1400s, O'ahu was unified by Kumuhonua, an 'Ewa ali'i nui (high chief).

Late Pre-Contact Period:

The population continued to grow and expand into the interior of all islands after AD 1600, with the appearance of interisland polities and internecine warfare by Captain Cook's arrival in AD 1778. At the time of European contact, and for some time before, the ali'i (chiefs)constituted a group of chiefly

levels that, among other things, held use rights over the land. The vast majority of Hawaiians belonged to local descent groups of commoners called makaʻāinana, who held usufruct (temporary) land rights and lived and farmed within ʻili ʻāina (land division of an ahupuaʻa paying tribute to the ahupuaʻa chief).

Land and architectural hierarchies mirrored social hierarchies in late pre-Contact Hawaiʻi whereby residence groups in traditional Hawaiian society were composed of one or more spatially distinct households called kauhale. The ideal kauhale was a spatially segregated compound composed of several structures with different functions, including men's sleeping houses, women's sleeping houses, cooking houses, women's menstruating houses, and other special-use structures or activity areas (e.g., lithic workshops, garden plots, etc.).

3.3.3.2 Traditional History and Loko Iʻa

Waikīkī became the seat of royal power in the 1400s when Māʻilikūkahi, aliʻi nui (high chief) of Oʻahu, moved his court to the south side of the island. Until then, the chiefs had lived in Waiʻalua and ʻEwa Waikīkī, with its sheltered bay and nearby valleys of Pālolo, Mānoa, and Nuʻuanu, was considered an ideal settlement location. Māʻilikūkahi is attributed with creating the land division system, enacting just laws, and bringing peace and prosperity to the island.

Another Oʻahu chief known for ruling during a time of prosperity on Oʻahu was Chief Kalamakua-a-Kaipūhōlua. He ruled around the sixteenth century and was the first to build an extensive irrigation system of loko iʻa (fishpond) and loʻi (irrigated taro field) in Waikīkī. The plains and coast of Waikīkī contained loko iʻa kalo (fishpond with taro), connected to loko puʻuone (dune bank fishpond) and loko kuapā (walled fishpond on the shoreline). The network was integrated with the natural landscape. Streams that flowed from the mountains transported nutrients to the loko and loʻi, which were connected by ʻauwai (channels one to two meters wide). Loko iʻa kalo could be near the shore or further inland, and like loʻi, watered via irrigation ditches. Salinity would vary by location due to tidal action. Typically, loko iʻa kalo contained āholehole (*Kuhlia sandvichensis*) and ʻoʻopu (Eleotridae and Gobiidae families), and kalo (taro).

3.3.3.3 Early Post-Contact Descriptions of Waikīkī

Waikīkī is described as a richly productive area in accounts by early European explorers. On the shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the seaside, presented a high degree of cultivation and fertility. Diamond "Hill" was noted for large groves of coconut and bread-fruit trees and the area had "the highest state of cultivation." In 1824-1895, the naturalist Andrew Bloxam was ashore from the HMS Blonde in 1824–1825 when he noted the abundance of Waikīkī. He noted that "the village of Whyteete is taken up with innumerable artificial fishponds extending a mile inland from the shore, in these the fish taken by nets in the sea are put, and though most of the ponds are fresh water, yet the fish seem to thrive and fatten. Most of these

fish belong to the chiefs and are caught as wanted. The ponds are several hundred in number and are the resort of wild ducks and other water fowl."

This period of political importance ended for Waikīkī in 1809, when Kamehameha moved his capital to Honolulu, which was more accessible to Western visitors. In 1829, Kamehameha III funded fifty percent of the construction cost for a new Kawaiahao Church, much grander and stronger than the prior three structures. Related to the current offshore APE, the lime for the church was sourced from the reef:

The material at this time was largely from the coral reef abreast of the town where there were large fields of it growing in varied thickness. The coral was cut in blocks two to three feet long, two feet in width, and larger and smaller sizes, in blocks weighing from two hundred to twelve hundred pounds. Lime was procured by burning the coral, which gave an excellent quality of the product.

Following this move, traditional agriculture in Waikīkī waned. The population in the area drastically decreased due to economic changes and the devastation caused by Western diseases.

3.3.3.4 The Dredging and Erosion of Waikīkī

During the 1880s, development intensified in Waikīkī, and the area underwent rapid transformation. By the end of the nineteenth century, many loko i'a were filled, and rice was planted in place of taro. The productive wetlands came to be seen by some, particularly potential developers, as "deleterious to the public health in consequence of being low, and at times covered or partly covered by water, or of being situated between high and low water mark, or of being improperly drained, or incapable by reasonable expenditure of effectual drainage." This viewpoint would culminate in the dredging of the Ala Wai Canal and the filling of land that had a long history of productive wetland agriculture and aquaculture.

In 1876, a group of prominent businessmen, which included Archibald Cleghorn, John O. Dominis, and James Makee, formed the Kapi'olani Park Association. Mō'ī David Kalākaua offered a 30-year lease of Kāneloa and Kapua for the endeavor on the east side of Waikīkī, which was at the time crown land. Kalākaua dedicated the park in June of 1877 in honor of Queen Kapi'olani. At the location of today's Honolulu Zoo, Makee and Cleghorn created a water landscape from the existing ponds.

In 1912, Walter F. Dillingham purchased 84.41 acres in Kālia from the Bishop Estate, which he used as a dump site for coral dredged during the construction of the Ala Wai Canal. This major undertaking, called the Waikīkī Land Reclamation Project, began in 1921 and was completed in 1928. The reclamation project resulted in the draining and filling of 1,400 acres, which were once productive ponds, irrigated fields, and home sites. Burned rubbish was also used as a fill material. The city used the wetlands as free dumping sites for incinerated rubbish, without compensating landowners, and justified the practice by arguing that filling the land would increase its value. State laws were passed that forced property owners to pay for the filling of their land, a matter in which they had no choice. Many Hawaiians and other locals who live on the land were displaced.

Multiple sand renourishment projects were undertaken throughout the twentieth century. In 1929, sand was pumped from a "reef flat" through the Halekulani Channel to the beach at the Halekulani Hotel. The current APE includes the Halekulani Sand Channel, also known as ʻĀpuakēhau Channel, and other sources have cited the APE location as a sand source for beach replenishment, which suggests the APE is the "reef flat" source for sand in 1929.

Waikīkī Beach improvement and maintenance in the late twentieth century included the construction and repair of seawalls and groins, and the placement of sand either brought in from another beach source or mined offshore at Waikīkī. More recently, sand was siphoned from offshore onto Waikīkī beaches in 2000. In 2006, 10,000 cubic yards of offshore sand were placed on the shore. In 2012, sand was pumped from 2,000 feet offshore. The most recent effort was in 2021. The Waikīkī Beach Special Improvement District Association (WBSIDA), in close partnership with DLNR, conducted a beach maintenance project for the Royal Hawaiian to Surfrider Moana beach area. The goal of the Waikiki Beach Maintenance Phase II project was to restore and maintain the public beach between the Kuhio Beach Ewa Groin and the Royal Hawaiian Groin.

3.3.3.5 Potential Impacts and Proposed Mitigation Measures

The APE for the undertaking measures approximately 11.4 ac. and located in ocean waters managed by the State of Hawai'i. The State's management authority extends seaward up to three nautical miles. TMK plats along the coast near the APE include TMKs (1) 2-6-001, 002, and 004.

The Archaeological Literature Review (ALR) found that no historic properties are within the proposed project area. The nearest historic properties are along the beach, where no work will be conducted, and there is no potential for submerged former terrestrial archaeological sites in the APE. As for isolated artifacts, such as traditional Hawaiian fishing gear, such finds are unlikely because the APE is in the Halekulani Sand Channel, which experiences dynamic and fluctuating water conditions and was previously mined for sand to replenish Waikīkī beaches.

The recommended finding for the assessment of adverse effects for the proposed undertaking pursuant to 36 CFR 800.5(d)(1) is "No adverse effect." The recommended effect determination for the proposed undertaking pursuant to HRS Chapter 6E and its implementing regulations at HAR §13-275-7(1) is "no historic properties affected."

3.3.4 Cultural Impacts

This section summarizes the Draft Cultural Impact Assessment (CIA) in Support of REEFrame that is contained in Appendix D. Please refer to this study for specific references.

3.3.4.1 *Cultural Background*

- *Mo'olelo and Wahi Pana*: The Hawaiian cultural landscape can be described through mo'olelo and wahi pana (significant Hawaiian place names). Mo'olelo may be myths, legends, proverbs, and events surrounding well-known individuals in Hawaiian history. The APE is offshore from the

coastal ʻili, that included (from west to east) of Kālia, Keōmuku, Helumoa, Ulukou, Kapuni, Uluniu, Auʻaukai, Hamohamo, Kekio, Kāneloa, and Kapua in the Waikīkī ahupuaʻa.

Waikīkī, which can be translated as "spouting water," is named for its former wetlands fed by numerous streams from the valleys of Makiki, Mānoa, and Pālolo. Hawaiian historian John Papa ʻĪʻī mentions some of the places in a description of a traditional trail that crossed lower Waikīkī:

Traditional history tells of aliʻi nui Kalamakua-a-Kaipuholua (Kalamakua) of Halawa on Oʻahu and Keleanohoanaʻapiʻapi (Kelea) of Maui. Their daughter Lāʻielohelohe was born at Helumoa and raised at Kaluakau, in Waikīkī. She was betrothed to Maui aliʻi nui Piʻilani, and after marrying, she lived at Halehuki on Maui. During one of her pregnancies, she returned to Oʻahu, and Kihaʻapiʻilani, future Maui aliʻi nui, was born at ʻĀpuakēhau. According to Native Hawaiian historian Samuel Kamakau, a rock was placed at ʻĀpuakēhau to mark where he was born.

There are many Hawaiian sayings associated with places and events in Waikīkī, several of which include Kālia ʻIli, which spanned the western half of coastal Waikīkī. For example, Kālia was a place for gathering salt, and the name was used as "a derogatory term for the dried, viscid matter in the corners of the eyes of an unwashed face." Kālia was also a place to gather ʻalamihi crabs which were abundant at Kālia. There is the Hoʻi i Kālia i ka ʻai ʻalamihi, or "Gone to Kālia to eat ʻalamihi crabs." This saying means a person is in a repentant mood, as it plays on the word ʻalamini, which may also be ala mihi (path of repentance).

- *Kai:* Many Hawaiian terms for specific places in the kai (sea) are defined by the break of the waves and the activities or practices associated with the area. Based on this description, the APE perhaps falls within the kua nalu (back of the wave) or kai kea (white sea). Also in the depths of the APE are the kai luʻu (sea for diving) and kai paeaea (sea for pole fishing).

  Next beyond these zones are kai ʻo leho and kai ʻokilo heʻe (sea for octopus fishing), the kai kaka uhu (sea for netting uhu), the kai kaʻili (sea for fishing with hook and line), and the kai lawaiʻa (sea for deep sea fishing).

- *Ka Lawaiʻa:* Ka lawaiʻa (fishing) is the dominant theme in moʻolelo related to Waikīkī. In a line from the Chant for Kūaliʻi, it is said "He kai hului ko Kālia," which translates as "A sea for fishing with a drawnet is the sea of Kālia," In ancient days when a school of mullet appeared at Kalia a bag net was set and the men swam around it in a row and surrounded the fish. Then the men would slap the water together and kick their feet, driving the frightened fish into the opening of their bag net. Thus, the fishermen of Kālia became known as human fishnets.

- *Limu:* Traditionally, numerous types of limu (seaweed) were gathered at Waikīkī for food, medicine, and spiritual practices. Historic accounts note that there were multiple types of limu. Nearly all the limu is sold in the market by native women, who offered other Hawaiian delicacies, such as sea urchins, roasted kukui nuts, crabs, cocoanut pudding, small cubes of raw beef liver, ready to serve with limu, etc.

Queen Liliʻuokalani owned the Hamohamo fishery located on the front of her property in the early 1900s. In 1906, a notice ran in Hawaiian newspapers prohibiting anyone from taking limu pakaeleawaʻa or limu huluhuluwaena (*Grateloupia filicina*), ʻopihi (Cellana sp.), pūpū ālealea (*Turbo sandwicensis*), ʻina (*Echinometra sp.*), hāʻueʻue (slate pencil sea urchin, *Heterocentrotus mammillatus*), and pipipi (*Nerita picea*) from the shores of Hamohamo, which belonged to Queen Liliʻuokalani. She propagated limu by transplanting samples collected from locations across all the main islands.

- *Manō:* In ancient times, the manō kumupaʻa (ancestral sharks) Kanehunamoku and Kamohoaliʻi, declared a kānāwai (law) on Oʻahu that made it kapu (taboo) for any shark there to bite people. This held true until more recent times, except for ʻUnihokahi (One-toothed), an akua manō (shark god) who had only one tooth. One of the Oʻahu places he swam was in the waters off Kahaloa (beach at today's Royal Hawaiian Hotel) in Waikīkī: At Waikīkī, akua mano protected the ocean from the malihini (foreign) sharks looking to eat humans.

- *Heʻe Nalu, Pākākā Nalu, and Kaha Nalu:* Waikīkī has always been known for surfing. This includes heʻe nalu (board surfing), pākākā nalu (outrigger canoe surfing), and kaha nalu (body surfing). The kai heʻe nalu (surf-riding sea) at Waikīkī was one reason aliʻi found it an attractive place to live. Surf riding has a wider range of spots, canoe surfing is also very generally practiced, and occasionally body surfing. This requires strong, expert swimmers to attain sufficient momentum to ride in on the surf without a board or other support. This, termed kaha nalu, is still practiced.

- *Heiau and Koʻa:* Several heiau (traditional Hawaiian temples) and koʻa (fishing shrines) were once located in Waikīkī ahupuaʻa. The heiaus or altars, at which fishermen performed their religious ceremonies, were of a class different from all others. Koʻa is a term for the altar at a kuʻula, which is generally a mere rude pile of stones, often placed on a promontory or elevation overlooking the sea. Coral or some sort of limestone was preferred to any other variety of stone. The altar itself was commonly called a koʻa, Kuʻula being the name of the chief patron deity of fishermen.

3.3.4.2 Summary of Cultural Practices and Impacts

As discussed in the previous section, Waikīkī has a strong, well-documented association with Native Hawaiian practices and beliefs, some of which have endured for centuries and continue to hold cultural significance. Traditionally, Hawaiians relied on the ocean at Waikīkī for sustenance and recreation through practices such as fishing, gathering, swimming, surfing, and canoeing. Umu (fish aggregation devices) and several types of traps were constructed by Native Hawaiians near the Waikīkī shoreline to attract desirable fish for harvesting. Limu was cultivated along rocky shorelines for food, medicine, and spiritual practices. Other marine life was also gathered in those rocky areas for sustenance. On shore, several heiau (traditional Hawaiian temples) and koʻa (fishing shrines) were once located in the Waikīkī ahupuaʻa and numerous Native Hawaiian burials have also been discovered in sands along the Waikīkī shoreline.

Little remains of the constructions of the early inhabitants of Waikīkī. Modern development has replaced the temples and shrines; rocky beach areas have been replenished with imported sand to promote recreational beach use and tourism; umu have been degraded by natural processes and beach management practices; and many iwi kūpuna (ancestral remains) have been disturbed by development and natural weathering. These factors have contributed to a significant decrease in some of the cultural resources and practices associated with Waikīkī, such as marine resource gathering and fishing. Climate change, unsustainable fishing practices, pollution, and the loss of natural coral populations have also contributed to the degradation of conditions that once made Waikīkī a bountiful coastal environment. While some gathering and fishing may continue along the Waikīkī coast, the area no longer provides the level of sustenance it once did for Native Hawaiians.

Surfing and swimming remain important and enduring cultural practices along the Waikīkī shoreline. He‘e nalu (board surfing), pākākā nalu (outrigger canoe surfing), kaha nalu (body surfing), and swimming attract visitors and local residents alike to the area. No adverse effects on surfing or swimming practices are anticipated to result from the proposed REEFrame project. The project area lies well offshore, in deeper waters where new coral growth would not result in appreciable changes to the nature, size, frequency, or occurrence of the Waikīkī surf breaks. The REEFrame modules (each about 6 feet in height) will be lowered to the bottom in a controlled manner approximately 0.52 to 0.75 miles offshore in depths of 40 to 60 ft. The Waikīkī surf breaks occur much closer to shore and in shallower waters with depths of 3 to 14 ft.

Canoe paddling, considered a traditional Hawaiian practice, remains a popular recreational activity in Waikīkī; several canoe clubs store their wa‘a (outrigger canoes) on shore and practice and compete in the area. The Proposed Action would involve the temporary anchoring of barges and support vessels at the project site for approximately two to four weeks and would require transiting canoes to avoid the anchored vessels. Such avoidance requirements are applicable when encountering any stationary or anchored vessel and would have no adverse effects on the exercise of traditional paddling practices.

The REEFrame project will not involve any actions on shore in Waikīkī. There are no known cultural properties in the offshore project area, and there is no potential for the Proposed Action to affect iwi kūpuna that may be buried on shore or have eroded to near shore areas. Anecdotal accounts indicate that cremation remains are occasionally scattered offshore, potentially in or near the project area. This ongoing practice would not be impacted by the Proposed Action. Any previously scattered remains would have been dispersed by ocean currents and are not anticipated to be present in the project area.

The quantity and variety of sea life present in the project area are expected to increase as a result of the Proposed Action. As the new reefs are colonized and grow, they are anticipated to attract more sea life to the area, as compared to current conditions and the no action alternative. This Proposed Action is anticipated to improve conditions for fishing in the project area and in adjacent locations as the new reefs mature and fish recruitment increases in the area.

Research has not identified any historic properties within the proposed project area. The nearest historic properties are along the beach, and there is no potential for submerged former terrestrial archaeological sites in the project area. As for isolated artifacts, such as traditional Hawaiian fishing gear, such finds are unlikely because the project area is in the Halekulani Sand Channel, which experiences dynamic and fluctuating water conditions and was previously mined for sand to replenish Waikīkī beaches.

3.3.4.3 Ka Pa'akai Analysis

An alternative analytical framework, commonly termed a Ka Pa'akai assessment, can be used for addressing the preservation and protection of cultural practices specific to Native Hawaiian communities. This approach resulted from a 2000 Hawaii Supreme Court ruling (Ka Pa'akai O Ka 'Aina versus Land Use Commission). In its decision, the court established the following three-part analytical approach:

> Part 1, identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary Native Hawaiian rights are exercised;
>
> Part 2, identify the extent to which those resources and rights will be affected or impaired; and
>
> Part 3, specify any measures to be taken to reasonably protect Native Hawaiian rights if they are found to exist.

A Ka Pa'akai assessment was prepared for the Proposed Action following the above analytical approach, and is discussed in Cultural Impact Assessment contained in Appendix D. Fifty-six individuals and organizations with a knowledge of cultural practices and features in the Waikīkī area were contacted and invited to consult in the preparation of this assessment. These included 21 cultural descendants identified from past CIA reports and burial treatment planning efforts, the Office of Hawaiian Affairs, several Native Hawaiian Organizations (NHOs), community groups, civic organizations, and businesses. None of the parties contacted provided any information to inform this assessment.

Based on the Ka Pa'akai assessment protocols, the evaluation of the REEFrame project, is as follows:

The identity and scope of valued cultural, historical, or natural resources, including the extent to which traditional and customary native Hawaiian rights are exercised.

> Waikīkī has a strong, well-documented association with Native Hawaiian practices and beliefs, some of which have endured for centuries and continue hold cultural significance. These include surfing, canoe paddling, and swimming. Prior development activities in Waikīkī have severely impacted resources associated with other traditional practices, including fishing and gathering.

Traditionally, Hawaiians relied on the ocean at Waikīkī for sustenance and recreation through practices such as fishing, gathering, swimming, surfing, and canoe paddling. Umu (fish aggregation devices) and several types of traps were constructed by Native Hawaiians near the Waikīkī shoreline to attract desirable fish for harvesting. Limu was cultivated along rocky shorelines for food, medicine, and spiritual practices. Other marine life was also gathered in those rocky areas for subsistence. On shore, several heiau (traditional Hawaiian temples) and koʻa (fishing shrines) were once located in the Waikīkī Ahupuaʻa. Numerous iwi kūpuna (Native Hawaiian ancestral remains) have also been discovered in sands along the Waikīkī shoreline.

Little remains of the constructions of the original inhabitants of Waikīkī. Modern development has replaced the temples and shrines; rocky beach areas have been replenished with imported sand to promote recreational beach use and tourism; umu have been degraded by natural processes and beach management practices; and many iwi kūpuna have been disturbed by development and natural weathering. These factors have contributed to a significant decrease in some cultural resources and practices associated with Waikīkī, such as marine resource gathering and fishing. Climate change, over-fishing, pollution, and the loss of natural coral populations have also contributed to the degradation of conditions that once made Waikīkī a bountiful shoreline environment. While some fishing and gathering may occur along the Waikīkī shoreline, the area no longer provides the level of subsistence it once did for Native Hawaiians.

Surfing and swimming remain important and enduring cultural practices along the Waikīkī shoreline. Heʻe nalu (board surfing), pākākā nalu (outrigger canoe surfing), kaha nalu (body surfing), and swimming attract visitors and local residents alike to the area. Canoe paddling, considered a traditional Hawaiian practice, remains a popular recreational activity in Waikīkī; several canoe clubs store their waʻa (outrigger canoes) on shore and practice and compete in the area.

The extent to which those resources—including traditional and customary native Hawaiian rights—will be affected or impaired by the proposed action.

The proposed action is not anticipated to impair any traditional or customary native Hawaiian rights, or valued resources. The proposed action is anticipated to have positive impacts on aquatic resources within the project area and surrounding locations, with an associated positive impact on fishing practices.

No adverse effects on surfing or swimming practices are anticipated to result from the proposed REEFrame project. The project area lies well offshore, in deeper waters where new coral growth would not result in appreciable changes to the nature, size, frequency, or occurrence of the Waikīkī surf breaks. The artificial reef modules (each about 2 meters in height) will be placed 0.52 to 0.75 miles offshore in water depths between 40 and 60 ft. The Waikīkī surf breaks occur much closer to shore and in shallower waters.

The proposed action would involve the temporary anchoring of barges and support vessels at the project site (for up to four weeks) and would require transiting canoes and fishing vessels to avoid the anchored vessels. Such avoidance requirements are typical when encountering any stationery or anchored vessel and would have no impact on the exercise of traditional paddling practices.

The REEFrame project will not involve any actions on shore in Waikīkī. There are no known cultural properties in the offshore project area, and there is no potential for the proposed action to affect iwi kūpuna that may be buried on shore or have eroded to near-shore areas. Anecdotal accounts indicate that cremation remains are occasionally scattered offshore, potentially in or near the project area. This ongoing practice would not be impacted by the proposed action. Any previously scattered remains would have been dispersed by ocean currents and are not anticipated to be present in the project area.

The quantity and variety of sea life present in the project area are anticipated to increase as a result of the proposed action. As the new reefs are colonized and grow, they are expected to attract more sea life to the area, as compared to current conditions and the no action alternative. This proposed action is anticipated to improve conditions for fishing in the project area and in adjacent locations as the new reefs mature

The feasible action, if any, to be taken by the agency to reasonably protect native Hawaiian rights if they are found to exist.

Traditional and customary Native Hawaiian practices continue to be exercised near the project area, including surfing, paddling, swimming, and fishing. The proposed action is not anticipated to impair those practices. The proposed action is anticipated to result in long-term improvements to the aquatic habitat offshore of Waikīkī, a valued natural and cultural resource, with a corresponding improvement in the opportunities for fishing and recreation. The lack of any identified potential for the REEFrame project to impair Native Hawaiian rights precludes the need for any additional protective measures. Public Services and Facilities

3.3.5 Recreational Facilities and Services

3.3.5.1 Existing Conditions

Located on the south shore of O'ahu, Waikīkī offers approximately 2 miles of publicly accessible beachfront that spans from Fort DeRussy Beach at the west end to Kaimana Beach at the east end. Residents and island visitors enjoy passive and active recreational activities typically offered by beaches including, but not limited to, sunbathing, swimming, paddleboarding, snorkeling, canoe paddling, and beachcombing. Surfing is a popular activity along Waikīkī and three popular surf sites located near the REEFrame project location including Threes, Paradise and Populars.

Threes is located on the west side of 'Āpuakēhau Channel and is the closest to the REEFrame Project Area. The origin of its name stems from it being the third surf site from east to west on the reef that

begins off the Sheraton Waikīkī and ends at Kaiser Channel near the Hilton Hawaiian Village. During the 1950s, young surfers from the Outrigger Canoe Club "discovered" the site and named it "Number Threes." Threes is the most commonly used moniker.[58]

Paradise is located on the east side of ʻĀpuakēhau Channel off the Halekulani Hotel. This site is also known as "Number Twos" or Twos.[59]

Populars is located east of Āpuakēhau Channel and offshore of the Sheraton Hotel. Prior to high-rise development, this was an area where many Hawaiians lived. This was the most popular place for them to surf and it was hence named Populars, or Pops for short.[60] Figure 17 depicts the location of these surf sites relative to the REEFrame location.

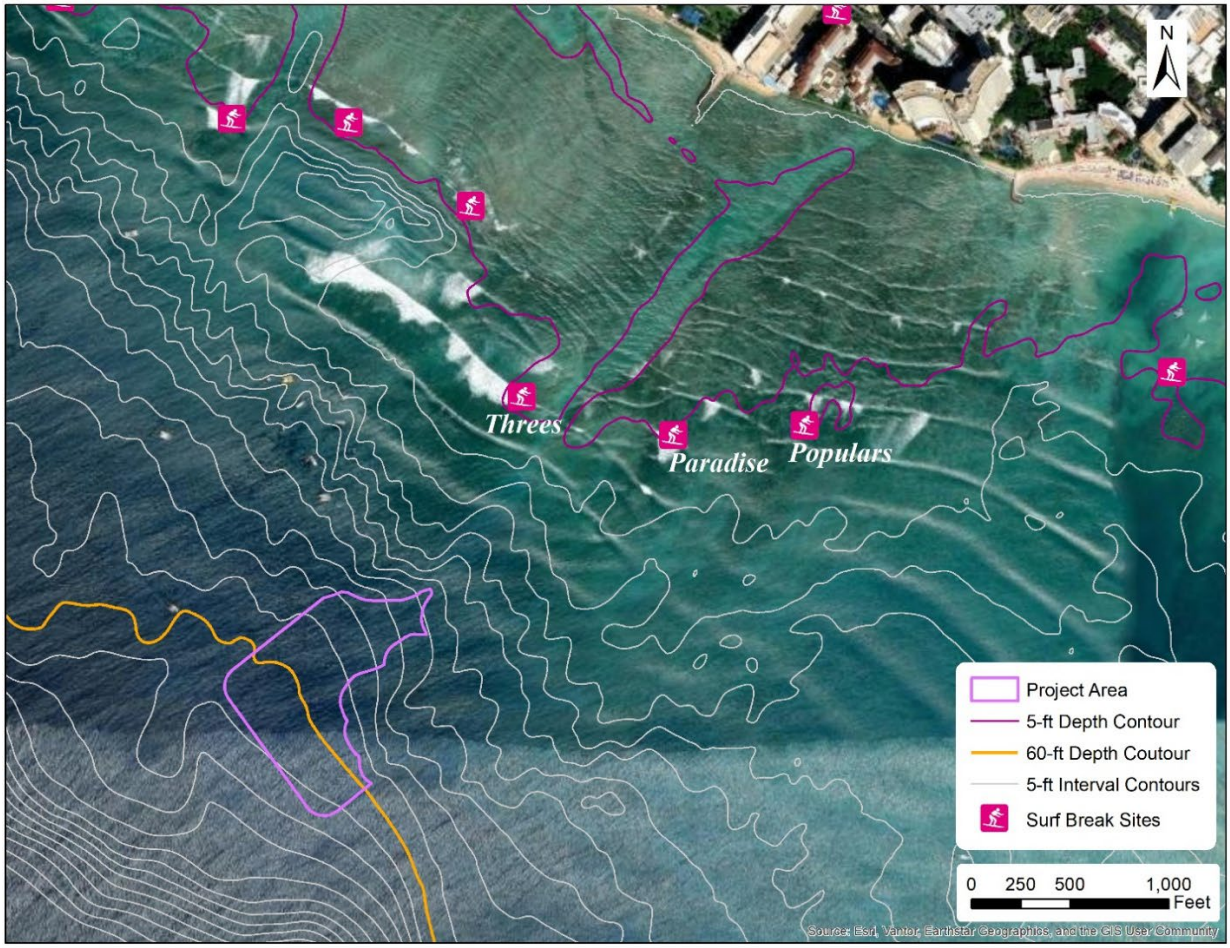


Figure 17: Threes, Paradise and Populars Surf Sites in Proximity to the REEFrame Project

[58] Clark, J. R. K. (2002). *Hawai'i place names: Shores, beaches, and surf sites* (p. 355). University of Hawai'i Press.
[59] Clark, J. R. K. (2002). *Hawai'i place names: Shores, beaches, and surf sites* (p. 286). University of Hawai'i Press.
[60] Clark, J. R. K. (2002). *Hawai'i place names: Shores, beaches, and surf sites* (p. 304). University of Hawai'i Press.

Additionally, canoe paddling, considered a traditional Hawaiian practice, remains a popular recreational activity in Waikīkī. Several canoe clubs store their wa'a (outrigger canoes) on shore and practice and compete in the area.

3.3.5.2 Potential Impacts and Proposed Mitigation Measures

In terms of general recreational activities in Waikīkī, REEFrame will provide additional benthic habitat that may enhance recreational features for diving, fishing, and other underwater activities. The Proposed Action is not anticipated to have any visual or coastal line-of-sight impacts beyond the deployment phase and arrival/departure of the barge.

Construction activities will be confined to the 11.4-acre Project Area located 0.52 to 0.75 miles offshore of Waikīkī Beach. None of the nearshore recreational resources will be negatively impacted.

The closest surf breaks are approximately 1,000 to 2,000 ft mauka of the Project Area, and the Proposed Action is not anticipated to impact the proximal surf breaks. It is possible that boat traffic and canoe paddling routes may need to deviate from their original paths to avoid interactions during deployment.

The Proposed Action would involve the temporary anchoring of barges and support vessels at the project site for approximately two to four weeks and would require transiting canoes to avoid the anchored vessels. Such avoidance requirements are applicable when encountering any stationary or anchored vessel and would have no adverse effects on the exercise of traditional paddling practices

3.3.6 Police, Fire Protection and Ocean Safety

3.5.2.1 Existing Conditions

The project area lies within Honolulu Police Department (HPD) District 6, which encompasses the Waikīkī peninsula. The nearest police station is the Waikīkī substation, located over 0.87 miles northeast of the project site at 2425 Kalākaua Avenue.

The nearest Honolulu Fire Department (HFD) fire station is Fire Station 07 located at 381 Kapahulu Avenue and is approximately 1.42 miles east of the project site.

Eight service lifeguard towers are stationed between Fort DeRussy Beach Park and Diamond Head Beach Park. Lifeguard towers nearest the REEFrame modules are located at Moana Surfrider Hotel, the Waikīkī Police Station, and Kūhiō Beach Park. Towers are operational daily from 8 a.m. to 6:30 p.m. Ocean Safety responds to the Emergency 911 system, and mobile responders are dispatched to 911 calls for assistance during operational hours.[61]

[61] City and County of Honolulu. (n.d.). *Lifeguard tower locations*. Honolulu Ocean Safety Department. https://www.honolulu.gov/hosd/lifeguard-tower-locations/

3.5.2.2 Potential Impacts and Proposed Mitigation Measures

Police, fire and ocean safety services would only be required due to construction-related accidents and accidents related to inadvertent encounters between public water users and construction equipment and activities.

Rules and standards enforced by the Department of Labor and Industrial Relations (DLIR) Hawai'i Occupational Safety and Health Division (HIOSH) are intended to promote construction-related safety and avoid and minimize construction accidents. The contractor shall take all necessary precautions for the protection and safety of its workers and the public in accordance with the Occupational Safety and Health Standards for the State of Hawai'i. Further, as a precautionary measure, it is recommended that the project contractor maintain ongoing communication regarding construction schedule and activities with relevant law enforcement.

To maintain public safety, mitigation measures will be necessary to avoid and minimize inadvertent encounters with water users near the construction site. During construction, the contractor shall provide, install and maintain all necessary protective facilities (e.g., aids to navigation, signs, buoys, lights, beacons, flares, barricades, markers, cones and other protective facilities) and shall take all necessary precautions for the protection, convenience and safety of the public. Further, any required public safety announcements regarding schedule and level of in-water activity should be designed to help the public plan in-water activities away from the REEFrame construction site for the duration of construction activities.

3.3.7 Roadways and Public Transportation

3.3.7.1 Existing Conditions

Kalākaua Avenue is a 3.4-mile main, vibrant thoroughfare frequently used by residents and visitors traversing through Waikīkī. It runs along iconic Waikīkī Beach, and serves as the tourism epicenter for dining, luxury shopping, and nightlife. The open waters beyond Waikīkī Beach are commonly traversed via recreational canoes, sailboats, and motorized boats. Key navigational channels near Waikīkī include the main entrance to the Ala Wai Boat Harbor and the offshore Kapua Channel near Diamond Head.

3.3.7.2 Potential Impacts and Proposed Mitigation Measures

The project site is located 0.52 to 0.75 miles offshore in water depths between 40 and 60 ft. Mobilization and demobilization of construction barges and support vessels to and from the Project Area will occur by water and therefore, will not impact any nearby roadways or public transportation, including public bus routes or stops and public parking stalls. The project APE has no overlap with navigation channels. During mobilization and demobilization, all construction vessels will follow deep-water routes (e.g., marked channels) whenever possible. Adequate notification will be made to the appropriate authorities (e.g., USCG, local port operators, USACE, etc.) prior to and during mobilization of construction vessels.

3.4 Potential Cumulative and Secondary Impacts

The Proposed Action is not part of a larger action and would not contribute to cumulative adverse environmental effects on the environment, nor would it generate substantial secondary impacts, such as population changes or effects on public facilities.

4. RELATIONSHIP TO LAND USE PLANS, POLICIES, AND CONTROLS

The project will require various permits and approvals from regulatory agencies at the Federal, State, and local levels. Regulatory agencies are tasked with ensuring that the project is compliant with statutes, rules, policies, and plans for which they are responsible to uphold. Each permit or approval that may be needed for this project is briefly described in this section followed by a discussion on how the Proposed Action relates and complies with permit/approval policies in a manner that either avoids or minimizes any negative impacts.

4.1 Federal

Construction work within waters of the U.S. may require a USACE permit in accordance with the CWA Section 404, the CWA Section 401 Water Quality Certification (WQC), the Rivers and Harbors Act Section 10, the Coastal Zone Management Act (CZMA), the Fish and Wildlife Coordination Act (FWCA), the ESA, the Magnuson-Stevens Fishery Conservation and Management Act (MSA) including the Essential Fish Habitat (EFH) provisions, the National Historic Preservation Act (NHPA) Section 106, and other applicable laws and regulations.

The USACE issues both Nationwide and Individual (i.e., Section 404 and Section 10) Permits. Nationwide Permits (NWPs) are designed to streamline the USACE permitting process of minor projects that will have minimal impact on the nation's aquatic environment. The REEFrame project is planned and designed to restore the site and surrounding aquatic ecosystem to a state resembling the natural ecosystem and may qualify for NWP 27 Aquatic Habitat Restoration, Enhancement, and Establishment Activities. Pre-consultation has been initiated with USACE, and a Pre-Construction Notice (PCN) will be submitted for agency review.

4.1.1 Clean Water Act, Section 404

Section 404 of the CWA of 1977 (33 United States Code [USC] 1251 et seq.) establishes a program to regulate the discharge of pollutants (i.e., dredged or fill material) into U.S. waters, which include navigable waters seaward of the high tide line, lakes, ponds, streams, ditches, and adjacent wetlands. Regulated activities include fill for water resource projects, infrastructure development, and mining projects. Section 404 requires a permit from the USACE before dredged or fill material may be discharged into any U.S. waters, including wetlands.

> *Relationship to the Proposed Action:* The Proposed Action includes placing structures within the Pacific Ocean, and after deployment, outplanting the structures with CoOs and sea urchins. As the placement of REEFrame structures into U.S. waters qualifies as "discharge of fill material" per definitions in 33 Code of Federal Regulations (CFR) Part 323, the Proposed Action will therefore likely require a permit from the USACE in accordance with Section 404 of the CWA. During construction of the Proposed Action, short-term impacts on the

nearshore reef environments, water quality, and marine resources will be mitigated by effective BMPs.

4.1.2 Rivers and Harbors Act, Section 10

Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403 et seq.) requires authorization from the USACE for the construction of any structure in or over navigable waters of the U.S., the excavation and dredging or deposition of material, or any obstruction or alteration to a navigable water. Note that the USACE's general definition of navigable waters are those "waters subject to the ebb and flow of the tide… and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce."

Relationship to the Proposed Action: The Proposed Action involves installing structures within the Pacific Ocean. These waters are tidal and considered navigable, and the Proposed Action may therefore likely require a permit from the USACE in accordance with Section 10 of the Rivers and Harbors Act. The project is not expected, however, to affect waterbody navigation.

4.1.3 Fish and Wildlife Coordination Act

The FWCA of 1934 (16 USC 661-666c) mandates that wildlife, including fish, should receive equal consideration as other aspects of water resource development. This is accomplished through consultation with NMFS, the USFWS, and appropriate State agencies whenever any body of water is proposed to be modified in any way and a federal permit or license is required. These agencies determine the possible harm to fish and wildlife resources, the measures needed to prevent the damage to and loss of these resources, and the measures needed to develop and improve the resources, in connection with water resource development. NMFS, the USFWS, and State agencies submit comments to Federal licensing and permitting agencies on the potential harm to living marine resources caused by the proposed water development project and recommendations to prevent harm.[62]

The FWCA compliance process includes:

(1) Consultation (notice of initiation);

(2) Reporting (e.g., field surveys and summary reports) and recommendations to protect, mitigate, and restore natural resources;

(3) Action agency consideration of recommendations; and

(4) Action agency implementation of recommendations.

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[62] National Marine Fisheries Service. (2004). *Essential fish habitat consultation guidance* (Version 1.1). U.S. Department of Commerce, National Oceanic and Atmospheric Administration. https://repository.library.noaa.gov/view/noaa/4187

Relationship to the Proposed Action: Construction and implementation of the Proposed Action may impact species identified in Section 3.1.7, which discusses project impacts on marine biological resources and EFH. Mitigation measures, including those recommended by public agencies, are also discussed in that section. Hence, implementation of the Proposed Action is planned to comply with the FWCA.

4.1.4 Endangered Species Act

The ESA of 1973 (16 USC 1531 et seq.) establishes protections for fish, wildlife, and plants that are listed as threatened or endangered. The ESA provides a framework for listing species, designating critical habitat for listed species, and developing and implementing recovery plans for listed species. It establishes procedures for interagency cooperation to avoid take of listed species, provides a mechanism for permitting of otherwise prohibited activities, and requires cooperation with states. The Act mandates that Federal agencies seek to conserve endangered and threatened species and use their authorities in furtherance of the Act's purposes, and outlines procedures for Federal agencies to follow when taking actions that may jeopardize listed species. Like the FWCA, the ESA is jointly administered by the USFWS and NMFS.

Relationship to the Proposed Action: Construction and implementation of the Proposed Action may impact species identified in Section 3.1.7, which discusses project impacts on marine biological resources, including threatened and endangered species. Mitigation measures, including those recommended by public agencies, are also discussed in that section. No significant impacts to ESA-listed species are anticipated to occur in the short-term during project construction. In the long-term time frame, this project seeks to restore aquatic ecology. Hence, implementation of the Proposed Action is expected to comply with the ESA.

4.1.5 Magnuson-Stevens Fishery Conservation and Management Act

The MSA first passed in 1976 (16 USC 1801 et seq.) is the primary law that governs marine fisheries management in U.S. federal waters. The MSA fosters the long-term biological and economic sustainability of marine fisheries, and its objectives include preventing overfishing, rebuilding overfished stocks, increasing long-term economic and social benefits, ensuring a safe and sustainable supply of seafood, and protecting habitat that fish need to spawn, breed, feed, and grow to maturity.

In Hawai'i, the MSA is administered by NMFS in conjunction with the WPRFMC. The WPRFMC has approved Fisheries Management Plans (FMP) for Hawai'i that designates ocean waters surrounding O'ahu as EFH, which is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The WPRFMC has also identified Habitat Areas of Particular Concern (HAPC), which are subsets of EFH that exhibit one or more of the following traits: rare, stressed by development, provide important ecological functions for federally managed species, or especially vulnerable to anthropogenic degradation.

Relationship to the Proposed Action: Construction and implementation of the Proposed Action may impact species identified in Section 3.1.7, which discusses project impacts on marine

biological resources including EFH. The project area is within EFH boundaries for three groups of Management Unit Species: pelagic fish, bottomfish, and crustaceans. However, the project area is not within or near a HAPC.[63] Mitigation measures, including those recommended by public agencies, are also discussed in Section 3.1.7. Hence, implementation of the Proposed Action is expected to comply with the MSA.

4.1.6 National Historic Preservation Act, Section 106

Section 106 of the NHPA of 1966 (16 USC 470 et seq.) requires Federal agencies to consider the effects of their undertakings on historic properties. An undertaking is a project, activity, or program carried out on behalf of a Federal Agency, utilizing federal financial assistance, requiring federal permits, licenses or approvals, or occurring on federal land. The DLNR State Historic Preservation Division (SHPD) is responsible for reviewing projects for compliance with the NHPA.

Relationship to the Proposed Action: The Proposed Action will not affect any historic or cultural properties or resources as indicated by the CIA. On the contrary, the project seeks to revitalize the historic significance and cultural practices that may be inhibited due to continuing ecosystem degradation. Since Federal Agency approval and federal funding triggers NHPA Section 106 review, compliance will be coordinated with SHPD. Notification of the Section 106 process undertaken for this project has been submitted to SHPD via Hawai'i Cultural Resource Information System (HICRIS).

4.2 State of Hawai'i

4.2.1 Section 401, State Certification of Water Quality

The purpose of the Section 401 WQC is to provide states with power to protect the water quality of federally regulated waters. A Section 401 WQC permit is required when the action needs a federal permit, license, certificate, approval, registration, or statutory exemption, and may result in any discharge of a pollutant into navigable waters. Section 401 WQC ensures the action meets state water quality standards. In Hawai'i, water quality standards are enforced by the State of Hawai'i DOH under HAR Title 11, Chapter 54. These water quality standards are reviewed every three years.

Relationship to the Proposed Action: As discussed in Section 3.1.4, the REEFrame project area is located at the mouth of the 'Āpuakēhau Channel in offshore marine waters designated Class A, open coastal waters, by the State of Hawai'i under HAR Title 11, Chapter 54, "Water Quality Standards." The marine bottom ecosystem is designated Class II, with a reef flat bottom subtype. It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Any other uses shall be permitted as long as it is

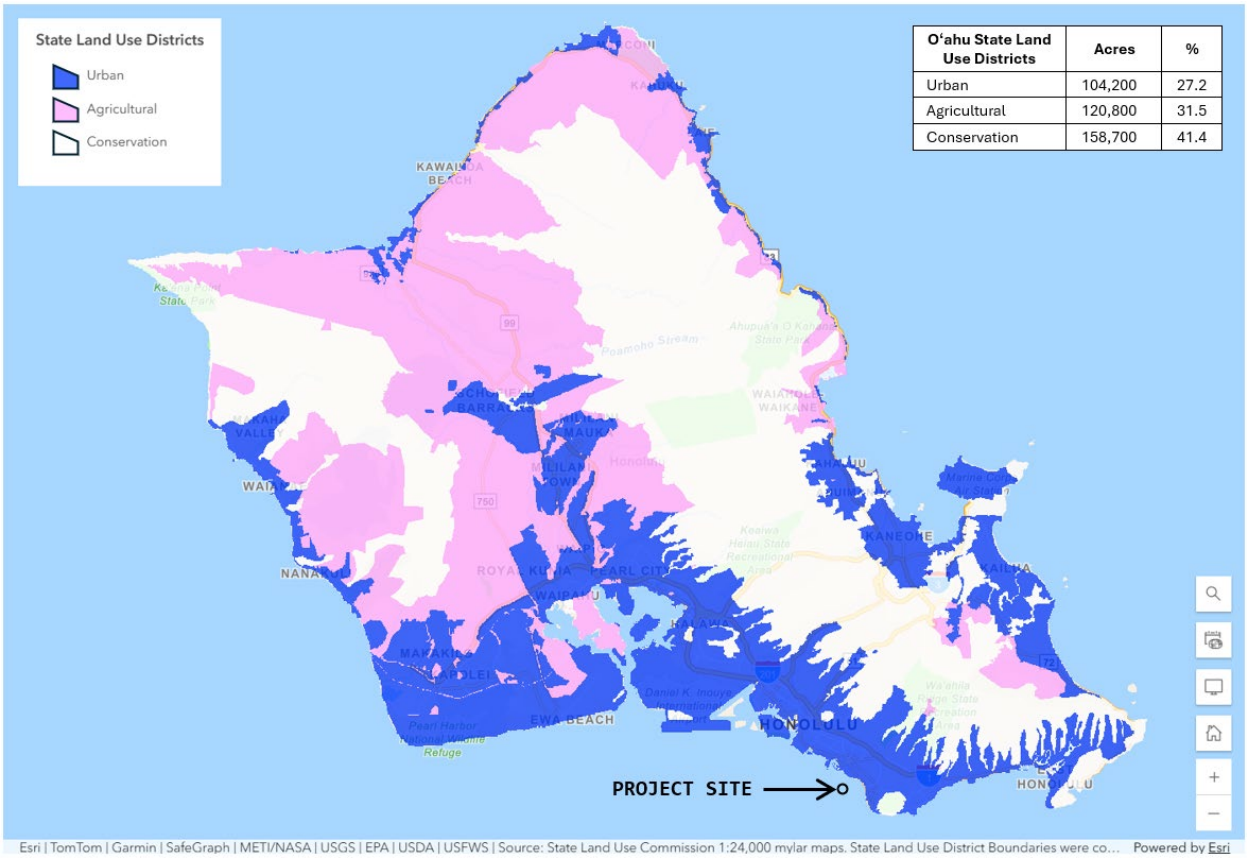
[63] National Marine Fisheries Service. (2020). *Essential Fish Habitat in Hawai'i.* Retrieved March 24, 2026, from https://www.fisheries.noaa.gov/s3//dam-migration/efh-hawaii-brochure-rebuild-for-web.pdf

compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class. The applicable requirements for this project shall be the current State of Hawai'i WQS for discharges into Class A waters.

The Proposed Action would affect ocean water quality during construction. Impacts would be minor, temporary, and mitigated with appropriate BMPs. Section 401 compliance will be coordinated with USACE and the DOH Clean Water Branch (CWB). The DOH provides a blanket Section 401 WQC for activities covered under certain USACE NWPs, including NWP 27 Aquatic Habitat Restoration, Establishment, and Enhancement Activities.

4.2.2 State Land Use

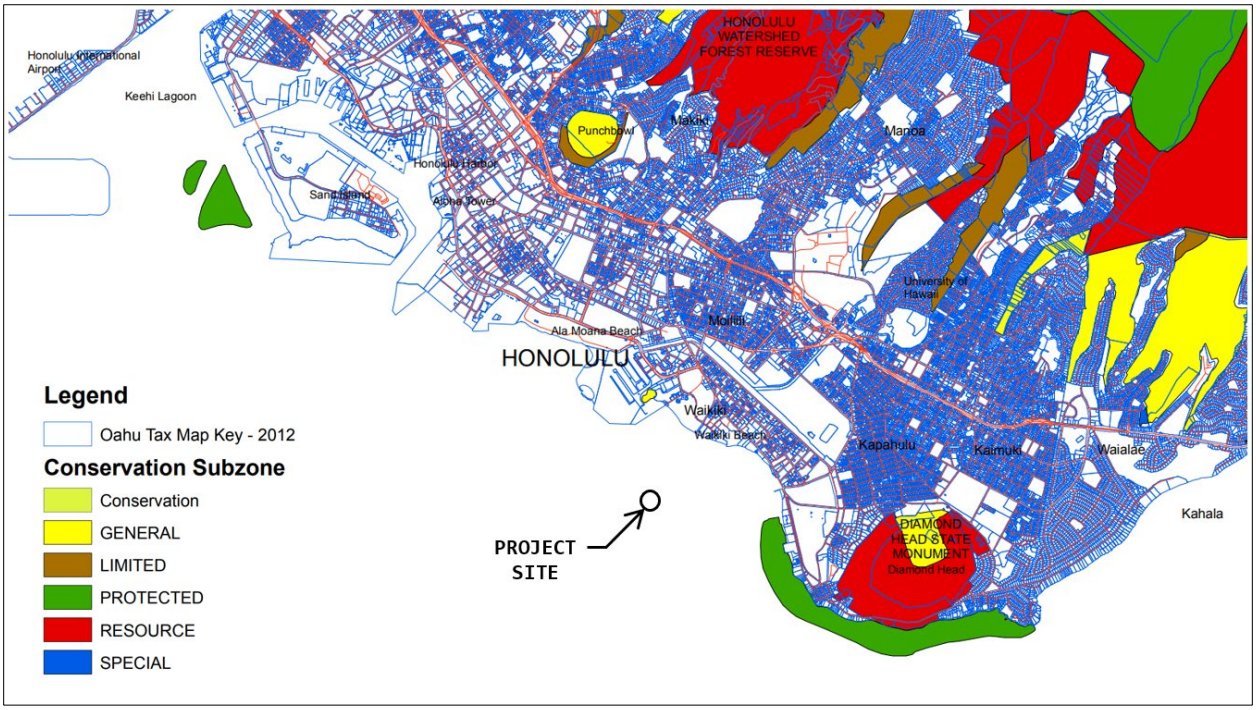
HRS Chapter 205-2 establishes a Land Use Commission (LUC) that classifies all lands in the State into four major State Land Use Districts (SLUD): Urban, Rural, Agriculture, and Conservation (Figure 18). The State LUC is responsible for determining district boundaries and managing any reclassifications or amendments.



Source: LUC, 2014. https://planning.hawaii.gov/wp-content/uploads/2015/04/State-Land-Use-District-slides1.pdf

Figure 18: State Land Use Districts, Island of O'ahu

Relationship to the Proposed Action: Per HAR Title 13, Chapter 5, submerged lands seaward of the shoreline to the extent of the State's jurisdiction (i.e., up to three nautical miles from the shoreline) are classified as Conservation District lands in the Resource (R) Subzone, unless specifically mapped in another subzone. Since the Proposed Action is located seaward of the shoreline and is not mapped within a specific subzone (Figure 19), the project site lies within the State's Conservation District Resource Subzone. The DLNR Office of Conservation and Coastal Lands (OCCL) is responsible for management of coastal resources including beaches, dunes, and rocky shorelines seaward of county jurisdictions (i.e., the shoreline) and/or within the State Conservation district. Therefore, a Conservation District Use Permit application will be submitted. For authorization to use State submerged lands, a perpetual, non-exclusive easement will be coordinated with the DLNR Land Division (LAND).



Source: DLNR, 2012. https://dlnr.hawaii.gov/occl/files/2013/08/oahu_consv_subz2012_1101.pdf

Figure 19: Conservation District Subzones, Island of O'ahu

The nearest non-submerged land areas to the project site lie in the Urban district, which contains activities or uses provided by ordinances or regulations of the county where the urban district is situated and are generally areas where there is a "city-like" amount of people, infrastructure, and services. Land use in urban districts is governed by the county government.

4.2.3 State Historic Preservation Program

The Constitution of the State of Hawai'i recognizes the value of conserving and developing the historic and cultural property within the State for the public good. Chapter 6E of the HRS is the

State's overarching historic preservation law, administered by the DLNR SHPD. SHPD reviews projects for impact to historic properties to lessen or mitigate those impacts.

> *Relationship to the Proposed Action:* Per HRS 6E-42, "before any agency… approves any project involving a permit, license, certificate, land use change, subdivision, or other entitlement for use, which may affect historic property, aviation artifacts, or a burial site, the agency… shall advise the department and prior to any approval allow the department an opportunity for review and comment on the effect of the proposed project on historic properties, aviation artifacts, or burial sites." The Proposed Action will not affect any historic or cultural properties or resources. Nevertheless, State Agency approval triggers HRS Chapter 6E review, and compliance will be coordinated with OCCL and SHPD.

4.2.4 State Endangered Species Statute

Threatened and endangered species, including aquatic life, wildlife, and land plants, are protected on Hawaiian home lands under the provisions of HRS Chapter 195D, as well as under the provisions of the federal ESA of 1973. Section 195D-4 makes it unlawful to "take" (i.e., harass, harm, kill, destroy, etc.) endangered or threatened species in the State. HRS Chapter 195D is administered by the DLNR, with the Division of Aquatic Resources (DAR) managing marine and aquatic species under this chapter and the Division of Forestry and Wildlife (DOFAW) managing terrestrial wildlife and plants under this chapter.

> *Relationship to the Proposed Action:* Construction and implementation of the Proposed Action may impact species identified in Section 3.1.7, which discusses project impacts on marine biological resources and EFH. Mitigations measures, including those recommended by public agencies, are also discussed in that section. Hence, implementation of the Proposed Action is expected to comply with HRS Chapter 195D. State Agency approval triggers HRS Chapter 195D review and compliance will be coordinated with OCCL and both DLNR DAR and DLNR DOFAW.

4.2.5 Hawai‘i Coastal Zone Management

Coastal Zone Management (CZM), as codified under HRS Chapter 205A, is a public initiative that integrates resource, ecosystem, and place-based management of coastal resources. CZM also sustainably balances the needs of economic development and conservation of resources. The Federal CZM Program was created through passage of the CZM Act of 1972. Approved state programs allow states to review federal actions (i.e., Federal Agency activities, federal license/permit activities, and federal financial assistance activities) to ensure they align with state enforceable policies. The Hawai‘i CZM Program was approved by the State in 1977 and the federal government in 1978. It codified in HRS Chapter 205A. Federal actions affecting any coastal use or resource shall be undertaken in a manner consistent to the maximum extent practicable with the State's CZM Program.

Hawai‘i's CZM Program is the State's resource management policy framework and guiding perspective for the design and implementation of allowable land and water uses and activities. The

CZM Program focuses its work on the State's complex coastal resource management problems in areas under the highest stress. Through Federal, State, and local cooperation, the Hawai'i CZM Program employs a wide variety of regulatory and non-regulatory techniques to address coastal issues and uphold environmental law. These techniques include stewardship, planning, permitting, education and outreach, technical assistance to local governments and permit applicants, policy development and implementation, and identification of emerging issues and exploration of solutions.

The CZM Program identifies 10 objectives and policies (HRS §205A-2 (b)(c). The following is a discussion of the project's relationship to each objective and relevant policies.

4.2.5.1 Recreational Resources

Objective: Provide coastal recreational opportunities accessible to the public.

Relevant policies:

- Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value.
- Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources.

Discussion: The Proposed Action will support coastal recreational opportunities by restoring the coral populations, thereby providing habitats for the benthic environment, including coral, fish, urchins and other ocean species. The increase in the benthic populations will provide diverse opportunities for gatherers, recreational fishers and divers and other water users to engage and interact with these ocean species. During construction, BMPs will be employed to meet public safety standards and natural resources conservation.

4.2.5.2 Historic Resources

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

Relevant policies:

- Identify and analyze significant archeological resources.
- Support state goals for protection, restoration, interpretation, and display of historic resources.

Discussion: An ALR and field survey study was conducted to determine whether there would be significant impacts to historical or archeological resources under the Proposed Action. The Proposed

Action is not anticipated to have significant impacts on existing historic and cultural resources within the project area.

4.2.5.3 Scenic and Open Space Resources

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

Relevant Policies:

- Identify valued scenic resources in the coastal zone management area.
- Ensure that new developments are compatible with their visual environments by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline.
- Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources.

Discussion: The REEFrame structures will be installed in depths of 40 to 60 feet and will not affect the coastal scenic and open space resources.

4.2.5.4 Coastal Ecosystems

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

Relevant policies:

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

Discussion: The Proposed Action supports the objective to protect valuable coastal ecosystems. Further, implementation of the Proposed Action will enhance the coastal ecosystem by increasing the coral population and habitats for benthic species in this area.

4.2.5.5 Economic Uses

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

Relevant policies:

- Concentrate coastal dependent development in appropriate areas.
- Ensure that coastal development and coastal related development are located, designed, and constructed to minimize exposure to coastal hazards and adverse social, visual, and environmental impacts in the coastal zone management area.

Discussion: REEFrame is anticipated to have long-term beneficial economic impacts to the community and the State by increasing underwater attractions for the resident and visitor populations.

4.2.5.6 Coastal Hazards

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

Discussion: REEFrame will be located 0.52 to 0.75 miles offshore in water depths between 40 and 60 ft. and will have no impact on coastal hazards.

4.2.5.7 Managing Development

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

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

Discussion: Ninety-one Draft EA pre-consultation requests were sent to agencies, community organizations and individuals. These requests included an overview of project objectives, location and technology to provide a framework for public comments. This list of the 91 recipients is included in Table 6 of this Draft EA. In addition, the project team conducted and continues to conduct community outreach, and the list and summary of these events is provided in Table 7.

4.2.5.8 Public Participation

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

Relevant policy: Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal related issues, developments, and government activities.

Discussion: As noted in the previous section, extensive dialogue with public agencies, community organizations and individuals has occurred, and will continue to occur through project construction. In addition, a presentation was made to the Waikīkī Neighborhood Board No.09 - September Meeting on September 9, 2025. A summary of the discussion is contained in Table 7.

4.2.5.9 Beach Protection

Objective: Protect beaches and coastal dunes for public use and recreation.

Relevant policies:

- Minimize the construction of public shoreline hardening structures, including seawalls and revetments, at sites having sand beaches and at sites where shoreline hardening structures interfere with existing recreational and waterline activities.
- Minimize grading of and damage to coastal dunes.

Discussion: The Proposed Action does not involve construction of shoreline hardening structures nor will it affect coastal dunes.

4.2.5.10 Marine and Coastal Resources

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

Relevant policies:

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

Discussion: All work in the marine environment will be carefully monitored with stringent BMPs in place. In the long term, the Proposed Action will have a positive effect on marine and coastal resources by restoring coral populations and increasing benthic habitats for ocean species in this area.

4.3 City and County of Honolulu

The Proposed Action does not include construction or site development landward of the shoreline or within the CCH's jurisdiction. Therefore, no building permits, site development permits, zoning

permits, or coastal area permits (e.g., Special Management Area [SMA] permit, shoreline setback permit) are applicable.

4.4 Permits and Approvals

Federal

U.S Army Permit (USACE)
Section 10, Rivers and Harbors Act, for Work in Navigable Waters of the U.S. (USACE)
Section 404, Clean Water Act, for Fill in Waters of the U.S. (USACE)
Section 106 Archaeological and Historic Preservation Act (AHPA) (16 USC §469(A) (1))
Endangered Species Act (16 USC §1536(A) (2) and (4))

Other Federal laws that may affect the project include:
Coastal Zone Management Act (16 USC §1456(C) (1))
Clean Air Act (CAA) (42 USC §7506(C))
Clean Water Act of 1977, as amended (33 USC §1251-1387)
EO 13089, Coral Reef Protection (63 FR 32701)
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (16 USC §703-711) (66 FR 3853)
Fish and Wildlife Coordination Act of 1934, as amended (16 USC §661-666(C) et seq.)
Magnuson-Stevens Fishery Conservation and Management Act (16 USC §1801 et seq.)
Marine Mammal Protection Act of 1972, as amended (16 USC §1361-1421(H) et seq.)
Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 USC §703-712 et seq.)
National Historic Preservation Act of 1966 (Section 106) (16 USC §470(F))
Rivers and Harbors Act (33 USC §403)

State of Hawai‘i

Conservation District Use Permit (BLNR DLNR OCCL)
Coastal Zone Management Consistency Determination (OPSD)
HRS Chapter 6E, State Historic Preservation Program Review (DLNR SHPD)
HRS Chapter 195D Conservation of Aquatic Life, Wildlife, and Land Plants Review (DLNR DAR; DLNR DOFAW)
Land Disposition / Right of Entry (DLNR LAND)
Section 401 Water Quality Certification (DOH CWB)

5. EA PRE-CONSULTATION AND COMMUNITY OUTREACH

5.1 EA Pre-Consultation

Solicitation requests for pre-consultation were sent to 91 entities via email on November 3, 2025. Recipients were sent a six-page pre-consultation package that presented the REEFrame team and associated partners, the location of the project area, the rationale for selecting the Project Area, and an overview of the REEFrame technology.[64] Recipients were asked to submit comments within 30 days, or December 4th, 2025. A reminder was sent to recipients on December 1st, 2025.

Comments were provided by eleven entities, and comments and project responses are contained in Appendix F.

Table 6: List of Consultation Agencies, Organizations and Individuals and Comments Received

Agency / Organization / Individual Included in Pre-Consultation	Submitted Pre-Consultation Comments
Federal	
U.S. Department of the Interior, Fish and Wildlife Service; USFWS Pacific Islands Fish and Wildlife Office	X (2)
U.S. Department of Commerce, National Marine Fisheries Services (NOAA Fisheries)	X
U.S. Army Corps of Engineers	X (2)
U.S. Environmental Protection Agency	
State of Hawai‘i	
State of Hawai‘i Department of Accounting and General Services	
State of Hawai‘i Department of Business, Economic Development and Tourism	
State of Hawai‘i Office of Planning and Sustainable Development	X
State of Hawai‘i Department of Health, Clean Water Branch	
State of Hawai‘i Department of Health, Safe Drinking Water Branch	
State of Hawai‘i Department of Health, Environmental Health Administration	

[64] Appendix E contains the pre-consultation package.

Agency / Organization / Individual Included in Pre-Consultation	Submitted Pre-Consultation Comments
State of Hawai‘i Department of Health Indoor and Radiological Health Branch	
State of Hawai‘i Department of Land and Natural Resources, State Historic Preservation District	
State of Hawai‘i Department of Land and Natural Resources, Division of Aquatic Resources	
State of Hawai‘i Department of Land and Natural Resources, Engineering Division	X
State of Hawai‘i Department of Land and Natural Resources, Office of Conservation and Coastal Lands	X
State of Hawai‘i Department of Land and Natural Resources, Land Division	X (2)
State of Hawai‘i Department of Land and Natural Resources, Boating and Ocean Recreation	
State of Hawai‘i Department of Land and Natural Resources, Conservation and Resources Enforcement	
State of Hawai‘i Department of Transportation	
State of Hawai‘i Department of Agriculture	
Office of Hawaiian Affairs	X
State of Hawai‘i Department of Agriculture	
Aha Moku Advisory Committee	
City and County of Honolulu	
City and County of Honolulu Emergency Services Department	
City and County of Honolulu Department of Environmental Services	
City and County of Honolulu Department of Facility Maintenance	
City and County of Honolulu Department of Planning and Permitting	
City and County of Honolulu Department of Planning and Permitting	
City and County of Honolulu Department of Parks and Recreation	
City and County of Honolulu Department of Transportation Services	
Honolulu Fire Department	

Agency / Organization / Individual Included in Pre-Consultation	Submitted Pre-Consultation Comments
Honolulu Police Department	X
Waikiki Neighborhood Board No. 9	
Honolulu Office of Climate Change, Sustainability and Resiliency	
Elected Officials	
U.S. Representative Ed Case	
U.S. Senator Brian Schatz	
U.S. Senator Mazie Hirono	
State Representative Adrian K. Tam	
State Senator Sharon Y. Moriwaki	
District 4 Councilmember & Chair of Honolulu City Council Tommy Waters	
Mayor Rick Blangiardi	
Organizations	
Aina Momona	
Coral Reef Alliance	
Eyes of the Reef	
Greenpeace	
Halekulani Hotel	
Hawai‘i Conservation Alliance	
Hawai‘i Fisherman’s Alliance for Conservation and Tradition	
Hawai‘i Hotel Alliance	
Hawai‘i Lodging & Tourism Association	
Hawai‘i Surfing Association	
Hawai‘i Tourism Authority	
Hawai‘i Visitors & Convention Bureau	
Hawaiian Civic Club: Ke One o Kākuhihewa (O‘ahu Council) - Waikīkī Hawaiian Civic Club	
Hawaiian Music Perpetuation Society (HMPS) - Project Partner	
Koa Kai Canoe Club	
Kuleana Coral Restoration	
Kumulokahi-Elks Canoe Club	
Malama Maunalua	
Ocean Alliance	

Agency / Organization / Individual Included in Pre-Consultation	Submitted Pre-Consultation Comments
Oahu Hawaiian Canoe Racing Association (OHCRA)	
Pacific Island Fishers Group	
Save our Surf	
Sierra Club	
Surfrider Foundation (Oahu Chapter)	
Surfrider Spirit Sessions	
The Nature Conservancy	
Waikīkī Business Improvement District	
Waikīkī Beach Special Improvement District Association (WBSIDA)	
Waikīkī Beach Replenishment (Dolan Eversole, Hawai'i Sea Grant)	
Waikīkī Aquarium (Judy Lemus, Acting Director)	
Waikīkī Surf Club	
Individuals	
Jay Agao	
Kathy Bell	
Richard "Babes" Bell	
Uilani Bell	
Joseph (Joe) K Camacho	
Jeninne Heleloa	
Marsha Kapu	
Aunty Ku'uipo Kumukahi	
Stan Lum	
Tulutulu Mana	
Joseph (Nappy) Napoleon	
Georgie Navarro	
Sam Rodrigues	
Rosalind (Roz) Solomon	
Jonathan Sudler	

5.2 Ongoing Community Outreach

The REEFrame team continues to collaborate with the stewards, users, businesses, organizations and traditional and cultural practitioners in Waikīkī. Through shared kuleana, the community works to honor the legacy of the ʻōpū aliʻi (servant leaders) who have called Waikīkī home. For generations, Hawaiʻi's servant leaders cared for the Waikīkī ahupuaʻa, recognizing the vast importance of our actions on this delicate ecosystem. Building permanent coral nurseries off Waikīkī Beach is a critical step for maintaining the deeply connected culture while restoring the ecosystem and the important species that inhabit the reef. REEFrame has engaged with community stakeholders since the project began and will continue to proactively connect with stakeholders through project implementation. Table 7 lists community groups, dates of meetings, a summary of these meetings and meeting highlights.

Table 7: Summary of Community Outreach Efforts

Community Group	Date of Meeting(s)	Meeting Summary	Meeting Highlights
Waikīkī Restoration Partnership	September 5, 2023; November 9, 2023; January 17, 2024; April 24, 2024	Meetings with NOAA, DAR and CI staff to give updates on Waikīkī projects for coordination and alignment.	Progress updates from various partners working on coral restoration in Waikīkī to stay connected and ensure projects' success.
REEFrame project partners and Hawaiian Music Perpetuation Society (HMPS)	October 18-20, 2023	REEFrame project partners convened on Oʻahu for a grounding ceremony facilitated by HMPS in Waikīkī, acknowledging the ʻāina and its caretakers and seeking their permission and guidance to proceed with the work.	The protocol grounded the REEFrame team in place and strengthened a shared commitment to moving forward with respect, intention, and guidance rooted in Waikīkī and its ancestral stewardship.
Conference presentations	Various dates	● November 7, 2023: 3rd Hawaiʻi Coral Restoration Symposium ● September 16, 2024: 2024 American Fisheries Society Meeting ● December 9, 2024: Reef Futures 2024 ● May 5, 2025: American Fisheries Society Pacific Islands Annual Chapter Meeting 2025 ● October 29, 2025: 4th Hawai'i Coral Restoration Symposium	Conferences provide opportunities to share REEFrame with a larger network of coral restoration practitioners in Hawaiʻi and globally, and the fishing community in the Pacific and globally. The team is actively exploring future opportunities.
HMPS	March 28, 2024	Meeting with HMPS at the Hoʻokela at the Hyatt in Waikīkī to get input on initial project sites.	Discussed the history of aliʻi in Waikīkī, important burial locations to avoid and other areas of historic and cultural significance.

Community Group	Date of Meeting(s)	Meeting Summary	Meeting Highlights
Fishers Working Group (FWG)	May 14, 2024	The REEFrame Project team hosted nine (9) FWG in person and virtually for an introduction to the REEFrame Project and DAR's coral restoration and fisheries habitat efforts, as there are overlap and synergies with the two different efforts that benefit from input from the FWG.	The meeting included participant introductions, a REEFrame project overview, and a DAR presentation, with the FWG expressing concerns about coral survivorship and module stability in low-coral, high-runoff areas, which was addressed citing Dr. Mark Hixon's CReME project as a successful proof of concept.
HMPS	June 27, 2024	In-person meeting with HMPS at the CI Kaimuki office to share progress on the REEFrame project (site selection and module design) and receive input and thoughts on how to best socialize the project.	HMPS asked clarifying questions, recommended additional groups for engagement, and emphasized Waikīkī's biological and cultural importance, highlighting the project's role in restoring once-abundant ecosystems and suggesting the use of mele to help convey the significance of coral.
DAR Hawai'i Coral Restoration Nursery (HCRN) and Urchin Hatchery teams	July 18, 2024	In-person meeting with five (5) DAR staff from the HCRN and Urchin Hatchery teams at the Ānuenue Fisheries Research Center (AFRC) and virtually to share progress on REEFrame project site selection and module design, and to receive input.	DAR shared feedback on best methods for coral restoration and outplanting of CoOs to be incorporated in the module design (i.e., varied hole sizes, and through-holes) to improve module suitability for corals and urchins.
Halekulani Corporation meeting	January 23, 2025	In-person meeting with officials from Halekulani Corporation at the Halekulani Hotel.	Co-created ideas and discussed a partnership, as the Halekulani Hotel is located on the coast fronting the preferred project site.

Community Group	Date of Meeting(s)	Meeting Summary	Meeting Highlights
Kūpuna Collaboration Event	January 25, 2025	The REEFrame project team met with eleven (11) kūpuna in-person at the Waikīkī Beach Marriott Resort's Queensbreak Restaurant to share the project with kupuna who grew up spending time in Waikīkī. This was an opportunity to hear their stories of what Waikīkī was like and how it's changed and discuss how the REEFrame project can help with habitat restoration in a place very special to them.	Kūpuna in attendance offered to provide continued support throughout the project and will be invited to future project updates.
Honolulu City Council Chair Tommy Waters (City & County)	January 31, 2025	Two members of the REEFrame project team virtually briefed Honolulu City Council Chair Tommy Waters' Senior Aide Kevin Imanaka and Policy Advisor Adam Doo to inform and answer questions on the REEFrame project.	Kevin Imanaka and Adam Doo were highly supportive and offered future help connecting with our local community and would like to be notified before future REEFrame outreach events.
REEFrame Scuba Outreach Meeting	April 25, 2025	The REEFrame project team virtually met with eight (8) members of the scuba diving industry active in Waikīkī.	Dive professionals expressed strong interest in staying involved throughout the project and offered concrete ways to contribute (i.e., including citizen science reporting, ecological surveys, and community engagement).
Hawai'i Sea Grant and the Waikīkī Beach Special Improvement District Association (WBSIDA)	May 6, 2025	Virtual meeting with Hawai'i Sea Grant and the Waikīkī Beach Special Improvement District Association (WBSIDA).	Discussed previous sand nourishment efforts and confirmed there is no planned sand removal at preferred project site. Asked to remain updated informally.
Meeting with Representative Adrian Tam	May 15, 2025	Two members of the REEFrame project team virtually briefed Waikīkī State Representative Adrian Tam to inform and answer questions on the REEFrame project.	Representative Tam asked questions and indicated that he liked the project. He suggested that we engage (1) hotels, (2) the Waikīkī Business Improvement District, and (3) the Waikīkī Neighborhood Board No. 9.

Community Group	Date of Meeting(s)	Meeting Summary	Meeting Highlights
Meeting with Senator Sharon Y. Moriwaki	May 27, 2025	Two members of the REEFrame project team virtually briefed Senator Sharon Moriwaki (Vice Chair of Ways and Means Committee) to inform and answer questions on the REEFrame project.	Senator Moriwaki was enthusiastic and supports nature-based solutions to climate threats in her Waikīkī district. She recommended local groups that we should engage.
Meeting with an author of books on Hawai'i's beaches	June 3, 2025	The REEFrame project team met virtually with an individual with experience working and researching Waikīkī.	The meeting provided valuable community-context guidance, with suggestions of inclusive outreach with beach concessions, canoe clubs, shoreline fishers, surfers, and related organizations.
Waikīkī Improvement Association (WIA)	July 15, 2025	Three members of the REEFrame project team met with Rick Egged (Executive Director) of the Waikīkī Improvement Association (WIA) at the WIA office.	The meeting was an important start to working with the visitor industry. There was strong support for the potential impact to the area and several outreach opportunities were offered.
Hawai'i Hotel Alliance (HHA)	July 21, 2025	Three members of the REEFrame project team met with Jerry Gibson of the Hawai'i Hotel Alliance.	Gibson was excited about the project and discussed ways to partner. Invited the REEFrame project team to present at a future HHA General Session.
Ocean tours community outreach event	August 7, 2025	The REEFrame project team met with one (1) ocean tour operator virtually. About 40 Waikīkī operators received an email invitation to attend.	The participant expressed strong support for the REEFrame project and noting that vessel operations can easily adapt around the planned structures. Also, praised the project's design, highlighted its compatibility with tourism and educational experiences, and suggested further engagement with beachside operators. The REEFrame project team is exploring different ways to engage the ocean tour groups to reach more operators.
Hawai'i Visitors and Convention Bureau (HVBC)	August 14, 2025	Two members of the REEFrame project team met with Aaron Sala, President and CEO of HVCB.	Sala expressed strong support for initiatives that will benefit the Waikīkī area.

Community Group	Date of Meeting(s)	Meeting Summary	Meeting Highlights
Department of Business, Economic Development and Tourism (DBEDT) and Outrigger	August 21, 2025	Three members of the REEFrame project team met with Jimmy Tokioka (head of DBEDT and has oversight over the Hawai'i Tourism Authority) and Jeff Wagoner with the Outrigger.	The agency and hotel officials expressed willingness to support a project that will help the Waikīkī area. They had overall concerns regarding coastal resilience and supported efforts such as REEFrame.
REEFrame presentation at Waikīkī Neighborhood Board No.09 - September Meeting	September 9, 2025	Hybrid meeting that included in-person and virtual participants.	Board members and community participants emphasized ecological benefits and strong cross-agency coordination, broadly supporting the deep-water sandy site while recognizing the project will not directly address shoreline erosion. They raised questions about funding, wildlife impacts, sand nourishment plans, pollution from the Ala Wai, and freshwater upwellings. The project team affirmed that REEFrame's coral-focused design, supported by proof-of-concept work, complements but does not replace broader watershed and nearshore management efforts.
REEFrame presentation at Climate Change Environmental Issues Forum	October 24, 2025	REEFrame was invited to present at "Waikīkī Talks: Climate Change," which included subject matter experts speaking about climate change effects and other environmental issues affecting Waikīkī.	Community participants appreciated hearing about the work being planned in the neighborhood and discussed ways to get involved.

Community Group	Date of Meeting(s)	Meeting Summary	Meeting Highlights
Meetings with surfers	October 22, 2025; December 5, 2025; January 13, 2026	Three separate meetings were convened with ten (10) surfers, all with different connections to Waikīkī - some who have been surfing the Threes surf break since the 50s, family surf shop in Waikīkī and all who care deeply about the preservation of surf in Hawai'i.	The main concern for surfers is if this project will impact existing surf breaks. The team shared the empirical modeling showing that the depth this project is at will not disrupt surf. On the other side of that, one surfer asked if we put these at shallower depths, can these structures fix surf breaks, like Paradise, which is slowly being lost due to degradation of the reef at that area. The team responded that these could support creation and/or restoration of surf breaks, but we do not want to impact surf with this project. In addition, another concern raised was the fact that a healthier reef ecosystem could lead to more sharks in the area.
Hawai'i Ocean Safety Team (HOST) Hawai'i	April 2, 2026	There were 21 total attendees who reacted positively to the REEFrame Project Plan presentation. Most of the meeting time was dedicated to Q&A and discussion.	In addition to general questions about the REEFrame modules and project plan, participants asked about the construction and restoration timeline, as well as which companies will be contracted for those activities. There were also questions about stakeholder engagement and how the project will be communicated to nearby businesses. Several individuals offered their own expertise or connections in marine construction and with local Waikīkī Beach tourism businesses.

6. ANTICIPATED FINDING OF NO SIGNIFICANT IMPACT (AFNSI)

In accordance with the provisions set forth in HRS Chapter 343, the Proposed Action was evaluated based on criteria established in HAR §11-200.1. Based on the analysis discussed hereafter in Section 6.2, the proposed project has been determined to qualify for a FONSI. Reasons supporting a FONSI determination are as follows.

1) *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource*

   The Proposed Action would not cause the loss or destruction of natural, historic, or cultural resources. The ALR found that no historic properties are within the proposed project area. The nearest historic properties are along the beach, where no work will be conducted, and there is no potential for submerged former terrestrial archaeological sites in the APE. As for isolated artifacts, such as traditional Hawaiian fishing gear, such finds are unlikely because the APE is in the Halekulani Sand Channel, which experiences dynamic and fluctuating water conditions and was previously mined for sand to replenish Waikīkī beaches. The recommended finding for the assessment of adverse effects for the proposed undertaking pursuant to 36 CFR 800.5(d)(1) is "No adverse effect." The recommended effect determination for the proposed undertaking pursuant to HRS Chapter 6E and its implementing regulations at HAR §13-275-7(1) is "No historic properties affected."

2) *Curtails the range of beneficial uses of the environment*

   The Proposed Action will not curtail the range of beneficials uses of the environment. Rather, the Proposed Action would result in beneficial uses of the marine ecosystem and associated species through the placement of permanent coral nurseries for coral restoration and improvement of fish habitat in the Waikīkī area. The Proposed Action will provide a suitable structure for participating agencies to regularly access and improve habitat restoration potential for the surrounding area. Further, the Proposed Action will improve local fishery productivity and protect the Waikīkī shoreline.

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

   The Proposed Action is consistent with HRS Chapter 344, State Environmental Policy, to conserve natural resources and enhance the quality of life. As discussed in various sections in this EA, deployment activities proposed for the Proposed Action are not expected to have adverse impacts to the surrounding natural resources and would be planned to avoid, minimize or mitigate any short-term impacts. Long-term project impacts will have a beneficial effect on the ocean environment.

4) *Substantially adversely affects the economic or social welfare of the community or State*

No significant impacts on the economic or social welfare of the community or the State are anticipated under the Proposed Action. Rather, the Proposed Action would generate short- and long-term economic vitality for the community by providing temporary construction job opportunities for the duration of project construction as well as increases in the visitor industry because of the new healthy reefs (e.g., hotels, dive shops, snorkel tours).

5) *Substantially adversely affects public health*

The Proposed Action would have no significant adverse effects on public health.

6) *Involves substantial secondary impacts, such as population changes or effects on public facilities*

The Proposed Action would neither induce secondary impacts nor negatively impact public facilities.

7) *Involves a substantial degradation of environmental quality*

The Proposed Action would not involve a substantial degradation of environmental quality. BMPs will be employed to avoid, minimize and mitigate construction-related impacts.

8) *Is individually limited but cumulatively has considerable effect on the environment or involves a commitment for larger actions*

The Proposed Action is not anticipated to result in cumulative effects and would therefore not involve a commitment to larger actions.

9) *Substantially adversely affects rare, threatened, or endangered species, or its habitat*

The Proposed Action is not anticipated to have substantial effects on rare, threatened, or endangered species, or any critical habitat. Although endangered plants, animals, and marine species may be present, BMPs will be implemented to avoid any adverse effects on their populations or critical habitats. Regarding the possibility of proximity to critical habitat, construction BMPs and coordination with public agencies will minimize the possibility of potential impacts to the biological resources within the project site during the construction period.

10) *Substantially adversely affect air or water quality or ambient noise levels*

No significant impacts on the area's long-term air or water quality or ambient noise levels are expected to result from the Proposed Action. BMPs will be implemented to minimize temporary impacts during construction activities. Dust abatement measures will be used to reduce potential impacts on air quality. In addition, construction noise that exceeds DOH guidelines will be mitigated.

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

The Proposed Action would not affect environmentally sensitive areas such as a floodplain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, and fresh water. Every effort will be made through stringent BMPs and agency coordination to prevent damage to coastal waters and benthic habitats.

12) Substantially affects scenic vistas and view planes identified in county or state plans or studies

The Proposed Action would not adversely affect the visual aesthetics of the areas identified in City and County or State plans and studies.

13) Requires substantial energy consumption

The Proposed Action would not require substantial energy consumption.

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APPENDIX A

BENTHIC SURVEY REPORT
REEFRAME PROJECT
REEFRAME: RESTORATION OF SEVERELY DEGRADED CORAL REEFS IN HAWAIʻI VIA PERMANENT CORAL NURSERIES ON 3D PRINTED CONCRETE REEF FRAMEWORKS

DATED APRIL 13, 2026

Benthic Survey Report
REEFrame Project

REEFrame: Restoration of Severely Degraded Coral Reefs in Hawai‘i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks

NOAA Award Number: NA23NMF4630084-T1-01

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Date:
April 13, 2026

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List of Acronyms and Abbreviations

APE	Area of Potential Effect
BMPs	Best Management Practices
CoOs	Corals of Opportunity
CReME	Coral Resilience Module Experiment
DAR	Division of Aquatic Resources
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FR	Federal Register
GPS	Global Positioning System
IPaC	Information for Planning and Consultation
PCSI	Pacific Consulting Services Inc.
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
UH	University of Hawai‘i at Mānoa
USFWS	U.S. Fish and Wildlife Service

1. Overview of the Proposed Action

1.1 Purpose of the Proposed Action

Funded by a $9 million grant from the National Oceanic and Atmospheric Administration's (NOAA) Office of Habitat Conservation, REEFrame will help restore Waikīkī's coral reefs by creating permanent undersea structures for enhancing coral habitat. This project seeks to restore coral habitat and simultaneously provide other environmental benefits like fish habitat. Developed in collaboration with Conservation International, the University of Hawai'i at Mānoa (UH), the Hawai'i Division of Aquatic Resources (DAR), ocean technology firm Natrx, ocean engineering firm Oceanit, archaeologists at Pacific Consulting Services Inc. (PCSI), and workforce development nonprofit ClimbHI, REEFrame was born from the shared desire to mālama (care for) our beloved island home.

1.2 Project Location and Existing Conditions

Urbanization, erosion and climate change have accelerated the decline of Waikīkī's coral reef ecosystem. Today, this ecosystem is among the most degraded in Hawai'i with the lowest herbivorous fish density in Hawai'i (Franklin et al. 2013; Donovan et al. 2023). REEFrame is a step towards restoring the important marine ecosystem of Waikīkī.

The REEFrame Project Area is at the mouth of the 'Āpuakēhau Channel along the south coast of O'ahu in Honolulu, Hawai'i as depicted in Figure 1. The Project Area is 0.52 to 0.75 miles off Waikīkī Beach in water depths between 40 to 60 feet. At these depths, REEFrame will avoid high wave energy, avoid potential effects on surf sites, and enable feasible underwater restoration activities. The Project Area will cover an area that measures 11.4 acres. The project's Area of Potential Effect (APE) encompasses possible areas that would be used in construction and installation activities and is much larger than the estimated actual footprint of the REEFrame modules.

In the proposed location, the seafloor composition is generally unconsolidated sediment and primarily consists of sand and rubble. Coral cover is generally low, hence the placement of the REEFrame structures will not have negative impacts on significant biological resources like living corals, endemic algae, and mobile marine invertebrates. Finally, the identified REEFrame site is adjacent to a natural reef which will provide corals of opportunity (CoOs) to seed REEFrame along with potential for natural coral recruitment. In turn, REEFrame will be situated in an accessible location for future coral restoration.

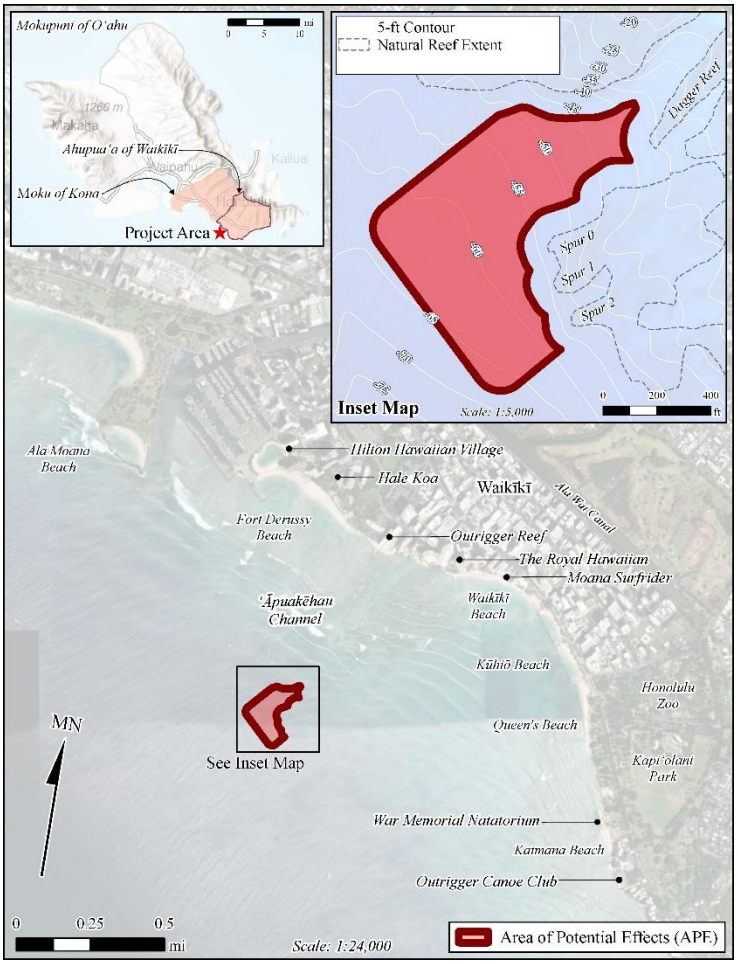


Figure 1. REEFrame APE (Image credit: PCSI)

The site was selected based on the following three considerations:

1. **Proximity to Restorable Coral Reef**: To function as a coral nursery, REEFrame should be adjacent to an area suitable for coral reef restoration. To select a preferred site location, the adjacent reefs were inspected for signs that transplanted corals from the nursery would have suitable conditions for coral growth.

2. **Water Depth**: Water depth at the REEFrame site is an important design consideration because greater water depth reduces the likelihood that wave forces will cause damage to the nursery. Deeper water also reduces the likelihood that the project will cause changes to wave characteristics at nearby surfing sites and affect safe navigation by ocean vessels. Shallower water is better for coral growth and makes coral nurseries more accessible, ensures safe operating depths for SCUBA divers, and therefore, more practical for restoration activities. To balance these considerations, REEFrame was designed to be installed at a depth range of about 40 to 60 feet.

3. **Seafloor Composition**: The composition of the seafloor at the selected site is important to reduce negative impacts on marine life. The chosen deployment areas consist of

unconsolidated sand with minimal algal cover, which will ensure that no existing corals are damaged by the project. To further minimize impact, modules will be installed a minimum of 100 feet from any nearby reef.

1.3 Description of the Proposed Action

The REEFrame project is intended to establish permanent coral nurseries off Waikīkī Beach comprising naturally shaped, stacked 3D-printed concrete modules created using innovative DryForming™ technology. The modules will contain holes, crevasses, ledges and other intentional design elements to help mimic a natural reef structure while simultaneously providing shelter space for colonizing fishes and invertebrates.

These modules will have attachment points for CoOs, which are healthy coral colonies and fragments that have been dislodged by storms or human activity, and used in cost-effective restoration efforts to regrow reefs. CoOs are valuable resources for nurseries and outplanting to boost coral resilience and recovery by providing coral pieces that can quickly return ecological services. CoOs are used in coral restoration projects across Hawai‘i by multiple organizations and restoration practitioners.

The REEFrame modules are intended to serve as permanent ecologically functional reefs, colonized by naturally occurring coral larvae and other marine life, and serve as habitat for outplanted corals that may be used in future restoration efforts. The modules are designed to be resistant to wave forces and provide shelter for beneficial species. They will have multiple levels of complexity that provide refuge for reef species known to benefit corals. The habitat features (surface texture, grooves, holes, and overhangs) are created using innovative DryForming™ technology and will enhance the biodiversity and provide ecosystem services to benefit CoOs and natural recruitment. This ecosystem-based approach to coral restoration provides an example of how habitat enhancement features can play a critical role in coral restoration efforts.

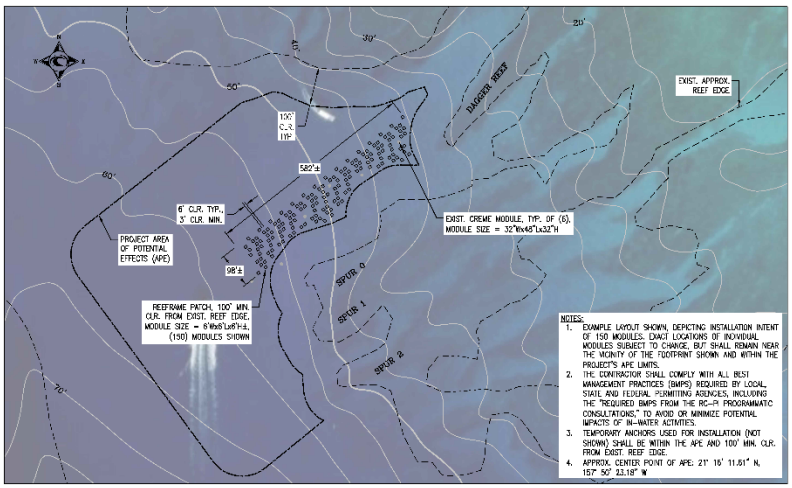


Figure 2. Potential REEFrame Site Plan (Image credit: Oceanit)

1.4 Feasibility Study: Coral Resilience Module Experiment (CReME)

The REEFrame Project is grounded in the foundational research conducted by Dr. Mark Hixon and graduate students at the University of Hawai‘i at Mānoa through the Coral Resilience Module Experiment (CReME). Initiated in summer 2016, the CReME project deployed standardized concrete structures to evaluate their effectiveness for supporting coral recruitment, coral transplantation, and reef-associated herbivores. Six concrete modules, each approximately one cubic yard in volume, were deployed in both low and high-shelter configurations near two contrasting reefscapes on O‘ahu: a degraded reef offshore of Waikīkī Beach and a relatively healthy, fully protected reef at Hanauma Bay.

The experiment was designed to test three primary hypotheses related to coral restoration mechanisms:

1. Herbivore Hypothesis: Higher herbivore biomass reduces algal overgrowth and enhances coral recruitment, survival, and growth.
2. Shelter Hypothesis: Greater structural shelter increases herbivore abundance, benefiting coral recruits and juveniles.
3. Reefscape Hypothesis: Healthier surrounding reefs support more herbivores and lower algae, leading to improved coral performance.

Results demonstrated that standardized concrete modules provide suitable and durable settlement surfaces for corals, whether recruited naturally or transplanted as corals-of-opportunity (CoOs). In addition, modules with higher structural complexity consistently supported greater biomass of herbivorous fishes and sea urchins compared to low-shelter modules at both study sites (Dilley et al. 2026).

Phase One: Natural Coral Recruitment (2016-2020)

The first phase of the CReME project focused on patterns of natural coral settlement, survival, and growth over time, addressing a critical gap in understanding early coral demographic processes essential for reef recovery. Settling corals from three dominant genera (*Pocillopora*, *Montipora*, and *Porites*) were surveyed quarterly for nearly four years. Surveys documented individual colony settlement, survivorship, and growth on the concrete modules.

Overall, herbivorous fishes and sea urchins colonized modules in greater abundance at Hanauma Bay than at Waikīkī, particularly on high-shelter modules. Correspondingly, algal overgrowth of juvenile corals was lower at Hanauma Bay. Coral demographic responses, however, were highly genus, site, and treatment-specific and generally did not strongly corroborate the three *a priori* hypotheses. The Herbivore Hypothesis was partially supported, as survival and growth of *Montipora* and survival of *Porites* were positively correlated with herbivorous fish biomass across sites. In addition, recruitment and survival of *Pocillopora* were negatively correlated with algal overgrowth across both reefscapes. The Shelter Hypothesis was mostly rejected, with limited support observed only for *Pocillopora* recruitment at Hanauma Bay and for survival of *Pocillopora* and *Porites* across sites. The Reefscape Hypothesis

received greater support, with healthier reef conditions positively influencing *Pocillopora* survival and *Montipora* recruitment and growth. Collectively, results from Phase One indicate that juvenile corals are more likely to thrive in environments with sufficient herbivory and lower nutrient-driven algal growth, even when structural enhancement alone is insufficient.

Phase Two: Active Restoration Experiments (2020-Present)

The second phase of the CReME project expanded to test active coral restoration approaches, including coral-of-opportunity transplants and herbivore additions. The source of transplanted corals for the REEFrame modules will at least initially be CoOs dislodged from nearby natural reefs via either natural wave surge or human-caused disturbance (e.g., anchor drags). To test this with the CReME modules, Dr. Hixon and lab transplanted naturally broken branches of antler coral (*Pocillopora grandis*) in 2020 (n=12), 2022 (n=28), 2023 (n=7), and eight naturally dislodged colonies of cauliflower coral (*Pocillopora meandrina*) in 2022. The 12 antler coral branches transplanted in 2020 were all small (approximately 15 centimeters long), and all but two died within eight months, likely due to predation by cushion stars (*Culcita novaeguineae*). The remaining 35 antler coral branches were larger (approximately 30 centimeters long) and all but one has survived to present, most showing substantial growth. Transplanted cauliflower coral colonies were all large (approximately 30 centimeters diameter), and all but two have survived to present, the fatality of one caused by cushion stars and the other from breaking off the module.

Efforts were also made to control algae through sea urchin transplants. Approximately 200 juvenile collector urchins (*Tripneustes gratilla*) raised at the DAR Urchin Nursery were transplanted to modules through three experimental methods. The urchin transplant attempts were unsuccessful most likely due to their ability to maintain attachment to the modules under wave conditions, having been cultured in onshore tanks with less water motion.

Lessons Learned and Application to REEFrame

Results from the CReME project provide critical guidance for the REEFrame Project design and implementation. The study demonstrates that placing concrete structures near intact reefs enhances coral restoration effectiveness by increasing coral larval settlement and herbivore presence. Outplanting of CoOs is a viable and effective restoration approach at the REEFrame site. The study also highlights the importance of herbivore replenishment in increasing coral restoration success and supporting natural reef recovery.

Findings related to urchin transplants have informed coordination with the DAR Urchin Nursery, with recommendations to raise urchins in surge tanks to strengthen tube feet prior to deployment. The REEFrame structures are designed with deep shelter crevices to reduce exposure to wave surge. In addition, given the documented predation pressure from cushion stars, close monitoring of cushion stars on REEFrame modules is recommended to enhance coral survivorship. Collectively, lessons learned from CReME directly inform REEFrame's adaptive design, site selection, and management strategies to maximize restoration success.

2. Study Methodology and General Findings

2.1 Survey Areas

The Proposed Action of the REEFrame project is within the project area of the CReME project. The REEFrame APE is larger than the actual footprint of the current REEFrame site plan, to account for construction and installation activities. Surveys collected for the CReME project can be applied to the REEFrame project area, as the REEFrame APE is comparable in benthic substrate. DAR conducted an additional survey of the entire project area on October 22, 2025, to complement previous surveys done by the CReME project. This section covers both CReME survey methodology and REEFrame survey methodology in two separate sub-sections with a subsequent results section combining the results of the two efforts.

2.1.1 CReME Project Methodology

Since 2016, Dr. Hixon and his lab at UH Mānoa have conducted surveys of the six CReME concrete modules collecting data on coral, herbivorous fish, urchins and algal cover.

Algal Overgrowth Assessment
Beginning in the third quarterly survey, algal competition at the colony scale was quantified by visually estimating benthic algal overgrowth on each coral colony. Overgrowth was scored into four quartiles (0-25%, 26-50%, 51-75%, 76-100% cover). For analysis, mean algal overgrowth per module per survey was calculated across all colonies.

Infaunal Surveys
Before the beginning of the CReME project, the infauna at the sand-bottomed study site (also the REEFrame site) was assessed through the courtesy of Dr. Julie Brock and lab. During Spring 2016, four replicate sand cores to a depth of about 10 centimeters were collected at randomized locations. Formalin preserved sediments were washed over a 0.5 millimeter mesh sieve. Retained material was sorted under a dissecting microscope and later identified.

Coral Surveys
Recruit and juvenile coral demography (recruitment, survival and growth) was monitored quarterly from May 2017 to March 2020. Surveys focused on the vertical north and south facing walls of each module.

Colonies were tracked individually through time. Data analyses focused on three dominant coral genera: *Pocillopora*, *Montipora*, and *Porites*. Colonies were grouped into four size classes (1-5, 6-10, 11-15, and 16-20 millimeters) to examine size-specific demographic patterns.

Herbivorous Fish and Urchin Surveys
During each coral survey, divers conducted visual censuses of herbivorous fishes and sea urchins within 1 meter of each module for approximately 10 minutes. All individuals were

identified and sized (fish total length, urchin test diameter). Size estimates were converted to biomass using published length-weight relationships. Both resident and transient herbivores observed during the census period were included.

2.1.2 REEFrame Project Area Methodology

The project area was surveyed by DAR to characterize the habitat and species composition. This was completed using underwater diver visual surveys. Divers carried a surface float with Global Positioning System (GPS) units to delineate their path. GPS units were programmed to take a point every 10 seconds. Divers then selected a swimming bearing that would cross the APE and hovered off the benthos so they could survey a 20 meter swath during their swimming transect (Figure 7). Once the divers reached the edge of the APE, the boat would signal for the divers to surface and repeat the process. Divers characterized the habitat type, complexity, and composition, and noted the presence/absence of fish species (Appendix A). Representative photos were taken to document the area and species observed. The ArcPro program (version 3.5) was used to upload GPS data and create maps to visualize data collected by divers. The GPS data were used to measure the total length of the transects and to determine the area surveyed. A total of 23,020 square meters, or 50% of the APE, was surveyed.

3. Findings

3.1 CReME Project

3.1.1 Benthic Invertebrate and Algal Surveys

Invertebrates: Quarterly diver surveys of the six CReME modules and six similarly sized natural coral patches (as reference sites) on the adjacent reef from 2016 to 2023 included occasional photographs of all sides of each module as well as counts of all large mobile macroinvertebrates on the modules. Over the seven years of the study, 16 different sea urchins, sea star and crustacean species were sighted (Appendix A).

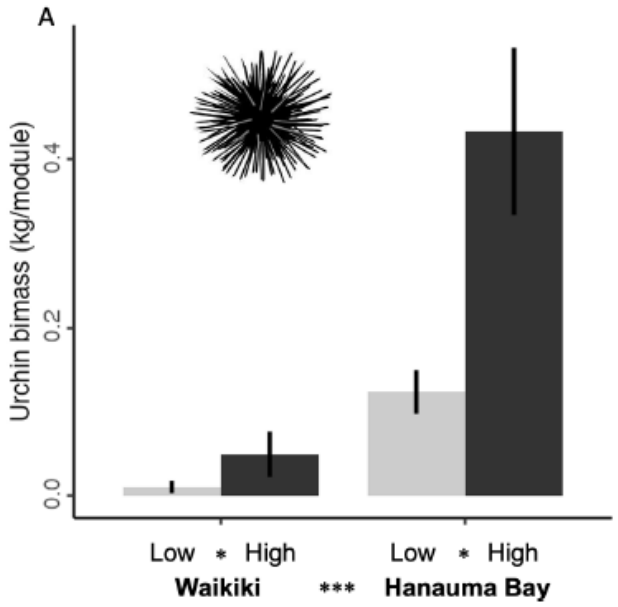


Figure 3. Urchin biomass recorded at low and high shelter CReME modules between 2017 and 2023 (Dilley et al. 2026). The original intent of this figure is to compare results. For the purposes of this report, only Waikīkī results are relevant to the REEFrame project.

Algae: By December 2016, all six modules were covered in turf algae, which were identified by physiological ecologist Dr. Celia Smith. Dr. Smith noted, "The samples were surprisingly similar in presence / absence of taxa across modules. Those marked with an asterisk in Table 1 were observed once but this is likely to be an underestimate as those taxa are generally common in many reef communities on O'ahu. Importantly, none of these eukaryotic entities appear to be invasive or non-indigenous taxa."

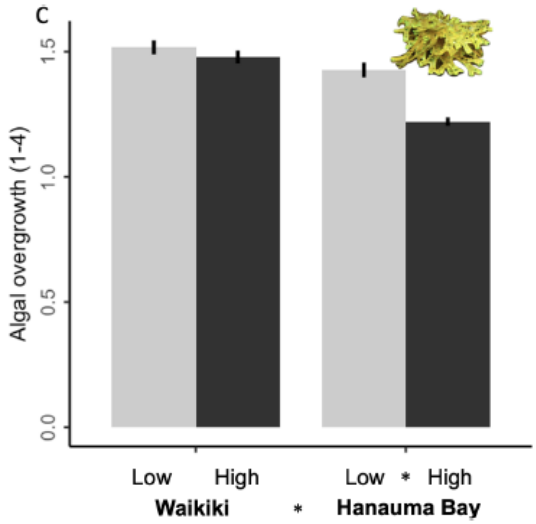


Figure 4. Mean level of algal overgrowth on coral colonies at low and high shelter CReME modules surveyed between 2017 and 2023 (Dilley et al. 2026). Numeric bins (1-4) were assigned to percent cover categories (1: 0-25%, 2:26-50%, 3: 51-75%, 4: 76-100% cover). The original intent of this figure is to compare results. For the purposes of this report, only Waikīkī results are relevant to the REEFrame project.

Table 1. Algae Present on CReME Modules

Phylogenetic group	Tentative genus identification
Cyanophyta	Small coccoid cells Unidentified filaments with sheaths in gel
Bacillariophyta	*Biddulphia* type of centric *Chrysanthemodiscus* *Climacosphenia* *Coscincodiscus* type of centric *Licmorphora* *Pleurosigma* type of pennate and other small unidentified diatoms
Chlorophyta	*Chaetomorpha* *Cladophora* *Derbesiod – Ostreobium* like siphon *Ulothrix* *
Ochrophyta	*Dictyota* Other Dictyotales *Padina* – like blade *Sphacelaria*
Rhodophyta	*Amansia* * *Anothrichium* *Centroceros* *Ceramium,* at least 2 species *Griffithsia* * *Jania* *Herposiphonia* *Hypnea* diminutive creeping species *Polysiphonia,* at least 2 species juvenile polysiphonous red *

3.1.2 Coral Surveys

Quarterly diver surveys of the six CReME modules from 2017 (when new corals first became visible) to 2020 (start of COVID-19 pandemic) included detailed data on the species and size of individual coral colonies, ranging as small as a single polyp (visualized via ultraviolet light and yellow visors) to several centimeters in diameter. These data were used to calculate survival and growth of the three dominant genera of corals – *Montipora*, *Pocillopora*, and *Porites* – as detailed in Appendix A. Also included are relatively uncommon data on corals of the genera *Diaseris*, *Fungia*, and *Leptastrea*.

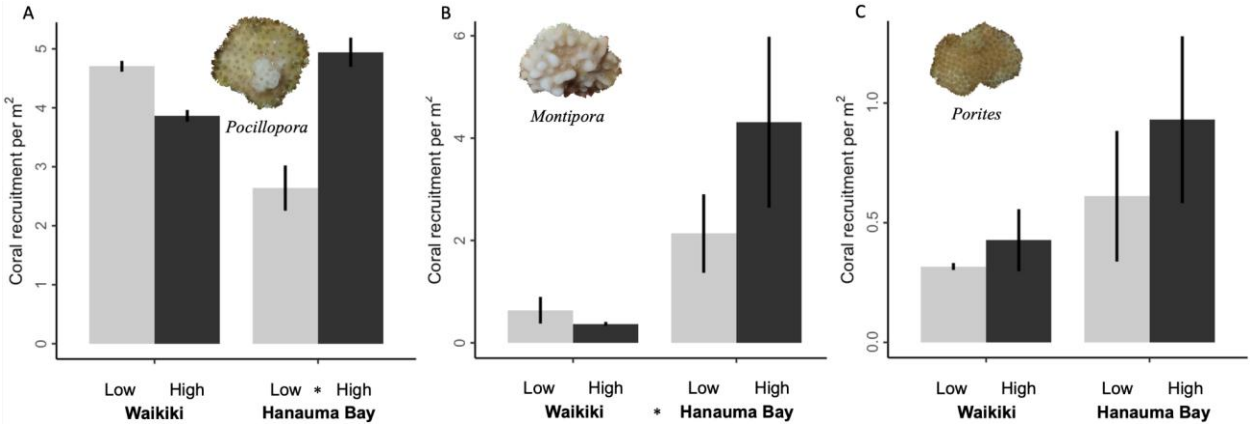


Figure 5. Mean coral recruitment by genus to low and high shelter CReME modules between 2017 and 2020 (Dilley et al. 2026). The original intent of this figure is to compare results. For the purposes of this report, only Waikīkī results are relevant to the REEFrame project.

3.1.3 Fish Surveys

Quarterly diver surveys of the six CReME modules and six similarly sized natural coral patches (as reference sites) on the adjacent reef from 2017 to 2023 included counts of all fish inhabiting and visiting each site. 95 fish species were seen at the CReME modules during surveys, which will be likely colonists of or visitors to the REEFrame structures (Appendix A).

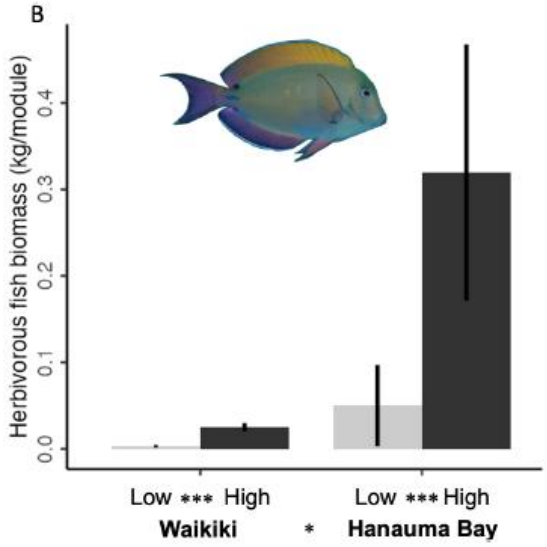


Figure 6. Mean herbivorous fish biomass recorded at low and high shelter CReME modules between 2017 and 2023 (Dilley et al. 2026). The original intent of this figure is to compare results. For the purposes of this report, only Waikīkī results are relevant to the REEFrame project.

3.1.4 Infaunal Surveys

Nematode worms, regarded as deposit feeders, were the most numerous taxon, being typically very abundant inhabitants of sediments. Nematodes were followed in abundance by marine oligochaete worms, polychaete worms, flatworms, mollusks, nemerteans, bryozoans, echinoderms, insects, and sipunculans. Crustaceans were not counted but included small crabs and copepods. A total of 28 species of polychaete worms representing 18 families were

collected. The most abundant polychaete was *Pionosyllis* sp.1, and syllids contributed most of the polychaetes. Other common polychaetes included *Micropodarke* sp.1 and *Armandia* sp.1. Most of the polychaete worms were motile species and carnivorous or omnivorous in their diets. These taxa are frequently found in reef sands from these depths off O‘ahu. There were no new records or new species. Detailed data are in Appendix B.

3.2 REEFrame Project Area

3.2.1 Benthic Survey

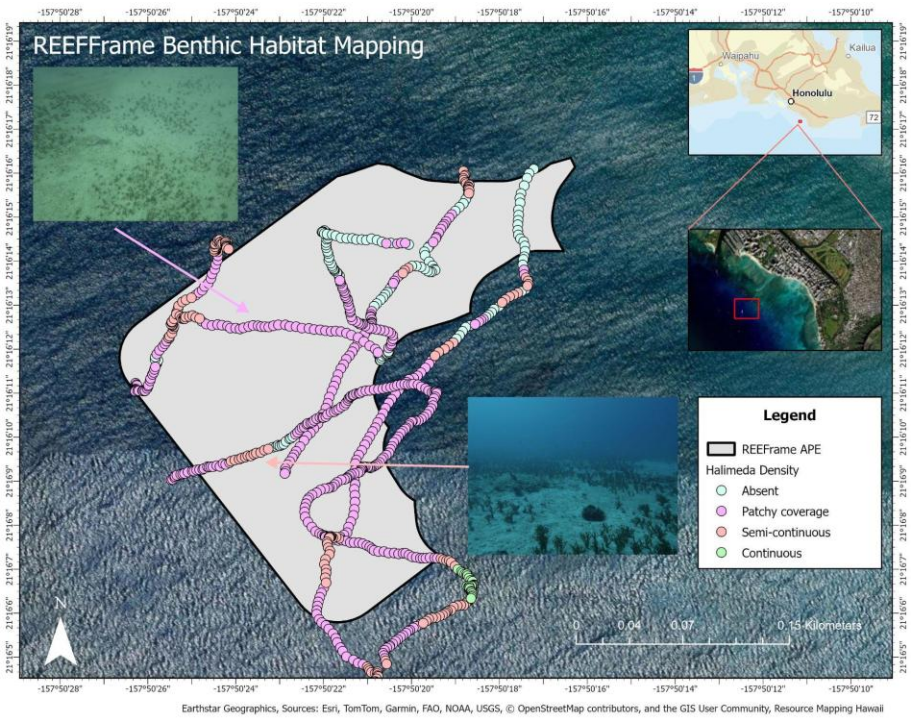


Figure 7. Benthic surveys were completed in the APE in October 2025. The habitat composition for the APE was classified as unconsolidated sediment, with the sediment type being sand. Each dot is color-coded by the density of the Halimeda kanaloana meadow. Photos were inserted to provide examples of density. (Image credit: DAR)

The sand habitat had a sparse coverage of *Halimeda kanaloana* meadows throughout the area. The overall density throughout the APE was patchy. Other algae species were observed living in the meadows, such as *Avrainvillea erecta*. These meadows were mainly found in deep water around Maui Nui. It is hypothesized that anthropogenic activities, such as the use of anchors, could have transported this species to O‘ahu (Spalding 2012).

3.2.2 Coral Survey

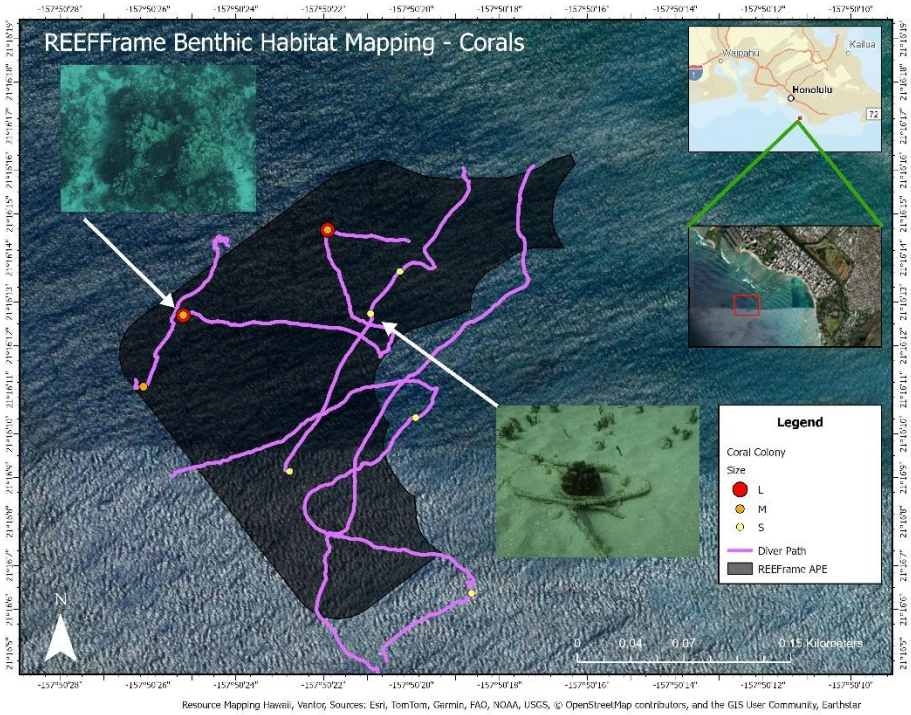


Figure 8. Benthic surveys identified the location of coral colonies found in the APE. The green lines indicate the survey path. The two large coral colonies found were *Porites lobata*, and were about 1 meter in size. Medium-sized colonies were 20 centimeters to 50 centimeters. Small colonies were anything under 20 centimeters. (Image credit: DAR)

Two coral species were observed in the APE: *Pocillopora meandrina* and *Porites lobata*, with an overall coral cover of less than 1%. The dominant species was *Pocillopora meandrina*. Most of the colonies were growing on discarded debris, such as pieces of metal or anchor line (see picture in Figure 8). The locations of the large *Porites lobata* colonies had high coral cover and should be avoided for deployment.

3.2.3 Fish Survey

12 fish species were observed, which are common species that inhabit sandy bottom habitats across O‘ahu. These species include: *Lutjanus kasmira, Sufflamen fraenatum, Fistularia commersonii, Paracirrhites arcatus, Iniistius umbrilatus, Thalassoma duperrey, Dascyllus albisella, Oxycheilinus bimaculatus, Sufflamen bursa, Scomberoides lysan, Heniochus diphreutes*, and *Malacanthus brevirostris* (Appendix A).

3.3 Results

3.3.1 Overview of Survey Efforts and Area

Biological surveys conducted within the REEFrame APE characterize an environment dominated by unconsolidated sandy substrate with low overall reef relief and sparse biological

cover. Data summarized here integrate long-term ecological monitoring conducted since 2016 within a subset of the larger proposed project site, and site-wide diver surveys completed in October 2025 across the full REEFrame project APE. Together, these datasets provide a comprehensive baseline of benthic habitat composition, coral abundance and size structure, associated fish assemblages, and benthic invertebrate communities within the proposed REEFrame deployment area.

3.3.2 Benthic Habitat Composition

Benthic habitat throughout the survey area is dominated by unconsolidated sandy sediment. Consolidated reef structure was limited and occurred primarily as small, isolated patches adjacent to, but largely outside of the proposed APE. Habitat complexity across the majority of the area is low.

Patchy meadows of *Halimeda kanaloana* were observed across portions of the survey area, with density varying spatially. These meadows were discontinuous and occurred primarily on sandy substrates, interspersed with areas of bare sand. Associated macroalgae was sparse, with occasional observations of *Avrainvillea erecta*. There was no evidence of continuous reef framework, high-relief substrate, or structurally complex benthic habitat within areas identified for potential module placement.

3.3.3 Coral Communities (Abundance and Size)

Overall coral cover within the survey area was low, estimated at less than 1%. Coral colonies were small, widely dispersed, and unevenly distributed across the landscape. Natural coral recruitment was documented on available hard substrate, including artificial structures and anthropogenic debris. Coral assemblages were dominated by three genera common to Hawaiian reefs: *Pocillopora*, *Montipora* and *Porites*. Colonies ranged in size from newly settled juveniles to larger established colonies, though the majority of observed colonies were small (<20 centimeters).

Two coral species were recorded during site-wide surveys: *Pocillopora meandrina* and *Porites lobata*. *Pocillopora meandrina* was the most frequently observed species and accounted for the majority of small colonies. Larger coral colonies were rare, but two large *Porites lobata* colonies (approximately 1 meter in diameter) were identified and mapped. These areas represent localized high-value coral habitat within an otherwise low coral cover environment and will be avoided during project deployment activities.

Transplants of CoOs conducted as part of the CReME project demonstrated that larger coral fragments (>30 centimeters) exhibited high survivorship and sustained growth when secured to stable substrates. Observed coral mortality was primarily associated with predation by cushion stars (*Culcita novaeguineae*).

3.3.4 Fish Assemblages

Fish assemblages within the survey area were composed primarily of reef and sand-associated species typical of low-complexity offshore habitats. A total of 95 fish species representing 38 families were documented across surveys.

Observed species included herbivores (e.g., surgeonfishes and parrotfishes) and transient predators. Fish abundance and diversity were greater in areas where shelter was available, including artificial structures and nearby natural reef patches, though overall herbivorous fish density was low relative to healthier reef systems in Hawai‘i.

Fish observed during site-wide surveys were common species expected in sandy bottom and patch-reef environments.

3.3.5 Benthic Invertebrates and Infauna

Surveys documented a diverse, but low-density assemblage of benthic invertebrates characteristic of sandy reef-adjacent habitats. Large mobile macroinvertebrates included multiple species of sea urchins, sea stars, and crustaceans. Sea urchin abundance was generally low across the survey area.

Infaunal sampling of sandy sediments revealed communities dominated by nematodes and polychaete worms. A total of 28 polychaete species representing 18 families were identified. Assemblage composition, feeding strategies, and diversity were consistent with previously documented infaunal communities from comparable depths and substrates around O‘ahu. No new infaunal taxa were observed.

4. Discussion

4.1 State- and Federally-Listed Marine Species

During some of the CReME surveys, pods of spinner dolphins (*Stenella longirostris*, federally protected) occasionally swam overhead and green sea turtles (*Chelonia mydas*, federally listed) occasionally visited the modules. Additional listed and protected species known to occur in the region include hawksbill sea turtles (*Eretmochelys imbricata*) and Hawaiian monk seals (*Neomonachus schauinslandi*). Coral species are protected by Hawai‘i State regulations, but no coral species that occur in Hawai‘i are currently federally listed.

NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) jointly administer the Endangered Species Act (ESA), with distinct jurisdictions based on species type.

Table 2. Federally listed species managed by NOAA Fisheries within the REEFrame area

Species/Common Name	ESA Status	Effective Listing Date/Federal Register (FR) Notice	Critical Habitat
Chelonia mydas Central North Pacific Green Sea Turtle	Threatened	05/06/2016 81 FR 20057	Proposed 07/19/2023 88 FR 46572
Neomonachus schauinslandi Hawaiian Monk Seal	Endangered	11/23/1976 41 FR 51612	9/21/2015 (revised) 80 FR 50925
Eretmochelys imbricata Hawksbill Sea Turtle	Endangered	06/03/1970 35 FR 8491	-

Critical Habitat in the Proposed Action Area

In designated areas of the Main Hawaiian Islands, critical habitat for monk seals includes the marine environment with a seaward boundary that extends from the 200-meter depth contour line (relative to mean lower low water), including the seafloor and all subsurface waters and marine habitat within 10 meters of the seafloor, through the water's edge 5 meters into the terrestrial environment (NOAA Fisheries 2015).

The specific areas within the designation, with their physical and biological features are:

1. Terrestrial areas preferred by monk seals for pupping and nursing with adjacent shallow, sheltered aquatic areas.
2. Marine areas from 0 to 200 meters in depth with water quality and sediment characteristics that support adequate prey quality and quantity for juvenile and adult monk seal foraging.
3. Significant areas used by monk seals for hauling out, resting or molting.

In areas of the Hawaiian Archipelago (Central North Pacific), the proposed critical habitat for green sea turtles includes the marine environment from the mean high water line to 20-meter depth (NOAA Fisheries 2023).

1. From the mean high water line to 20-meter depth, sufficiently dark and unobstructed nearshore waters adjacent to nesting beaches are proposed as critical habitat by USFWS, to allow for the transit, mating, and internesting of reproductive individuals, and the transit of post-hatchlings.
2. From the mean high water line to 20-meter depth, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and "potholes") and food resources (i.e., seagrass, marine algae, or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, or reproduction.

Essential Fish Habitat in the Proposed Action Area

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the 1996 Sustainable Fisheries Act, and the associated Essential Fish Habitat (EFH) regulations (NOAA 2002) require identification and protection of habitats used by federally managed fish species, including marine and anadromous species. Federal agencies that fund, permit, or carry out actions that may adversely affect EFH must consult with the National Marine Fisheries Service (NMFS).

USFWS Information for Planning and Consultation (IPaC)

Information for Planning and Consultation (IPaC) map tool by USFWS was used to identify any listed species, critical habitat, migratory birds or other natural resources within the REEFrame project APE. The IPaC report was produced not through a formal consultation effort and was used as a tool to inform this report. Table 3 provides a summary of the tools' results produced on April 10, 2026 with the full report in Appendix C.

Table 3. IPaC findings within the REEFrame APE accessed on April 10, 2026

	Scientific Name	Common Name	Listing Status
Birds	*Hydrobates castro*	Band-rumped Storm-petrel	Endangered
	Pterodroma sandwichensis	Hawaiian Petrel	Endangered
	Puffinus newelli	Newell's Shearwater	Threatened
	Phoebastria (=Diomedea) albatrus	Short-tailed Albatross	Endangered
Reptiles	*Eretmochelys imbricata*	Hawksbill Sea Turtle	Endangered
Critical Habitats	There are no critical habitats at this location.	N/A	N/A
National Wildlife Refuge lands	There are no refuge lands at this location.	N/A	N/A
Fish hatcheries	There are no fish hatcheries at this location.	N/A	N/A

4.2 Impact Assessment

The REEFrame Project Area is sited unconsolidated sandy substrate and incorporates a minimum 100-foot buffer from natural reef habitat, consistent with conditions requested by the DAR. As a result, no direct impacts to marine species, hard bottom, or natural reef structure are

anticipated. If live coral is found in the deployment area where modules will be placed, the team will work with DAR to secure a Special Activity Permit to relocate corals. Project-related disturbances from deployment are expected to be limited to the sandy seafloor and would be localized, minor, and short term in nature. The selected construction contractor will be required to follow all Best Management Practices (BMPs) and will be requested to use visual aids to ensure safe placement. These temporary effects are not expected to result in lasting degradation of benthic habitat. Over the long term, the project is anticipated to provide net ecological benefits by enhancing structural habitat complexity and supporting reef restoration objectives, which outweigh the impacts associated with deployment activities.

4.3 Recommended Mitigation Measures

Mitigation measures have been incorporated throughout the design, site selection and plans for implementation of the REEFrame Project to avoid and minimize potential environmental impacts while maximizing long-term ecological benefits. Having no project impacts within a 100-foot buffer ensures that no direct impacts to live coral, hard bottom, or natural reef structure are anticipated. Project activities are located to avoid known coral colonies, consolidated substrate, and areas of elevated biological complexity, and no work would occur within natural reef habitat. Deployment activities are designed to minimize disturbance to surrounding sediments and the water column. Structures are engineered for stability to prevent movement after installation.

Measures to protect biological resources are integrated into project implementation. All activities would comply with applicable federal and state regulations for protected species. If protected species are observed near active work areas, activities would be modified or temporarily halted as necessary to avoid disturbance. Structure designs incorporate shelter features intended to enhance habitat value for reef-associated species. Lessons learned from the CReME project regarding herbivore use and shelter have been incorporated into module design, including deep refuge spaces to reduce exposure to wave energy.

The project will follow all required BMPs to mitigate negative impacts. Although minor and short-term impacts to sandy substrate may occur during installation, these effects are expected to be temporary and reversible. Sandy habitats are naturally dynamic and routinely experience disturbance and recovery processes. Over the long term, the project is anticipated to provide net ecological benefits by introducing durable substrate in an area with limited natural structure, supporting CoO outplants, enhancing habitat for reef-associated fishes and invertebrates, and contributing to broader coral restoration objectives.

Post-deployment monitoring will be conducted to evaluate structure stability, coral survivorship, and biological utilization of the structures. Monitoring results would support adaptive management, allowing for adjustments to coral placement, predator management, or maintenance actions as needed to optimize ecological outcomes. Ongoing coordination with DAR and other resource agencies would ensure continued compliance with permit conditions and incorporation of best available science throughout project implementation.

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Appendix A: Combined Species List of Algae, Coral, Urchin, Sea Star, Crustacean and Fish Data

List of algae, coral, urchin, sea star, crustacean and fish species observed during both the CReME surveys and the October 2025 survey. Presence or absence indicated for each survey in the table below:

Table 4. Combined Species List of Algae, Coral, Urchin, Sea Star, Crustacean and Fish Data

Category	**Scientific name**	**Common name**	**CReME Surveys**	**Oct. 2025 Survey**	**Notes**
Algae	*Halimeda kanaloana*	N/A	Present	Present	N/A
Algae	*Avrainvillea erecta*	N/A	Present	Present	N/A
Coral	*Porites lobata*	Lobe coral	Present	Present	CReME: CoO outplant Oct 2025: Two large colonies (1m, should be avoided for deployment)
Coral	*Pocillopora meandrina*	Cauliflower coral	Present	Present	Dominant species in both survey efforts CReME: CoO outplant
Coral	*Montipora capitata*	N/A	Present	Absent	N/A
Coral	*Montipora patula*	N/A	Present	Absent	N/A
Coral	*Pocillopora grandis*	Antler coral	Present	Absent	CReME: CoO outplant
Coral	*Diaseris*	N/A	Present	Absent	N/A
Coral	*Fungia*	N/A	Present	Absent	N/A
Coral	*Leptastrea*	N/A	Present	Absent	N/A
Coral	*Cyphastrea ocellina*	N/A	Absent	Absent	N/A
Urchin	*Chondrocidaris gigantea*	Rough-spined urchin	Present	Absent	N/A

Category	Scientific name	Common name	CReME Surveys	Oct. 2025 Survey	Notes
Urchin	*Diadema paucispinum*	Long-spined urchin	Present	Absent	N/A
Urchin	*Diadema savignyi*	Savignyi's long-spined urchin	Present	Absent	N/A
Urchin	*Echinometra mathaei*	Rock-boring urchin	Present	Absent	N/A
Urchin	*Echinometra oblonga*	Oblong urchin	Present	Absent	N/A
Urchin	*Echinostrephus aciculatus*	Needle-spined urchin	Present	Absent	N/A
Urchin	*Echinothrix calamaris*	Banded urchin	Present	Absent	N/A
Urchin	*Echinothrix diadema*	Blue-black urchin	Present	Absent	N/A
Urchin	*Echinothrix* sp.	unknown	Present	Absent	N/A
Urchin	*Eucidaris metularia*	Ten-Lined Urchin	Present	Absent	N/A
Urchin	*Heterocentrotus mamillatus*	Red pencil urchin	Present	Absent	N/A
Urchin	*Tripneustes gratilla*	Collector urchin	Present	Absent	Urchin outplants used in CReME project
Urchin	*unknown unknown*	Unknown urchin	Present	Absent	N/A
Sea Star	*Acanthaster plancii*	Crown of thorns sea star	Present	Absent	N/A
Sea Star	*Culcita novaeguineae*	Cushion star	Present	Absent	N/A
Crustacean	*Parribacus antarcticus*	Sculptured slipper lobster	Present	Absent	N/A

Category	Scientific name	Common name	CReME Surveys	Oct. 2025 Survey	Notes
Fish	*Gymnomuraena zebra*	Zebra moray	Present	Absent	N/A
Fish	*Gymnothorax eurostus*	Stout moray	Present	Absent	N/A
Fish	*Gymnothorax flavimarginatus*	Yellowmargin moray	Present	Absent	N/A
Fish	*Gymnothorax meleagris*	Whitemouth moray	Present	Absent	N/A
Fish	*Gymnothorax undulatus*	Undulated moray	Present	Absent	N/A
Fish	*Scuticaria tigrina*	Tiger snake moray	Present	Absent	N/A
Fish	*Synodus dermatogenys*	Clearfin lizardfish	Present	Absent	N/A
Fish	*Synodus ulae*	Lizardfishes	Present	Absent	N/A
Fish	*Synodus variegatus*	Reef lizardfish	Present	Absent	N/A
Fish	*Myripristis berndti*	Bigscale soldierfish	Present	Absent	N/A
Fish	*Myripristis kuntee*	Pearly soldierfish	Present	Absent	N/A
Fish	*Sargocentron punctatissimum*	Peppered squirrelfish	Present	Absent	N/A
Fish	*Sargocentron xantherythrum*	Hawaiian squirrelfish	Present	Absent	N/A
Fish	*Sardinella marquesensis*	Marquesan sardine	Present	Absent	N/A
Fish	*Antennarius commerson*	Commerson's frogfish	Present	Absent	N/A
Fish	*Antennatus tuberosus*	Reticulated frogfish	Present	Absent	N/A

Category	Scientific name	Common name	CReME Surveys	Oct. 2025 Survey	Notes
Fish	*Acanthurus blochii*	Ringtail surgeonfish	Present	Absent	N/A
Fish	*Acanthurus dussumieri*	Eyestripe surgeonfish	Present	Absent	N/A
Fish	*Acanthurus nigrofuscus*	Brown surgeonfish	Present	Absent	N/A
Fish	*Acanthurus nigroris*	Blueline surgeonfish	Present	Absent	N/A
Fish	*Acanthurus olivaceus*	Orangeband surgeonfish	Present	Absent	N/A
Fish	*Acanthurus triostegus*	Convict tang	Present	Absent	N/A
Fish	*Ctenochaetus strigosus*	Goldring surgeonfish	Present	Absent	N/A
Fish	*Naso brevirostris*	Paletail unicornfish	Present	Absent	N/A
Fish	*Naso hexachanthus*	Sleek unicornfish	Present	Absent	N/A
Fish	*Naso unicornis*	Bluespine unicornfish	Present	Absent	N/A
Fish	*Zebrasoma flavescens*	Yellow tang	Present	Absent	N/A
Fish	*Apogon erythrinus*	Hawaiian ruby cardinalfish	Present	Absent	N/A
Fish	*Foa brachygramma*	Bay cardinalfish	Present	Absent	N/A
Fish	*Ostorhinchus maculiferus*	Hawaiian spotted cardinalfish	Present	Absent	N/A
Fish	*Pristiapogon kallopterus*	Iridescent cardinalfish	Present	Absent	N/A
Fish	*Exalias brevis*	Spotted coral blenny	Present	Absent	N/A

Category	Scientific name	Common name	CReME Surveys	Oct. 2025 Survey	Notes
Fish	*Caranx melampygus*	Bluefin trevally	Present	Absent	N/A
Fish	*Decapterus macarellus*	Mackerel scad	Present	Absent	N/A
Fish	*Scomberoides lysan*	Leatherback	Present	Present	N/A
Fish	*Chaetodon kleinii*	Blacklip butterflyfish	Present	Absent	N/A
Fish	*Chaetodon miliaris*	Milletseed butterflyfish	Present	Absent	N/A
Fish	*Chaetodon multicinctus*	Multiband butterflyfish	Present	Absent	N/A
Fish	*Chaetodon quadrimaculatus*	Fourspot butterflyfish	Present	Absent	N/A
Fish	*Heniochus diphreutes*	Pennant butterflyfish	Present	Present	N/A
Fish	*Cirrhitops fasciatus*	Redbarred hawkfish	Present	Absent	N/A
Fish	*Paracirrhites arcatus*	Arc-eye hawkfish	Present	Present	N/A
Fish	*Priolepis aureoviridis*	Golden green goby	Present	Absent	N/A
Fish	*Anampses chrysocephalus*	Psychedelic wrasse	Present	Absent	N/A
Fish	*Anampses cuvier*	Pearl wrasse	Present	Absent	N/A
Fish	*Bodianus albotaeniatus*	Hawaiian hogfish	Present	Absent	N/A
Fish	*Coris venusta*	Elegant coris	Present	Absent	N/A
Fish	*Cymolutes lecluse*	Hawaiian knifefish	Present	Absent	N/A

Category	Scientific name	Common name	CReME Surveys	Oct. 2025 Survey	Notes
Fish	*Halichoeres ornatissimus*	Ornate wrasse	Present	Absent	N/A
Fish	*Iniistius pavo*	Peacock razor wrasse	Present	Absent	N/A
Fish	*Iniistius pavo*	Blackside Razorfish	Absent	Present	N/A
Fish	*Labroides phthirophagus*	Hawaiian cleaner wrasse	Present	Absent	N/A
Fish	*Oxycheilinus bimaculatus*	Two-spot wrasse	Present	Present	N/A
Fish	*Pseudocheilinus evanidus*	Disappearing wrasse	Present	Absent	N/A
Fish	*Pseudocheilinus tetrataenia*	Fourline wrasse	Present	Absent	N/A
Fish	*Pseudojuloides cerasinus*	Pencil wrasse	Present	Absent	N/A
Fish	*Stethojulis balteata*	Belted wrasse	Present	Absent	N/A
Fish	*Thalassoma duperrey*	Saddle wrasse	Present	Present	N/A
Fish	*Monotaxis grandoculis*	Bigeye emperor	Present	Absent	N/A
Fish	*Lutjanus kasmira*	Bluestripe snapper	Present	Present	N/A
Fish	*Mulloidichthys flavolineatus*	Square-spot goatfish	Present	Absent	N/A
Fish	*Mulloidichthys vanicolensis*	Yellowfin goatfish	Present	Absent	N/A
Fish	*Parupeneus multifasciatus*	Manybar goatfish	Present	Absent	N/A

Category	Scientific name	Common name	CReME Surveys	Oct. 2025 Survey	Notes
Fish	*Parupeneus pleurostigma*	Sidespot goatfish	Present	Absent	N/A
Fish	*Centropygi potteri*	Potter's angelfish	Present	Absent	N/A
Fish	*Chromis hanui*	Chocolate-dip chromis	Present	Absent	N/A
Fish	*Chromis ovalis*	Oval chromis	Present	Absent	N/A
Fish	*Chromis vanderbilti*	Blackfin chromis	Present	Absent	N/A
Fish	*Dascyllus albisella*	Hawaiian dascyllus	Present	Present	N/A
Fish	*Stegastes marginatus*	Hawaiian gregory	Present	Absent	N/A
Fish	*Heteropriacanthus cruentatus*	Common bigeye	Present	Absent	N/A
Fish	*Ptereleotris heteroptera*	Indigo dartfish	Present	Absent	N/A
Fish	*Calotomus carolinus*	Stareye parrotfish	Present	Absent	N/A
Fish	*Scarus psittacus*	Palenose parrotfish	Present	Absent	N/A
Fish	*Scarus rubroviolaceus*	Ember parrotfish	Present	Absent	N/A
Fish	*Zanclus cornutus*	Moorish Idol	Present	Absent	N/A
Fish	*Bothus pantherinus*	Panther flounder	Present	Absent	N/A
Fish	*Caracanthus typicus*	Hawaiian coral croucher	Present	Absent	N/A
Fish	*Dendrochirus barberi*	Hawaiian lionfish	Present	Absent	N/A

Category	Scientific name	Common name	CReME Surveys	Oct. 2025 Survey	Notes
Fish	*Iracundus signifer*	Decoy Scorpionfish	Present	Absent	N/A
Fish	*Scorpaenodes kelloggi*	Kellogg's scorpionfish	Present	Absent	N/A
Fish	*Scorpaenopsis diabolus*	Devil scorpionfish	Present	Absent	N/A
Fish	*Sebastapistes fowleri*	Dwarf scorpionfish	Present	Absent	N/A
Fish	*Sebastapistes galactacma*	Galactic scorpionfish	Present	Absent	N/A
Fish	*Taenianotus triacanthus*	Leaf scorpionfish	Present	Absent	N/A
Fish	*Aulostomus chinensis*	Pacific trumpetfish	Present	Absent	N/A
Fish	*Doryrhamphus exisus*	Bluestripe pipefish	Present	Absent	N/A
Fish	*Melichthys niger*	Black triggerfish	Present	Absent	N/A
Fish	*Sufflamen bursa*	Lei triggerfish	Present	Present	N/A
Fish	*Sufflamen fraenatum*	Bridled triggerfish	Present	Present	N/A
Fish	*Cantherhines dumerilii*	Barred filefish	Present	Absent	N/A
Fish	*Cantherhines sandwichiensis*	Squaretail filefish	Present	Absent	N/A
Fish	*Cantherhines verecundus*	Sly filefish	Present	Absent	N/A
Fish	*Canthigaster coronata*	Crowned toby	Present	Absent	N/A
Fish	*Canthigaster jactator*	Hawaiian whitespotted toby	Present	Absent	N/A

Category	Scientific name	Common name	CReME Surveys	Oct. 2025 Survey	Notes
Fish	*Parapercis schauinslandi*	Redspotted sandperch	Present	Absent	N/A
Fish	*Malacanthus brevirostris*	Flagtail/Stripetail Tilefish	Absent	Present	N/A
Fish	*Fistularia commersonii*	Bluespotted Cornetfish	Absent	Present	N/A

Appendix B: Waikīkī Infaunal Data 2016

D. Waikiki Data

Taxon	Family	Troph.	Motility	Number of Individuals Replicate NW	NE	SW	SE	Total
POLYCHAETA								
Aonidella sp. 1	Spi	S	DM					
Armandia sp. 1	Oph	D	M		4	4	5	13
Augeneriellia sp. 1	Sab	S	T			1		1
Brania sp. 1	Syl	O	M					0
Capitella sp	Cap	D	M	1				1
Capitellidae sp.	Cap	D	M					0
Dispio sp. 1	Spi	D	DM					0
Eusyllinae sp.	Syl	O	M			2		2
Exogone sp. C	Syl	O	M	1	1			2
Glycera sp. 1	Gly	C	M			1		1
Hesionidae sp.	Hes	C	M			2		2
Hesionidae sp. D	Hes	C	M					0
Hesionura sp. 1	Phy	C	M			1		1
Heteropodarke sp. B	Hes	C	M					0
Levensenia sp. 1	Par	D	M				1	1
Linopherus sp. 1	Amn	C	M			1		1
Lumbrineris sp.	Lum	C	M	1				1
Magelona sp. A	Mag	D	DM					0
Magelona sp.	Mag	D	DM		1			1
Micropodarke sp. 1	Hes	C	M	1		26		27
Ophryotrocha sp. 1	Dor	D	M			1		1
Phyllodoce sp.	Phy	C	M			2		2
Pionosyllis sp. 1	Syl	O	M	43	13	82	19	157
Pionosyllis sp. G	Syl	O	M					0
Pionosyllis sp. H	Syl	O	M					0
Pionosyllis sp. 2	Syl	O	M					0
Pisione sp. A	Pis	D	M			1		1
Polyopthalmus sp. 1	Oph	D	M			9		9
Protodorvillea sp. 1	Dor	D	M				1	1
Protodrilus sp. 1	Pro	D	M		1			1
Pseudexogone sp. 1	Spi	D	DM					0
Scololepis sp. 1	Spi	D	DM					0
Salvatoria sp.	Syl	O	M		1		1	2
Sigambra sp. 1	Pil	O	M	1				1
Sphaerosyllis sp. 1	Syl	O	M			1		1
Sphaerosyllis sp. 2	Syl	O	M			2		2
Sphaerosyllis sp. G	Syl	O	M			9		9
Spio sp. 1	Spi	D	DM			1		1
Syllidae sp.	Syl	O	M				1	1
Syllides sp. 1	Syl	O	M			7		7

OLIGOCHAETA		146	247	80	76	549
NEMATODA		187	1104	488	180	1959
PLATYHELMINTHES		6	62	31	10	109
ECHINODERMATA						
Echinoidea			1			1
NEMERTEA		2	12	6	1	21
MOLLUSCA		9	11	1	2	23
INSECTA				4		4
SIPUNCULA						
Apionsoma misakianum		1				1
Sipuncula sp.		2				2
BRYOZOA		8	8	3	4	23
CHORDATA						
Branchiostoma sp. A				1		1
Total Individuals/Replicate		409	1466	767	301	
Total Taxa/Replicate		14	13	26	12	
Total Individuals Sampled						2943
Total Taxa Sampled						39
Total Polychaetes		48	21	153	28	
Total Taxa		6	6	18	6	
Trophic Summary for Polychate Taxa	Omnivores	10				
	Detritivores	10				
	Suspension Feeders	1				
	Carnivores	7				
Motility Summary for Polychaete Taxa	Motile	25				
	Discretely Motile	2				
	Tubicolous	1				
Trophic Summary for Polychaete Abundance	Omnivores	184				
	Detritivores	30				
	Suspension Feeders	1				
	Carnivores	35				
Motility Summary for Polychaete Abundance	Motile	247				
	Discretely Motile	2				
	Tubicolous	1				

Appendix C: IPaC Report at REEFrame APE

IPaC Information for Planning and Consultation

U.S. Fish & Wildlife Service

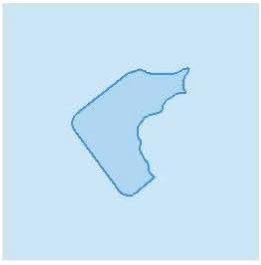
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Honolulu County, Hawaii



Local office

Pacific Islands Fish And Wildlife Office

(808) 792-9400
(808) 792-9580

MAILING ADDRESS
300 Ala Moana Boulevard, Box 50088
Honolulu, HI 96850-5000

PHYSICAL ADDRESS
300 Ala Moana Boulevard, Room 3-122
Honolulu, HI 96850-0056

NOT FOR CONSULTATION

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Band-rumped Storm-petrel Hydrobates castro No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1226	Endangered
Hawaiian Petrel Pterodroma sandwichensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6746	Endangered
Newell"s Shearwater Puffinus newelli Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2048	Threatened
Short-tailed Albatross Phoebastria (=Diomedea) albatrus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/433	Endangered

NOT FOR CONSULTATION

Reptiles

NAME	STATUS
Hawksbill Sea Turtle Eretmochelys imbricata Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3656	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act [2] and the Migratory Bird Treaty Act (MBTA) [1]. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their nests, should follow appropriate regulations and implement required avoidance and minimization measures, as described in the various links on this page.

The data in this location indicates that no eagles have been observed in this area. This does not mean eagles are not present in your project area, especially if the area is difficult to survey. Please review the 'Steps to Take When No Results Are Returned' section of the Supplemental Information on Migratory Birds and Eagles document to determine if your project is in a poorly surveyed area. If it is, you may need to rely on other resources to determine if eagles may be present (e.g. your local FWS field office, state surveys, your own surveys).

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Bald and Golden Eagle information is not available at this time

Bald & Golden Eagles FAQs

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are an eagle (Bald and Golden Eagle Protection Act requirements may apply).

NOT FOR CONSULTATION

Proper interpretation and use of your eagle report
On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort line or no data line (red horizontal) means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide you in knowing when to implement avoidance and minimization measures to eliminate or reduce potential impacts from your project activities or get the appropriate permits should presence be confirmed.

How do I know if eagles are breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If an eagle on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:
The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

NOT FOR CONSULTATION

Migratory birds

The Migratory Bird Treaty Act (MBTA) [1] prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (FWS).

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-

migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Migratory bird information is not available at this time

Migratory Bird FAQs

Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Avoidance & Minimization Measures for Birds describes measures that can help avoid and minimize impacts to all birds at any location year-round. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is one of the most effective ways to minimize impacts. To see when birds are most likely to occur and breed in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location, such as those listed under the Endangered Species Act or the Bald and Golden Eagle Protection Act and those species marked as "Vulnerable". See the FAQ "What are the levels of concern for migratory birds?" for more information on the levels of concern covered in the IPaC migratory bird species list.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) with which your project intersects. These species have been identified as warranting special attention because they are BCC species in that area, an eagle (Bald and Golden Eagle Protection Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, and to verify survey effort when no results present, please visit the Rapid Avian Information Locator (RAIL) Tool.

Why are subspecies showing up on my list?

Subspecies profiles are included on the list of species present in your project area because observations in the AKN for **the species** are being detected. If the species are present, that means that the subspecies may also be present. If a subspecies shows up on your list, you may need to rely on other resources to determine if that subspecies may be present (e.g. your local FWS field office, state surveys, your own surveys).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Bald and Golden Eagle Protection Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

NOT FOR CONSULTATION

Although it is important to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially BCC species. For more information on avoidance and minimization measures you can implement to help avoid and minimize migratory bird impacts, please see the FAQ "Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Proper interpretation and use of your migratory bird report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list does not represent all birds present in your project area. It is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide implementation of avoidance and minimization measures to eliminate or reduce potential impacts from your project activities, should presence be confirmed. To learn more about avoidance and minimization measures, visit the FAQ "Tell me about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Interpreting the Probability of Presence Graphs
Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:
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To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

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Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

NOT FOR CONSULTATION

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

NOT FOR CONSULTATION

APPENDIX B

EFH CONSULTATION VERIFICATION FORM AND REQUIRED BEST MANAGEMENT PRACTICES (BMPS) FROM THE RC-PI PROGRAMMATIC CONSULTATIONS

ESA CONSULTATION VERIFICATION FORM SIGNED DECEMBER 8, 2025

EFH Consultation Verification Form

NOAA OHC Restoration Center- Pacific Islands

And

NOAA Fisheries/PIRO/Habitat Conservation Division

The NOAA OHC Restoration Center- Pacific Islands (RC-PI) will use this Notification and Verification Form to notify PIRO HCD of proposed activities that meet the conditions of the Essential Fish Habitat (EFH) Programmatic. The RC-PI will submit this form together with supporting project information to EFHESAconsult@noaa.gov. Within 15 days of receipt of the *EFH Notification and Verification Form*, NMFS will email RC-PI to confirm whether the given activities comply or do not comply with the EFH Programmatic.

NMFS and/or the RC-PI can propose modifications to the verification form language by written agreement (email is acceptable) by the RC-PI and the PIRO EFH Branch Chief.

EFH MUS in the project area:

Present in Project Area?	Management Unit Species (Groups)	EFH for Eggs and Larvae	EFH for Juveniles and Adults
Yes	Bottomfish	Overall water column down to 400 m (Marianas and American Samoa) and 700 m depth (Hawaii) from shoreline out to the 200-mile U.S. Exclusive Economic Zone (EEZ) boundary. For eggs in Hawaii, out to 50 nautical miles and in Marianas and American Samoa out to EEZ.	Water column and all bottom from shoreline down to 400m depth
No	Seamount Groundfish	Water column down to 200m depth of all EEZ waters north of 28° and west of 180°	Water column and bottom from 120m to 600m depth, north of 28° and west of 180°, all EEZ
Yes	Pelagics	Water column down to 200m depth from shoreline out to EEZ boundary	Water column down to 1000m depth from shoreline out to EEZ boundary
No	Precious Corals	Known precious coral beds in the Hawaiian Islands located at: Keahole point, between Milolii and South Point, the Auau Channel, Makapuu, Kaena point, the southern border of Kauai, Wespac bed, Brooks bank bed, and 180 Fathom Bank	
Yes	Crustaceans	Crab: Water column down to 150m depth from shoreline out to EEZ boundary	Crab: Bottom from shoreline down to 100m depth

Type of Action:

☒ Vessel Operation

- ☒ Small Vessels (50ft or less)
- ☒ Large Barges

☒ Monitoring, Mapping, and Data Collection

☒ Coral Reef Restoration and Interventions

- ☒ Coral Collection and Transport
- ☒ Coral Outplanting
- ☐ Coral Nursery Development, Expansion, and Maintenance
- ☐ Coral Sexual Propagation
- ☐ Rubble Stabilization
- ☒ Reef Structure Installation
- ☐ Other intervention

☐ Watershed, River, Wetland, and Estuary Restoration

☐ Reduce Physical Impacts to Coral Reef Ecosystems

☒ Education and Outreach

Project Description:

REEFrame is a habitat restoration project intended to restore Waikīkī's coral reefs by creating and installing reef structures as permanent coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. REEFrame is a collaborative project led by Conservation International in partnership with the University of Hawai'i at Mānoa, the Hawai'i Division of Aquatic Resources, Natrx, Oceanit, ClimbHI, and Pacific Consulting Services Inc., and funded by NOAA's Office of Habitat Conservation.

The REEFrame technology is a strategic use of building blocks to foster coral growth. A REEFrame module comprises five total units, including four units that form the base and the fifth unit on top. The modules comprise concrete material with steel hardware covered in concrete coatings. Each module measures six feet wide and six feet tall. The design weight is an average of five tons and structurally designed to be stable in a 50-year southern swell storm event where wave heights may reach or exceed 18 feet. Approximately 150 modules will be placed on the sandy sea floor off Waikīkī'. Coral restoration activities will consist of attaching corals of opportunity and coral pyramid modules from the State of Hawai'i Division of Aquatic Resources Hawai'i Coral Restoration Nursery to the REEFrame modules.

Education and outreach activities include engaging community stakeholders, including but not limited to: resource management agencies, Waikīkī residents, cultural groups and kupuna, surfing community, fishers, scuba dive tour companies, wa'a (canoe) clubs, youth / schools, visitor industry, and the scientific community.



Figure 1: Typical REEFrame Module

Project Number:

Applicant:

Conservation International

Geographic Location (latitude/longitude):

21°16'11.61"N, 157°50'23.18"W

Project Purpose:

Waikīkī is the most iconic beach in Hawai'i, yet is one of the most degraded reefs in the islands, with low coral cover, structural complexity, and fish abundance. REEFrame will help restore Waikīkī's coral reefs by creating permanent coral habitat. REEFrame module structures are high-relief concrete structures onto which "corals-of-opportunities" will be attached both temporarily (nursery function) and permanently (restoration reef function), as well as attracting native species that benefit corals (e.g., herbivores). The project is designed to provide a suitable nursery for "corals of opportunity," which are living coral colonies previously dislodged by storms, ship groundings, anchor drags and other disturbances. These corals will be attached to the REEFrame modules, thereby creating coral reef habitat. By mimicking the complex shapes and surface textures of natural coral reef formations, REEFrame will be home to a diverse assemblage of herbivorous fishes and other marine life, such as urchins, that will help to control algae that compete with corals. Urchins from the State of Hawai'i Division of Aquatic Resources' coral nursery will also be added to the modules and serve as natural grazers. Over time, the complex structure of the REEFrame nurseries will be colonized by naturally settling coral larvae and eventually become coral reefs in their own right.

A preliminary feasibility study (Hixon CReME modules), initiated in 2016, has demonstrated the effectiveness of concrete structures in this location. The test structures have successfully attracted naturally settling coral larvae, fish, and invertebrates. Furthermore, both naturally settled colonies and corals of opportunity transplanted onto the test structures have shown high survival and growth. This success provides confidence that a scaled-up nursery will be effective for restoring Waikīkī reefs.

Describe project area:

The REEFrame location is approximately 0.5 miles off Waikīkī Beach off south Oahu in water depths between 40 to 60 feet in the Āpuakēhau Channel. The deployment area consists of unconsolidated sand and sediments with minimal algae cover. The proposed project will cover an area that measures 1,700 feet by 1,200 feet, or approximately 47 acres. The project area encompasses all possible areas that would be used in construction and installation activities and is much larger than the estimated footprint of the REEFrame modules.

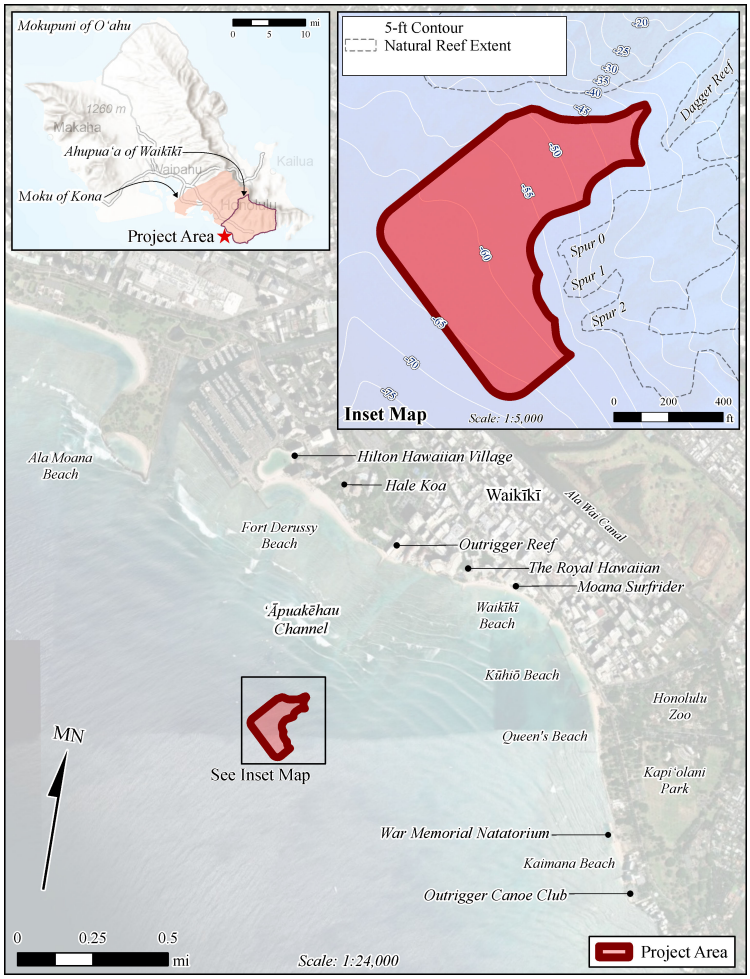


Figure 2: REEFrame site location.

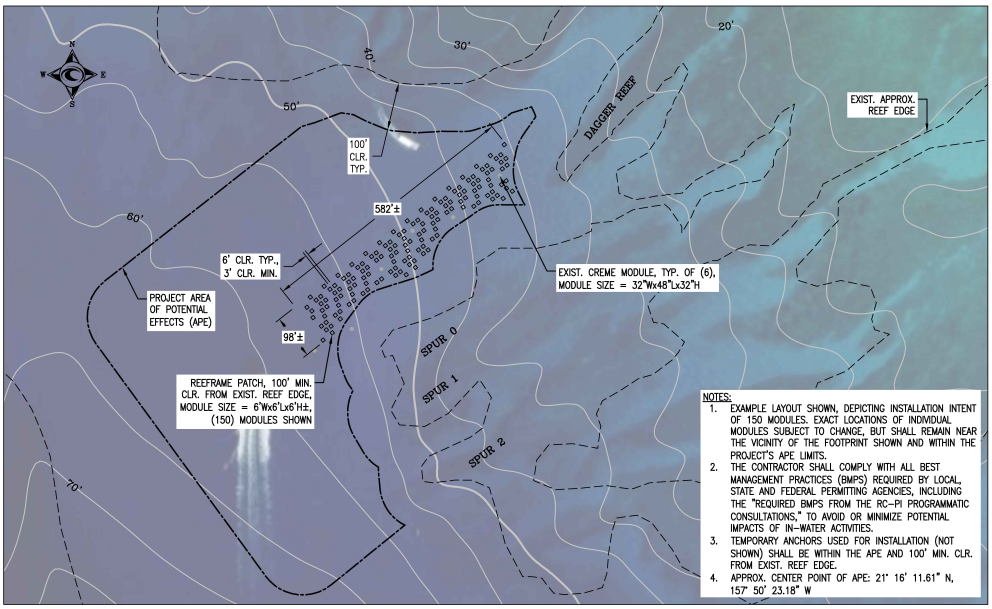


Figure 3: Example site plan for REEFrame. Exact locations of individual modules are subject to change.

Size of impact area:
47 acres

Presence or absence of in-water vegetation and/or corals:
Corals present on adjacent reef

In-water work duration:
Deployment: 2-4 weeks
Monitoring: 1-4 weeks per year
Coral Collecting and Outplanting: 2-8 weeks per year

Water depth:
40-60 feet

Are special aquatic sites in the project area? ☒ Yes ☐ No

☐ Sanctuaries and refuges
☐ Wetlands
☐ Mudflats
☐ Vegetated shallows
☒ Coral reefs
☐ Riffle and pool complexes

Type of Equipment to be Used to Complete Work:

REEFrame Module Installation: Barges, tugboats, or vessels to install and assist with installation. Barges and vessels may use dynamic positioning or a 4-point mooring system to remain on site. Project personnel will use cranes from a barge to lower the modules into place.

Monitoring: Small vessels will be used to transport divers and/or snorkelers to/from the REEFrame site to conduct visual or photographic surveys. These monitoring activities may include the temporary placement of tapes, light chains, or quadrats directly on the reef or seafloor. Long-term monitoring projects may use transect markers secured in hard ground, rubble, or sediment areas where they will not affect living corals. Long-term makers will be rebar or stainless steel rods or pins, no larger than 0.63-2.54 centimeters (cm) (0.25-1 in) diameter, which are driven into the seabed by divers using hand-held hammers. Divers may also use hand-held pneumatic drills to drill a hole no larger than 1.9 3.2 cm (0.75-1.25 in diameter) in the seabed to insert long-term markers. These holes may be filled with a marine safe epoxy (such as All-Fix, Marine Weld TM, and Splash Zone TM) to hold the pin in place. Divers may also mark pins with small floats on short stainless steel leaders and label them with tags to assist with relocation. Divers using Structure-from-Motion will use cameras to capture underwater photographs over reefs. Projects may also deploy cameras to monitor reef fish or other motile species. Moored instruments may be deployed to passively collect physical data (e.g. temperature recorders).

Coral Collecting and Outplanting: Small vessels will be used to transport SCUBA divers to/from the REEFrame site. Divers will attach corals using variety of methods including direct attachment, the use of a tile (e.g., ceramic, aragonite, or concrete tile or “plug”), or restoration modules (e.g., a disk or pyramid made from concrete or limestone). Project personnel may affix tiles or restoration modules using stainless steel rods and pins. The outplanting method used will depend on the size of the coral colonies, type (colony, fragment, or module), or the location (modules or nearby control site) where they will be transplanted. Divers may need to prepare substrates and remove fouling organisms before attaching corals. Coral attachment will use marine safe epoxy, cement/concrete, or other mechanical devices (e.g., plastic cable ties). When concrete is used, only Portland Type II cement, mixed with aggregates such as sand, gravel, recycled concrete, crushed stone will be used. Divers will use the minimum amount of epoxy or concrete needed to accomplish the project. To transport colonies, project personnel may use any of the following: baskets/trays, lift bags or buoyancy control device for baskets/trays holding coral, underwater drills, Diver Propulsion Vehicles (DPVs).

Provide the methodology and installation for the project activities (type of method, type of equipment to be utilized, etc.) and how equipment may affect the resource.

The REEFrame modules will be fabricated at the Natrx facility in Amelia, Louisiana, and transported to Hawai‘i. Construction of REEFrame will require construction barges with a mounted crane to carefully place the units on the sandy seafloor. Up to 150 REEFrame modules will be deployed and arranged in a pattern that complements the nearby natural reef formations. If 150 modules are installed, the total installation will have a footprint of approximately 12,675 sq. ft. on the seafloor. Coral attachment points will be incorporated on the REEFrame modules to aid in future coral outplanting to the modules.

To reduce negative impacts on existing coral habitat and wildlife, the chosen deployment area consists of unconsolidated sand and sediments with minimal algal cover. Additionally, all modules will be placed a minimum distance of 100 feet away from existing reef. REEFrame untis will be free

of any material that may risk water quality (dirt, dust, etc.) before they are deployed at the site. To help control the risks of inadvertently placing a structure on the natural reef, construction will proceed only during fair weather conditions at the site (calm waves, currents and winds). GPS will be used to confirm the placement locations of each module.

To help control the short-term risks of the construction activities on ocean water quality, the benthic environment, wildlife, and cultural resources, Best Management Practices (BMPs) will be established prior to the deployment of REEFrame.

Construction activities will commence upon obtaining permits and approvals, which is estimated to be in late 2026/early 2027. Once approvals are issued, on-site construction activities (deployment) are expected to take two to four weeks.

What are the substrate types on/in the project area? (http://www.pacioos.hawaii.edu/voyager/)

☐ Aggregate reef	☐ Aggregate patch reef
☒ Individual patch reef	☐ Pavement
☐ Pavement with sand channels	☐ Rock/boulder
☐ Reef rubble	☐ Scattered coral/rock
☒ Spur and groove	☐ Artificial
☐ Mud	☒ Sand
☐ Open water	☐ Other:

Has a survey been completed for the project area? ☒Yes ☐ No

Are photographs and/or videos of the project area available? ☒ Yes ☐ No

What are the potential adverse impacts expected from the action?
3.2 Physical Damage – Accidental physical abrasion may occur during REEFrame module installation, monitoring, or coral collecting and outplanting.

3.3 Iron Enrichment – May be caused by coral outplanting with pins. The steel inside the REEFrame units is enclosed in cement so is not expected to have an adverse impact.

3.4 Sedimentation - Resuspension of sediment during REEFrame module installation, monitoring, or coral collecting and outplanting may briefly cause sediment to resettle on corals in the immediate vicinity and increase turbidity.

3.5 Invasive Species - Species can be introduced via transport on equipment or vessel hulls.

3.6 Disturbance of infauna – Disturbance of infauna may occur during REEFrame module installation and coral collection.

3.8 Noise Pollution – The use of vessels, DPVs, and underwater drills may modify behavior of fishes or other coral reef inhabitants.

3.10 Removal/collection - The removal and collection of corals during coral collecting.

3.12 FAD effect – The installation of the REEFrame modules may naturally attract aggregations of fish.

Avoidance measures and best management practices to be implemented. Refer to conservation recommendations listed in the Programmatic:

All relevant Programmatic EFH Conservation Recommendations will be implemented, including recommendation 1, 2, 3, 4, 5, 6,7, 8, and 9.

RC-PI Initiation of EFH Programmatic Consultation

By submitting this Notification and Verification Form, the RC-PI indicates that the proposed activity meets the description of activities provided in the Programmatic EFH Consultation.

Conservation Recommendations:

☒ All conservation recommendations described in the EFH Programmatic Agreement will be implemented.

RC-PI Project Manager
Name: Shannon Ruseborn

Date:12/8/2025

By providing your name, you are certifying that to the best of your knowledge, the information provided in this form is accurate and based upon the best available scientific information.

NMFS Regional Office Determination (To be completed by PIRO EFH Coordinator):

After receiving the Notification and Verification Form, PIRO will contact RC-PI with any concerns and indicate whether PIRO concurs with the RC-PI determination within 15 days.

☒ PIRO concurs with RC-PI determination that the project complies with the Programmatic EFH Consultation.

☐ PIRO does not concur with RC-PI determination that the project complies with the Programmatic EFH Consultation, and additional information may be required. Please follow up for further discussion.

☐ PIRO does not concur with RC-PI determination that the project complies with the Programmatic EFH Consultation, and the RC-PI should initiate a separate individual consultation.

Authorization by NMFS Personnel

Name: DELANEY.DAVID.GRANAHAN.1595803329

Digitally signed by DELANEY.DAVID.GRANAHAN.1595803329
Date: 2025.12.09 07:28:35 -10'00'

Date:

APPENDIX A

ESA Consultation Verification Form

NOAA OHC Restoration Center- Pacific Islands

and

NOAA Fisheries, Pacific Island Regional Office,

Protected Resources Division

Programmatic ESA Consultation Verification Form

NMFS PCTS Number:
PIRO Reference Number: I-PI-25-2594-DG
Project Name: REEFrame
Subject: RC-PI Notification and Verification Form

This form constitutes the verification under the RC-PI Programmatic ESA Section 7 Consultation. The RC-PI has initially determined proposed action is not likely to adversely affect endangered or threatened under the Endangered Species Act (ESA) and NMFS jurisdiction to destroy or adversely modify designated critical habitat. The permittee will be required to comply with the RC-PI Programmatic Consultation general conditions, special conditions, and activity-specific best management practices (BMPs) to avoid effects to threatened and/or endangered marine species.

Date of Request: 12/8/2025
Date of Requested NMFS Response: 15-days from Date of Request
Applicant Name: Conservation International
Project Location: The REEFrame location is approximately 0.5 miles off Waikīkī Beach off south Oahu in water depths between 40 to 60 feet in the Āpuakēhau Channel.
Project Center Latitude & Longitude: 21°16'11.61"N, 157°50'23.18"W
RC-PI Project Manager Name: Shannon Ruseborn
Phone Number & Email: 808 725-5017; shannon.ruseborn@noaa.gov
Project Description: Provide justification, description of marine environment to be impacted, additional BMPs, special conditions, avoidance and minimization measures the applicant has proposed in order to comply with the RC-PI programmatic consultation the proposed project is not likely to adversely affect endangered or threatened species under NMFS jurisdiction or to destroy or adversely modify critical habitat. Attach map and drawings.
See below at end of form.

- ☑ Vessel Operation
  - ☑ Small Vessels (50ft or less)
  - ☑ Large Barges
- ☑ Monitoring, Mapping, and Data Collection
- ☑ Coral Reef Restoration and Interventions
- ☐ Watershed, River, Wetland, and Estuary Restoration
- ☐ Reduce Physical Impacts to Coral Reef Ecosystems

☑ Education and Outreach

NOAA Species/Critical Habitat Present in Action Area:

Identify all the species potentially found in the action area.

Marine Mammals and/or Sea Turtles:

☑ Green sea turtle (*Chelonia mydas*)
- ☑ Central North Pacific DPS (threatened) – Hawaii
- ☐ Central West Pacific DPS (endangered) – Guam/CNMI
- ☐ Central South Pacific DPS (endangered) – American Samoa

☑ Hawksbill sea turtle (*Eretmochelys imbricata*), endangered

☐ Hawaiian Insular false killer whales (*Pseudora crassidens*), endangered (Hawaii only)
- ☐ Indo-West Pacific DPS Scalloped Hammerhead shark (*Sphyrna lewini*), threatened (Guam/CNMI Only)

☑ Hawaiian monk seals (*Neomonachus schauinslandi*), endangered (Hawaii only)

☐ Giant manta ray (*Manta birostris*), threatened

Critical Habitat:

☑ Hawaiian monk seal (*Neomonachus schauinslandi*) critical habitat (Hawaii only)

☐ Hawaiian Insular false killer whales (*Pseudora crassidens*), critical habitat (Hawaii only)

☐ Threatened coral species, proposed critical habitat

☑ Green sea turtle (Chelonia mydas), proposed critical habitat
- ☑ Central North Pacific DPS (threatened) – Hawaii
- ☐ Central West Pacific DPS (endangered) – Guam/CNMI
- ☐ Central South Pacific DPS (endangered) – American Samoa

Threatened Coral Species in American Samoa:

☐ *Acropora globiceps*

☐ *Acropora retusa*

☐ *Acropora speciosa*

☐ *Isopora crateriformis*

☐ *Euphyllia paradivisa*

Threatened Coral Species in Marianas Islands (Guam and CNMI):

☐ *Acropora globiceps*

Proposed Giant Clam Species (Guam, CNMI, and American Samoa):

☐ Horse's Hoof Clam (*Hippopus hippopus*)

☐ Smooth Giant Clam (*Tridacna derasa*)

☐ True Giant Clam (*Tridacna gigas*)

RC-PI Conclusion:

☑ The proposed project is consistent with the RC-PI Programmatic Section 7 consultation, as described and checked above.

☐ The proposed project is consistent with the RC-PI Programmatic Section 7 consultation per the justification, BMPs, and/or special conditions provided above.

Shannon Ruseborn
RC-PI Signature

December 8,2025
Date

NOAA Fisheries Determination:

☒ NMFS concurs with the RC-PI determination that the proposed project is consistent with the RC-PI Programmatic Section 7 consultation as described and checked above.

☐ NMFS does not concur with the RC-PI determination that the proposed project is consistent with the RC-PI Programmatic Section 7 consultation as described and checked above and recommends a separate Section 7 consultation.

NMFS Representative Signature

December 10, 2025
Date

Project Description

REEFrame is a habitat restoration project intended to restore Waikīkī's coral reefs by creating and installing reef structures as permanent coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. REEFrame is a collaborative project led by Conservation International in partnership with the University of Hawai'i at Mānoa, the Hawai'i Division of Aquatic Resources, Natrx, Oceanit, ClimbHI, and Pacific Consulting Services Inc., and funded by NOAA's Office of Habitat Conservation.

The REEFrame technology is a strategic use of building blocks to foster coral growth. A REEFrame module comprises five total units, including four units that form the base and the fifth unit on top. The modules comprise concrete material with steel hardware covered in concrete coatings. Each module measures six feet wide and six feet tall. The design weight is an average of five tons and structurally designed to be stable in a 50-year southern swell storm event where wave heights may reach or exceed 18 feet. Approximately 150 modules will be placed on the sandy sea floor off Waikīkī'. Coral restoration activities will consist of attaching corals of opportunity and coral pyramid modules from the State of Hawai'i Division of Aquatic Resources Hawai'i Coral Restoration Nursery to the REEFrame modules.

Construction activities will commence upon obtaining permits and approvals, which is estimated to be in late 2026/early 2027. Once approvals are issued, on-site construction activities (deployment) are expected to take two to four weeks.

Project Justification

Waikīkī is the most iconic beach in Hawai'i, yet is one of the most degraded reefs in the islands, with low coral cover, structural complexity, and fish abundance. REEFrame will help restore Waikīkī's coral reefs by creating permanent coral habitat. REEFrame module structures are high-relief concrete structures onto which "corals-of-opportunities" will be attached both temporarily (nursery function) and permanently (restoration reef function), as well as attracting native species that benefit corals (e.g., herbivores). The project is designed to provide a suitable nursery for "corals of opportunity," which are living coral colonies previously dislodged by storms, ship groundings, anchor drags and other disturbances. These corals will be attached to the REEFrame modules, thereby creating coral reef habitat. By mimicking the complex shapes and surface textures of natural coral reef formations, REEFrame will be home to a diverse assemblage of herbivorous fishes and other marine life, such as urchins, that will help to control algae that compete with corals. Urchins from the State of Hawaii Division of Aquatic Resources' coral nursery will also be added to the modules and serve as natural grazers. Over time, the complex structure of the REEFrame nurseries will be colonized by naturally settling coral larvae and eventually become coral reefs in their own right.

A preliminary feasibility study (Hixon CReME modules), initiated in 2016, has demonstrated the effectiveness of concrete structures in this location. The test structures have successfully attracted naturally settling coral larvae, fish, and invertebrates. Furthermore, both naturally settled colonies and corals of opportunity transplanted onto the test structures have shown high survival and growth. This success provides confidence that a scaled-up nursery will be effective for restoring Waikīkī reefs.

Project location/description of marine environment

The REEFrame location is approximately 0.5 miles off Waikīkī Beach off south Oahu in water depths between 40 to 60 feet in the Āpuakēhau Channel. The deployment area consists of unconsolidated sand and sediments with minimal algae cover. The proposed project will cover an area that measures 1,700 feet by 1,200 feet, or approximately 47 acres. The project area encompasses all possible areas that would be used in construction and installation activities and is much larger than the estimated footprint of the REEFrame modules.

Avoidance and minimization measures

To reduce negative impacts on existing coral habitat and wildlife, the chosen deployment area consists of unconsolidated sand and sediments with minimal algal cover. Additionally, all modules will be placed a minimum distance of 100 feet away from existing reef. REEFrame untis will be free of any material that may risk water quality (dirt, dust, etc.) before they are deployed at the site. To help control the risks of inadvertently placing a structure on the natural reef, construction will proceed only during fair weather conditions at the site (calm waves, currents and winds). GPS will be used to confirm the placement locations of each module.

Construction will stop if a sea turtle, monk seal, or any other endangered or protected species enters the construction site or nearby vicinity.

The RC-PI will implement best management practices (BMPs) to help avoid, minimize, or reduce adverse effects from the action on ESA-listed species. The BMPs are described in detail in Section 6 of the February 27, 2025 BE. These measures include:

- General BMPs for all activities
- Vessel operations and anchoring
- SCUBA and snorkel operations
- Coral Restoration
- In-water equipment and sampling

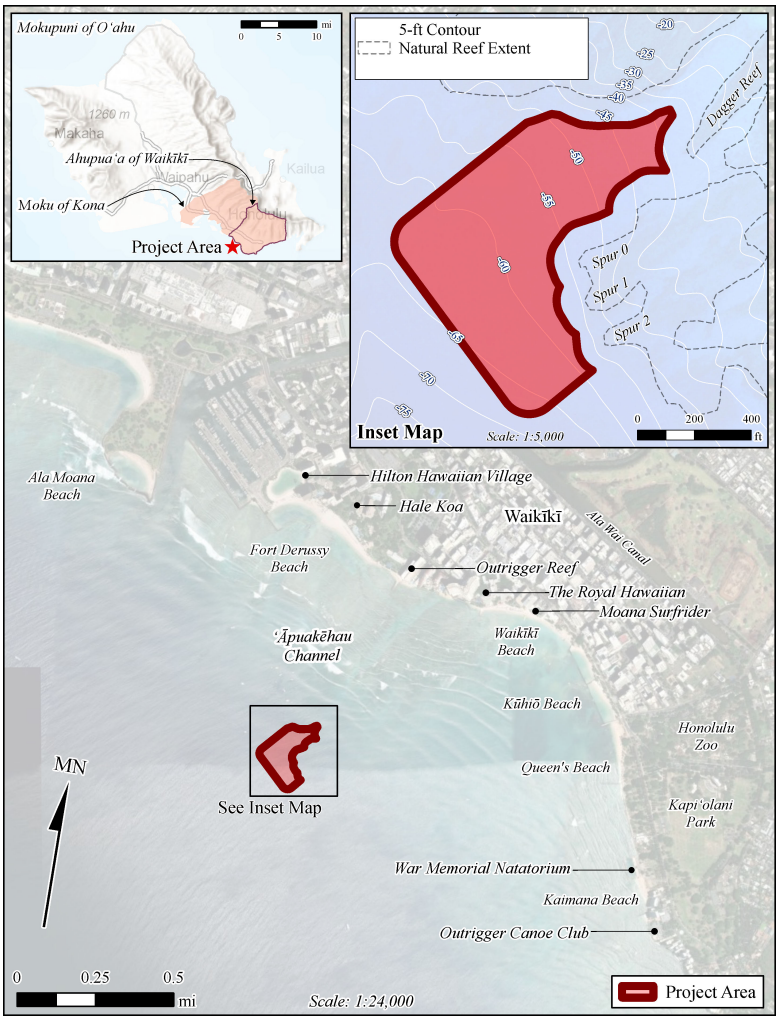




Figure 1: Typical REEFrame Module

NOAA Office of Habitat Conservation (OHC) Restoration Center – Pacific Islands (RC-PI)

Required Best Management Practices (BMPs) from the RC-PI Programmatic Consultations

Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) BMPs

RC-PI will implement the following BMPs for use during all activities to avoid or minimize potential impacts of in-water activities (i.e., monitoring, mapping, data collection, coral restoration, reduction of physical impacts, and outreach activities), watershed restoration activities, and vessel use to EFH resources, whenever practical and possible.

General BMPs

- Fueling of land-based vehicles and equipment shall take place at least 50 m away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
- Chemicals that are toxic/not marine-safe are excluded from use under this programmatic unless explicitly discussed and described in the activity descriptions in section 3
- All required Federal, State, and local permits will be in place before implementation of any RC-PI activities.

Vessel Operations and Anchoring

- Vessels used in implementing activities must meet all EPA Vessel General Permit and Coast Guard requirements for the control of pollution from air emissions, vessel discharges, and trash.
- Vessels should maintain a safe operating speed consistent with the area through which it is transiting. All vessels will operate at 'no wake/idle' speeds at all times while in water depths where the draft of the vessel provides less than a 2 meter (6 foot) clearance. All vessels will follow deep-water routes (e.g. marked channels) whenever possible. If operating in shallow water, all vessels will use a dedicated lookout to assist the pilot with avoiding large coral colonies.
- To reduce the risk of vessel impacts to coral reefs, colonized hard bottom, and seagrass areas, the vessel operator will carry and consult appropriate nautical charts, benthic habitat maps and aerial photographs, and/or use real-time data (e.g., global positioning system with nautical chart and depth finder on boat) to continuously observe and verify water depths and vessel location.
- Vessel operators should use recreational mooring buoys or live boating (boat operator keeps engine on to keep boat on station without anchoring) when possible. If anchoring, operators will only use designated anchoring areas or anchor in mud or sand.
- If anchoring is necessary, vessels should be anchored on uncolonized bottom. Vessels should not be anchored on a hard bottom that contains hard and/or soft coral, regardless of the percentage of coral cover present. The type of bottom present will be confirmed by divers/snorkelers, or from the vessel using a glass-bottom bucket or by other appropriate means, prior to anchoring.
- Commercial vessels will be operated by experienced staff who have applicable training and certifications to do so.

- Operational and maintenance standards for vessels will be practiced.
- Operations will only occur during preferable ocean conditions with contingency plans to cancel or delay the action for favorable weather conditions.
- In case of an emergency or safety situation, the captain and crew will rely on their expertise to anchor the vessel following the other established BMPs, if it is safe to do so.
- PI-RC and NMFS will be notified within 48 hours in the event a vessel is grounded and/or abandoned during the proposed action.
- Depending on the action, vessels will wait at a safe distance in deeper waters after deploying personnel overboard to avoid anchoring.
- Established moorings will be used to the greatest extent practicable.
- Anchors will be routinely monitored for slippage by the vessel crew and a watch will be maintained when personnel are onboard.
- Vessels will follow established transportation channels whenever practicable.
- Fueling operations will be done internally or in designated refueling areas.
- Vessels will take reasonable steps to alert other vessels in the vicinity of whale(s).
- Vessels will not allow lines to remain in the water, and no trash or other debris will be thrown overboard, thereby reducing the potential for marine mammal entanglement.
- The transit route for the vessels will avoid designated critical habitat to the extent practicable.
- Avoid direct contact such as anchor impact to corals, seagrass, or other sessile ESA- listed resources.
- Use designated anchorage areas when available.
- Avoid anchoring in and immediately adjacent to coral and seagrass.
- In-water tethers, as well as mooring lines for vessels and marker buoys will be kept taut and to the minimum lengths necessary, and will remain deployed only as long as needed to properly accomplish the required task.
- All objects and equipment will be lowered to the bottom in a controlled manner. This can include the use of equipment, divers, or buoyancy controls such as lift bags that affect positive control over the rate of descent.
- A contingency plan to control toxic materials will be required. A hard copy of the plan will be available on board the vessel, and will be discussed with all personnel to ensure quick response in case of spills, fires or materials unintentionally entering the water column.
- Appropriate materials to contain and clean potential spills will be stored on the vessel or at the worksites and be readily available.
- Fueling of land-based vehicles and equipment will take place at least 50 feet away from the water, preferably over an impervious surface. Fueling of vessels will be done at approved fueling facilities.

Self-Contained Underwater Breathing Apparatus (SCUBA)/Snorkel

- SCUBA divers/snorkelers involved in in-water activities will have proper training and be capable of responsible dive/snorkel practices (e.g., proper buoyancy) such that they minimize injury to organisms or cause unnecessary habitat impacts. It is the responsibility of NOAA and/or its grantees/contractors to ensure that divers/snorkelers are trained to a level commensurate with the type and conditions of the diving activity being undertaken. The organization must have the capacity (appropriate insurance, safety policies, etc.) to oversee all proposed diving/snorkeling activities.
- To minimize disturbances and damage (to animals and habitats), divers should use low-impact techniques, which include employing neutral buoyancy, point of entry/exit, the use of appropriate dive equipment and tools, expert boat anchoring (e.g., hand placement by divers/snorkelers or verified non-living bottom habitat before deployment), job-specific diver training, and diver awareness.

- Before entering the water, all divers shall be made aware of ESA-listed corals, and the requirement to avoid contact with the corals while performing their duties. This shall include taking measures to avoid kicking the reef with fins and to secure dive and survey equipment in a manner that will prevent these from being drug across the substrate.
- Divers should stay off the bottom and should never stand or rest on corals or other sessile benthic invertebrates.
- During all in-water activities, participants in education programs and other activities should avoid stepping on/standing on corals, and kicking coral colonies while swimming.

Coral Restoration

Coral Collection

- Corals collected for purposes of micro- fragmentation, propagation and outplanting will be collected from the same general location that they will be outplanted to, to mitigate for the spread of coral disease, aquatic invasive species, or parasitic organisms.
- Collection/sampling design of corals of opportunity will ensure that collection activities are distributed across shoreline/reef flat/benthic areas, so as not to consolidate the impacts of collection.
- Projects proposing the collection of coral fragments for use in laboratory/research/restoration studies shall take less than 15% of the colony unless it is clearly demonstrated that the removal of a larger amount will not negatively impact the survival of the coral or impact the local population of that species. For some species, greater than 50% of the colony including entire colonies will be collected, but the need to do this should be clearly demonstrated.

Coral Restoration/Transplantation/Relocation

- Projects involving the collecting corals for transplantation should only collect a minimal portion of the wild colony (e.g., no more than 15% of an attached wild colony is removed, when possible, colonies are removed from areas where there are competitive interactions and are likely to die or be overgrown), but these amounts will vary and can be greater when a need is demonstrated.
- Corals will be transported from source site to recipient site using methods that minimize high exposure to UV light, high temperatures, and will not be exposed directly to air during transport, if above surface (i.e. will be maintained in temperature-stable, clean, shaded seawater during transport).
- Upon arrival at the outplanting site (if using baskets/containers/platforms for transportation), team will confirm that the basket/container/platform is not lowered down into mud or sediment or raised or lowered without control or appropriate speed (i.e. containers holding corals will not be dropped onto sea floor without control).
- Methods will be utilized that enable the safe transport of colonies or fragments without abrading polyps or coral tissue through the transport method (e.g. careful placement of colonies or fragments in baskets or transport containers, low density of fragments per load and single layering of colonies). Divers will assist transport of colonies across the reef to ensure the stability of the platform and the buoyancy of the lift bags/surface buoys (if utilizing these tools).
- Tools and equipment will not be placed on live bottom substrate or any organism unless contact with the organism is a necessary component of the project. Divers will avoid contact with organisms wherever possible.
- Caching will only be used at sites and times of year where there is low energetic water motion, to avoid corals being dislodged from an upright position and abraded, broken, scoured or covered with sand or rubble.

Coral Nurseries

- A nursery maintenance and monitoring plan and timeline will be developed and included with the proposed project. The plan will include method(s) to be used to remove structures that are no longer needed, functional, or for a design that has become obsolete. Structures must be constructed in a manner that ensures the structures will not move or flip during storm events or due to human impacts such as anchor drag.
- Stabilization of structures can be achieved with the use of weights and/or penetrating anchor systems such as Duckbill® or Helix® anchors or rebar driven to sufficient depth to prevent movement or lifting of the structures.
- Floating structures that use lines as part of the support system or for attaching corals must be constructed in a manner to eliminate or minimize the chances of entanglement.:
    - Line nurseries must have, at a minimum, either horizontal or vertical components that are rigid (e.g., PVC pipe) to prevent the structures from collapsing and potentially causing entanglement of animals.
    - Vertical lines for anchoring structures to the seafloor must have sufficient tension created by buoys on the line to avoid slack or loops from forming and to keep the lines off the seafloor.
    - Buoys should be tied to the rigid component of the structure with the minimum use of line such that less than 50 cm (20 in) of line is exposed between each buoy and the structure.
    - Line used to attach corals vertically to the nursery structures must be no longer than 20 cm (8 in).
    - Horizontal lines must be at least 20 cm (8 in) apart and must be kept taut and supported by a rigid frame structure (PVC or similar) in order to avoid slack in the horizontal lines.
    - The use of monofilament lines instead of steel cables to reduce the need to replace cables regularly is acceptable as long as the lines for floating structures are kept taut and follow the recommendations above for new floating structures to avoid entanglement of marine organisms.

<u>In-Water Equipment and Sampling</u>

ROV/AUV

- ROV/AUV operators should have the training necessary to maintain and operate these vehicles at a depth above the seafloor and coral structures in order to avoid contact.
- ROV/AUVs will be operated at a max speed of 56 knots.
- Stiffer line materials should be used for towing and kept taut during operations to reduce the potential for entanglement in bottom features such as coral habitats.
- All vessel operation BMPs will also be followed during ROV/AUV operations.

Buoy Installation

- Buoys should only be installed at locations with no or low vertical relief and no coral colonization within a 3-m (~10- ft) radius from the buoy anchor location to avoid breakage or abrasion of sessile benthic organisms from the movement of buoy and tackle.
- A mid-line float should be attached to the buoy chain approximately 0.6 m (2 ft) above the chain attachment point to the bottom anchor in order to prevent the anchor chain from dragging on the seafloor should the chain become detached from the anchor.
- A helical screw anchor or drill and epoxied pin anchor, depending on substrate type,

should be used to minimize the footprint of the anchor in the marine bottom.
- An oversight vessel should be used to ensure no marine mammals or sea turtles are in the area during buoy installation. If marine mammals or sea turtles are observed within 50 meters, operations will cease until the animal has left the area.

Acoustic/Echosounder Use
- The following deployments are expressly excluded from coverage under this programmatic; the deployment of active acoustic devices, with the exception of systems that operate in frequency bands well outside the hearing ranges of ESA-listed marine life (such as certain wave and current monitoring systems operating above 200 kHz), and moorings with acoustic release devices that only transmit a brief signal during deployment, then again during recovery of the mooring.
- Use directional echosounders with the smallest beam width practicable to concentrate noise directly under the vessel to the maximum extent practicable.
- Minimize the use of all active acoustic systems (e.g., turn off all non-navigational echosounders when not actively mapping)
- Power down or turn off a mapping echosounder if a marine mammal is observed closely approaching or within 100 m of the vessel.

Moored Instruments
- The installation and removal of in-water structures for research equipment should be performed by divers. All equipment must be removed once the study is complete. Exceptions include anchors under the substrate which may be cut even with the seafloor so as not to disturb the benthos.
- Moored instruments should be securely placed on/anchored into uncolonized hard bottom areas of rubble or sand.
- Any lines associated with moored instruments should be taut to avoid the possibility of entanglement of protected species.

Reduce Impacts of Fishing Gear
- Projects involving the use of traps, nets, or other types of fishing gear used to sample fish populations should include measures to ensure the use of these gear types minimizes impacts to benthic habitats.
- Nets should be monitored at all times to ensure ESA-listed species and other non-target species do not become entangled. If entanglement does occur, the animals will be freed immediately in accordance with any existing guidelines (https://www.fisheries.noaa.gov/national/resources-fishing/fishing-tips-protect-sea- turtles-and-marine-mammals) and PIRC and NFMS PRD notified

Bottom sediment disturbing activities (to reduce sediment impacts to habitat and protected species)
- Turbidity and siltation from project-related work shall be minimized and contained through the appropriate use of erosion control practices, effective silt containment devices, the curtailment of work during adverse weather and tidal/flow conditions, and slow, gentle deployment of structures onto the seafloor.
- If operations are anticipated to increase sedimentation or suspended material longer than 24 hours, a plan will need to be submitted outlining actions to avoid impacts to coral spawning and recruitment.

Invasive Species and Disease
- When working in areas where there is an identified risk of spreading invasive species or

disease or if a particular activity can increase the chance of spreading invasive species or disease, grantees/principle investigators should ensure spread does not occur by decontaminating gear, vessels, and other equipment (see field manual by Woodley et al., 2008 and Coral Disease Decontamination Protocol 2019 for recommendations https://nmsfloridakeys.blob.core.windows.net/floridakeys-prod/media/docs/coral-disease-decontamination-protocol.pdf).

- Laboratory studies involving the use of live plants, animals, bacteria, and viruses should ensure proper steps are taken so that non-native species or pathogens are not introduced or spread as a result of the work.

Discharge, Waste, and Pollution Controls

On-site Pollution Controls

- A contingency plan to control toxic materials is required.
- Appropriate materials to contain and clean potential spills shall be stored at the work site, and be readily available.
- Heavy equipment in and near water bodies should consider the use of biofuels and non-petroleum-based hydraulic fluids.
- All project-related materials and equipment placed in the water shall be free of pollutants.
- The project manager and heavy equipment operators shall perform daily pre-work equipment inspections for cleanliness and leaks. All heavy equipment operations shall be postponed or halted should a leak be detected, and shall not proceed until the leak is repaired and equipment cleaned.
- Fueling of land-based vehicles and equipment shall take place at least 50 m away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
- Turbidity and siltation from project-related work shall be minimized and contained through the appropriate use of erosion control practices, effective silt containment devices, and the curtailment of work during adverse weather and tidal/flow conditions.
- A plan shall be developed to prevent debris and other wastes from entering or remaining in the marine environment during the project.
- Properly confine, remove, and dispose of construction waste, including every type of debris, discharge water, concrete, cement, grout, debris and sediment from the washout facility, welding slag, petroleum product, or other hazardous materials generated, used, or stored on-site.
- All vehicles and other heavy equipment will be (a) operated in a safe manner; (b) stored, fueled, and maintained in a vehicle staging area set back from any natural waterbody or wetland; and (c) inspected daily for fluid leaks before leaving the vehicle staging area.
- Generators, cranes, and any other stationary equipment operated within (50 m) of any natural waterway or wetland will be maintained as necessary to prevent leaks and spills from entering the water.
- Use procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities if a spill occurs. Heavy equipment can also leak oil and fluids. Equipment is always refueled away from stream corridors, and operators are required to have a spill response plan in place in case of a leak.

Watershed Restoration

Erosion Control

- Temporary erosion controls will be in place before any significant alteration of the

restoration site and will be monitored during construction to ensure proper function. The following erosion control structures or approaches may be used: turbidity curtains, hay bales, and erosion mats may be used where appropriate. When possible, stream flow would be diverted from work areas to prevent excess turbidity.

- Vegetation and soil disturbance will be confined to the minimum area and minimum length of time necessary to complete the action, and to otherwise prevent or minimize erosion associated with the action.
- Reduce the potential for erosion and head cuts through grade control structures or bank recontouring.
- Work will cease under high flows or seasonal conditions that threaten to disturb turbidity reduction measures, except for efforts to avoid or minimize resource damage.
- Exposed areas will be mulched and seeded after ground-disturbing activities are complete.
- Any woody debris, mature native vegetation, topsoil, and native channel material displaced by construction will be stockpiled for use during site restoration. When construction is finished, all streambanks, soils, and vegetation will be cleaned up and restored as necessary to renew ecosystem processes that form and maintain productive fish habitats.

Methods to Reduce Soil Compaction

- Existing access ways will be used whenever possible. Temporary access roads will not be built on slopes greater than 50%, where grade, soil, or other features suggest a likelihood of excessive erosion or failure. Soil disturbance and compaction will be minimized within 46 m (150 ft) of a natural waterbody or wetland. All temporary access roads will be removed when the action is completed, the soil will be stabilized, and the site will be revegetated. Temporary roads in wet or flooded areas would be restored shortly after the work period is complete.
- Heavy equipment will be selected and operated in a manner that minimizes adverse effects to the environment (e.g., minimally-sized, low-pressure tires, minimal hard turn paths for tracked vehicles, temporary mats or plates within wet areas or sensitive soils).
- To the extent feasible, heavy equipment will work from the top of the bank, unless work from another location would result in less habitat disturbance.

Adequate training of volunteers

- Training should be provided to ensure minimal impact to the restoration site by volunteers. Volunteers shall be trained in the use of low-impact techniques for planting, equipment handling, and moving around the restoration site to avoid unnecessary impacts on native flora and fauna.

Minimize pollution impacts on habitat and protected species

- Avoid using products with large concentrations of pesticides. All pesticides usage will require a Pesticide Usage Plan and follow guidelines provided by our office.
- Avoid planting vegetation when a severe storm is approaching.

Unmanned Aerial Vehicles (UAS) operations:

- All UAS will undergo a pre-flight test prior to deployment to ensure that the equipment is working properly and weather conditions are conducive to flying a mission.
- All UAS operations will be conducted with a pilot and a spotter to ensure that the UAS is monitored at all times.
- Should any UAS make an emergency landing in the water, small boats will be deployed immediately to retrieve the equipment to minimize potential for pollution (e.g. loss of gas or batteries into the marine environment).

Other

- All required Federal, State, and local permits will be in place before implementation of any RC-PI activities.
- Vessels used in implementing activities must meet all EPA Vessel General Permit and Coast Guard requirements for the control of pollution from air emissions, vessel discharges, and trash.
- Projects involving laboratory studies will follow the laboratory's environmental compliance guidelines and ensure that chemicals are disposed of in a proper manner, and comply with the ethical treatment of animals.

Endangered Species Act (Section 7) BMPs

National Marine Fisheries Service [NMFS]-managed species only

General BMPs that apply to all activities:

- Do not attempt to feed, touch, ride, or otherwise intentionally interact with any ESA- listed marine species.
- Observers will report when motile ESA-listed marine species are within 50 m of the proposed work and halt work, and work will only begin/resume after the animals have voluntarily departed the area.
- If ESA-listed motile marine species are noticed within 50 m after work has already begun, that work may continue only if the activity will not adversely affect the animal(s).
- Fueling of land-based vehicles and equipment will take place at least 50 m away from the water, preferably over an impervious surface. Fueling of vessels will be done at approved fueling facilities.
- Chemicals that are toxic/not marine-safe are excluded from use under this programmatic unless explicitly discussed and described in the activity descriptions
- All required Federal, State, and local permits will be in place before implementation of any RC-PI activities.
- All structures and equipment will be removed from the environment and discarded appropriately onshore when they are no longer needed
- All objects and equipment will be lowered to the bottom in a controlled manner. This can include the use of equipment, divers, or buoyancy controls such as lift bags that affect positive control over the rate of descent.
- A contingency plan to control toxic materials will be required. A hard copy of the plan will be available on board the vessel, and will be discussed with all personnel to ensure quick response in case of spills, fires, or materials unintentionally entering the water column.
- Appropriate materials to contain and clean potential spills will be stored on the vessel or at the worksites and be readily available.
- A contingency plan to control toxic materials is required.
- Heavy equipment in and near water bodies should consider the use of biofuels and non- petroleum-based hydraulic fluids.
- All project-related materials and equipment placed in the water shall be free of pollutants.
- The project manager and heavy equipment operators shall perform daily pre-work

equipment inspections for cleanliness and leaks. All heavy equipment operations shall be postponed or halted should a leak be detected, and shall not proceed until the leak is repaired and equipment cleaned.

- Fueling of land-based vehicles and equipment shall take place at least 50 m away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
- A plan shall be developed to prevent debris and other wastes from entering or remaining in the marine environment during the project.

Vessel operations and anchoring:

- Constant vigilance will be kept for the presence of ESA- or MMPA-listed marine species during all aspects of the project, particularly in-water activities such as boat operations, diving, and deployment of anchors and mooring lines.
- When piloting vessels, vessel operators will alter course to remain at least 50 m from marine mammals and sea turtles.
- Reduce vessel speed to 10 knots or less when piloting vessels at or within the ranges described above from marine mammals and sea turtles. Operators will be particularly vigilant in watching for turtles at or near the surface, and if practicable, reduce vessel speed to 5 knots or less.
- Vessels will maintain a safe operating speed consistent with the area through which it is transiting. All vessels will operate at 'no wake/idle' speeds at all times while in water depths where the draft of the vessel provides less than a 2 meter (6 foot) clearance. All vessels will follow deep-water routes (e.g. marked channels) whenever possible. If operating in shallow water, all vessels will use a dedicated lookout to assist the pilot with avoiding large coral colonies.
- Marine mammals and sea turtles will not be encircled or trapped between multiple vessels or between vessels and/or the shore.
- When whales are sighted, maintain a distance of 100 meters or greater between the whale and the vessel.
- Vessel operators should use recreational mooring buoys or live boating (boat operator keeps engine on to keep boat on station without anchoring) when possible. If anchoring, operators will only use designated anchoring areas or anchor in mud or sand.
- Operations will only occur during preferable ocean conditions with contingency plans to cancel or delay the action for favorable weather conditions.
- Depending on the action, vessels will wait at a safe distance in deeper waters after deploying personnel overboard to avoid anchoring.
- Vessels will follow established transportation channels whenever practicable.
- The transit route for the vessels will avoid designated critical habitat to the extent practicable.
- Avoid direct contact such as anchor impact to corals, seagrass, or other sessile ESA-listed resources.
- In-water tethers, as well as mooring lines for vessels and marker buoys will be kept taut and to the minimum lengths necessary, and will remain deployed only as long as needed to properly accomplish the required task.

SCUBA and Snorkel Operations:

- Before entering the water, all divers shall be made aware of ESA-listed corals, and the requirement to avoid contact with the corals while performing their duties. This will include taking measures to avoid kicking the reef with fins and to secure dive and survey equipment in a manner that will prevent these from being drug across the substrate.
- If a sea turtle or marine mammal is observed within 50m while using DPVs or drills, the equipment will not be used until the animal has exited the area of its own accord.
- Divers should stay off the bottom and should never stand or rest on corals or other sessile benthic invertebrates.
- During all in-water activities, participants in education programs and other activities will avoid stepping on/standing on corals, and kicking coral colonies while swimming.

Coral Restoration:

- Corals collected for purposes of micro- fragmentation, propagation and outplanting will be collected from the same general location that they will be outplanted.
- Collection/sampling design of corals of opportunity will ensure that collection activities are distributed across shoreline/reef flat/benthic areas, so as not to consolidate the impacts of collection.
- Corals will be transported from source site to recipient site using methods that minimize high exposure to UV light, high temperatures, and will not be exposed directly to air during transport.
- Upon arrival at the outplanting site, the team will ensure that the container is not lowered down into mud or sediment or raised or lowered without control or appropriate speed (i.e. containers holding corals will not be dropped onto sea floor without control).
- Divers will assist with the transport of colonies across the reef to ensure the stability of the platform and the buoyancy of the lift bags/surface buoys (if utilizing these tools).
- Tools and equipment will not be placed on live bottom substrate or any organism unless contact with the organism is a necessary component of the project. Divers will avoid contact with organisms wherever possible.
- Caching will only be used at sites and times of year where there is low energetic water motion, to avoid corals being dislodged from an upright position and abraded, broken, scoured or covered with sand or rubble.
- A nursery maintenance and monitoring plan and timeline will be developed and included with proposed projects. The plan will include method(s) to be used to remove structures that are no longer needed, functional, or if a design has become obsolete. Structures must be constructed in a manner that ensures the structures will not move or flip during storm events or due to human impacts such as anchor drag.
- Stabilization of structures will be achieved with the use of weights and/or penetrating anchor systems anchors or rebar driven to a sufficient depth to prevent movement or the lifting of the structures.
- Floating structures that use lines as part of the support system or for attaching corals must be constructed in a manner to eliminate or minimize the chances of entanglement.

- Line nurseries must have, at a minimum, either horizontal or vertical components that are rigid to prevent the structures from collapsing and potentially causing entanglement of animals.
- Vertical lines for anchoring structures to the seafloor must have sufficient tension created by buoys on the line to avoid slack or loops from forming and to keep the lines off the seafloor.
- Buoys should be tied to the rigid component of the structure with the minimum use of line such that less than 50 cm of line is exposed between each buoy and the structure.
- Lines used to attach corals vertically to the nursery structures must be no longer than 20 cm.
- Horizontal lines must be at least 20 cm apart and must be kept taut and supported by a rigid frame structure to avoid slack in the horizontal lines.

<u>In-water Equipment and Sampling</u>:

- ROV/AUV operators should have the training necessary to maintain and operate these vehicles at a depth above the seafloor and coral structures in order to avoid contact.
- ROV/AUVs will be operated at a max speed of 5 knots.
- Stiffer line materials should be used for towing and kept taut during operations to reduce the potential for entanglement in bottom features such as coral habitats.
- All vessel operation BMPs will also be followed during ROV/AUV operations.
- Buoys will be installed at locations with no or low vertical relief and no coral colonization within a 3m radius from the buoy anchor location.
- A mid-line float will be attached to the buoy chain above the chain attachment point to the bottom anchor in order to prevent the anchor chain from dragging on the seafloor.
- Minimize the use of all active acoustic systems (e.g., turn off all non-navigational echosounders when not actively mapping)
- Power down or turn off a mapping echosounder if a marine mammal is observed closely approaching or within 100 m of the vessel.
- The installation and removal of in-water structures for research equipment will be performed by divers.
- All equipment must be removed once the study is complete. Exceptions include anchors under the substrate, which may be cut even with the seafloor so as not to disturb the benthos.
- Moored instruments should be securely placed on/anchored into uncolonized hard bottom areas of rubble or sand.
- Lines associated with moored instruments will be taut to avoid the possibility of entanglement of protected species.
- Turbidity and siltation from project-related work shall be minimized and contained through the appropriate use of erosion control practices, effective silt containment devices, the curtailment of work during adverse weather and tidal/flow conditions, and slow, gentle deployment of structures onto the seafloor.
- If operations are anticipated to increase sedimentation or suspended materials longer than 24 hours, a plan will need to be submitted outlining actions to avoid impacts to coral spawning and recruitment.

Watershed restoration:

- Work will cease under high flows or seasonal conditions that threaten to disturb turbidity reduction measures, except for efforts to avoid or minimize resource damage.

Unmanned Aerial Vehicle Operations:

- All UAS operations will be conducted with a pilot and a spotter to ensure that the UAS is monitored at all times.
- All flights will be high enough in elevation so as not to disturb ESA-listed species (minimum: 200 ft.). Additionally, UAS should not hover over any ESA-listed species.

Pesticide or Herbicide Use:

- Apply the minimum amount of pesticide necessary to meet site objectives.
- Consider removal of invasive plants via mechanical means, such as hand pulling, where such treatments may be effective and would pose a lesser risk to ESA-listed fish and critical habitat than pesticide treatments.
- Mixing, container transfer, and storage of herbicides and application equipment must not occur within 150 feet of surface water.
- Pesticide will not be applied when a precipitation event is forecasted to take place within 48 hours following an application.
- No broadcast spraying of pesticides may be used within riparian reserves/riparian buffers (i.e., within 100 feet of a stream or other surface water).
- Require spot spraying or hand-application techniques when applying pesticides within 100 feet of a stream or other water body.
- Keep all spray applicators as low to the ground as possible to reduce wind drift.
- Pesticides will not be applied when sustained wind conditions exceed 5 mph in riparian areas, or 8 mph in upland areas.

APPENDIX C

ARCHAEOLOGICAL LITERATURE REVIEW IN SUPPORT OF REEFRAME: RESTORATION OF SEVERELY DEGRADED CORAL REEFS IN HAWAIʻI VIA PERMANENT CORAL NURSERIES ON 3D PRINTED CONCRETE REEF FRAMEWORKS, WAIKIKI AHUPUAʻA, KONA MOKU ISLAND OF OʻAHU, STATE OF HAWAIʻI

DATED JANUARY 2026

DRAFT REPORT

Archaeological Literature Review in Support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawai‘i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupua‘a, Kona Moku, Island of O‘ahu, State of Hawai‘i

TMK: (1) 2-6 (Offshore)

Prepared for:
Conservation International Foundation
2011 Crystal Drive, Suite 600
Arlington, VA 22202

January 2026

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DRAFT REPORT

Archaeological Literature Review in Support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawai‘i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupua‘a, Kona Moku, Island of O‘ahu, State of Hawai‘i (1) 2-6 (Offshore)

By
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January 2026

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MANAGEMENT SUMMARY

Document Title:	Archaeological Literature Review in Support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawai‘i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupua‘a, Kona Moku, Island of O‘ahu, State of Hawai‘i
Date/Revised Date:	Draft: January 2026
SHPD HICRIS Project No.:	2025PR01358
SHPD Reference Document:	-
Federal Award ID No.	NA23NMF4630084
Archaeological Permit #:	SHPD Permit No. 26-37
Project Location:	Māmala Bay, Honolulu, HI 96815
Project TMK:	(1) 2-6 (Offshore)
Ocean Authority:	State of Hawai‘i
Project Proponents:	Conservation International Foundation
Project Tasks:	Archaeological Literature Review
Parcel Acreage:	N/A
Project Area	Approx. 11.38 ac. (44.61 ha)
Principal Investigator:	Dennis Gosser, M.A.
Regulatory Oversight:	Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended. Hawaii Environmental Policy Act (HEPA), Chapter 343 of the Hawaii Revised Statutes (HRS) HRS, Chapter 6E-8 and Title 13 of the Hawai‘i Administrative Rules (HAR), Subtitle 13 (State Historic Preservation Division Rules), and Chapter 275 (Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E8, HRS).
Project Background:	REEFrame is a three-year, collaborative coral reef restoration project in Hawai‘i that seeks to foster coral growth and improve habitat by building permanent coral nurseries. Innovative DryForming™ technology will be used to create naturally shaped concrete modules that will provide an ideal habitat for both recruiting and growing coral, fish, and other reef life. These REEFrame modules will be installed off the coast of Waikīkī Beach, in approximately 40.0–60.0 feet of water, and serve primarily as coral nurseries, providing attachment sites for corals that will support reef restoration projects. Simultaneously, these permanent structures will also provide shelters for a variety of species, as they are naturally colonized by corals, fish, and other sea life. Eventually, they will become de facto natural reefs.
SIHP #:	None
Findings:	The APE is located roughly 0.6 miles (0.92 km) offshore from Waikīkī Beach. Consequently, it is extremely unlikely that any traditional Hawaiian cultural deposits, human burials, or buried post-Contact historic properties are present in the APE. Additionally, there are no submerged historic properties within one mile of the APE.
Human Skeletal Remains:	None
Recommended Effect Determination:	The recommended finding for the assessment of adverse effects for the proposed undertaking pursuant to 36 CFR 800.5(d)(1) is “No adverse effect.” The recommended effect determination for the proposed undertaking pursuant to HRS Chapter 6E and its implementing regulations at HAR §13-275-7(1) is “no historic properties affected.”

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PCSI Editorial Policy

PCSI follows the latest edition of the Society for American Archaeology (SAA) Style Guide regarding textual elements (e.g., numbers, dates, statistical copy, italicization, capitalization, hyphenation, and accents and diacritical marks) and citations. The authority for English spelling is the most recent edition of Merriam-Webster’s Collegiate Dictionary. Unless noted, the authorities for Hawaiian spelling and geographic place names are the Hawaiian Dictionary (Pukui and Elbert 1986), the most recent listing of the Hawai‘i Board on Geographic Names (HBGN), and Place Names of Hawaii (Pukui et al. 1974). PCSI uses the official spelling of Hawaii (without an ‘okina) to refer to the State and State agencies (unless an alternative spelling has been officially adopted); spellings presented in quotations and references retain their original punctuation.

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INTRODUCTION

Under contract to Conservation International, Pacific Consulting Services, Inc. (PCSI) has prepared this Archaeological Literature Review (ALR) report in support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawai‘i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupua‘a, Kona Moku, Island of O‘ahu, State of Hawai‘i (Figure 1). Funding for the project is from the National Oceanic and Atmospheric Administration’s (NOAA) Office of Habitat Conservation. In addition to NOAA, entities from the public, private, and nonprofit sectors are involved in this project, including Conservation International, the University of Hawai‘i at Mānoa, the Hawai‘i Division of Aquatic Resources, ocean technology firm Natrx, ocean engineering firm Oceanit, and workforce development nonprofit ClimbHI. The project is in ocean waters under the jurisdiction of the State of Hawai‘i.

Pursuant to Hawaii Environmental Policy Act (HEPA), Chapter 343 of the Hawaii Revised Statutes (HRS), an Environmental Assessment is required for the undertaking. Additionally, because the project involves federal funding and permitting, compliance with the National Historic Preservation Act (NHPA) of 1966 is required. Specifically, NHPA Section 106 requires consultation with interested parties for the proposed undertaking. A historical, cultural, and archaeological background study was conducted to identify any historic properties in the area of potential effects (APE) and then evaluate any potential impact and recommend mitigation of any adverse effects, if warranted. This archaeological study was conducted in accordance with the Secretary of Interior’s Standards and Guidelines for Archaeology and Historic Preservation, as well as HRS Chapter 6E of the HRS and Title 13 of the Hawaii Administrative Rules (HAR), Subtitle 13 (State Historic Preservation Division Rules), Chapter 275 (Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS).

AREA OF POTENTIAL EFFECTS

The Area of Potential Effects (APE) for the undertaking measures approximately 11.38 acres (44.61 hectares) and is in ocean waters managed by the State of Hawai‘i. The state’s management authority extends seaward to a maximum of three nautical miles. Tax Map Key (TMK) plats along the coast near the APE include (1) 2-6-001, 002, and 004 (Figure 2–Figure 4). No work will be conducted on land (e.g., the beach or shoreline). The APE is shown on aerial imagery in relation to the Waikīkī coast in Figure 5.

PROJECT DESCRIPTION

REEFrame is a three-year, collaborative coral reef restoration project in Hawai‘i that seeks to foster coral growth and improve habitat by building permanent coral nurseries. Innovative DryForming™ technology will be used to create naturally shaped concrete modules that will provide an ideal habitat for both recruiting and growing coral, fish, and other reef life.

REEFrame modules are digitally designed 3D printed concrete reef systems. A module comprises five total units, including four units which form the base and the fifth unit on top. The REEFrame modules will be installed approximately 0.6 miles (1.0 kilometer) off the coast of Waikīkī Beach, at depths of approximately 40.0–60.0 feet (approximately 12.0–18.0 meters), and serve primarily as coral nurseries, providing attachment sites for corals that will support reef restoration projects. Simultaneously, these permanent structures will also provide shelters for a variety of species, as they are naturally colonized by corals, fish, and other sea life. Eventually, they will become de facto natural reefs.

The modules comprise concrete material with steel hardware covered in concrete coatings and contain holes, crevasses, ledges and other intentional design elements to help mimic a natural reef structure. These features vary between modules, and aim to provide habitat for coral, fish and other sea life. Each module measures six feet wide and six feet tall. The design weight is an average of five tons and structurally designed to be stable in a 50-year southern swell storm event where wave heights may reach or exceed 18 feet with a sustained 18 second period.

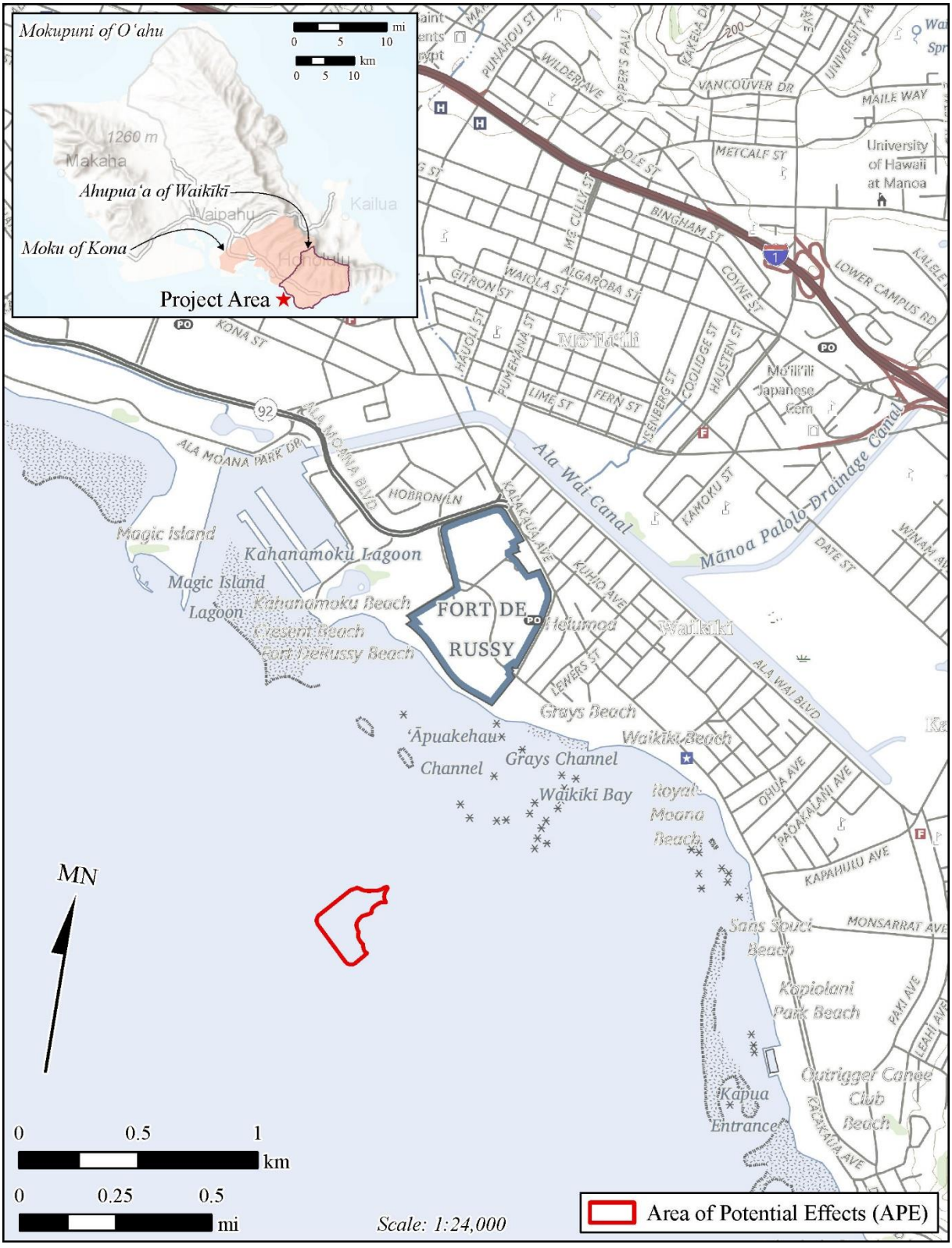


Figure 1. Area of Potential Effects (APE) Shown on 7.5-Minute Series USGS Honolulu Topographical Quadrangle (2024).

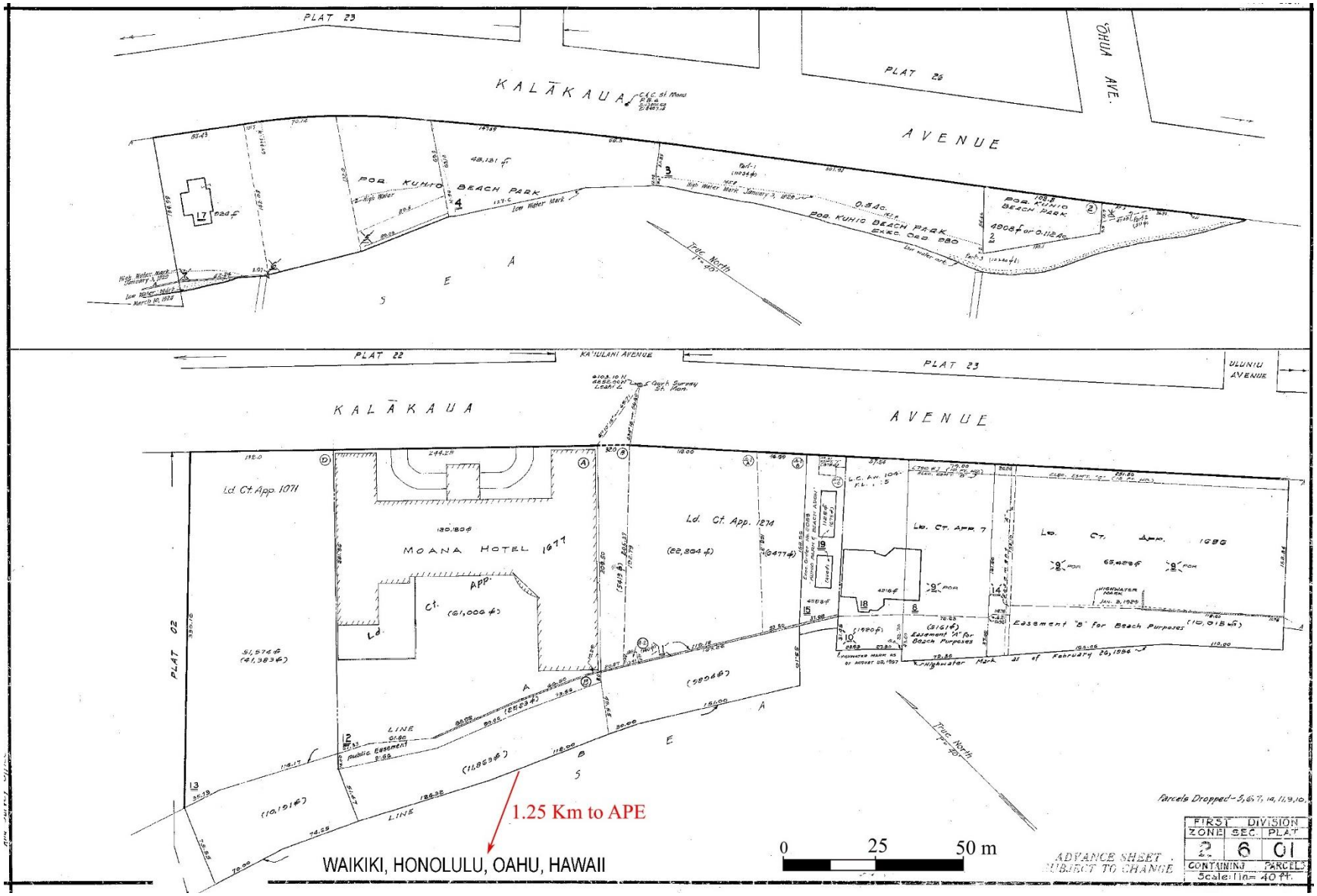


Figure 2. Tax Map Key (TMK) Plat Map (1) 2-6-001 (TH 1932a).

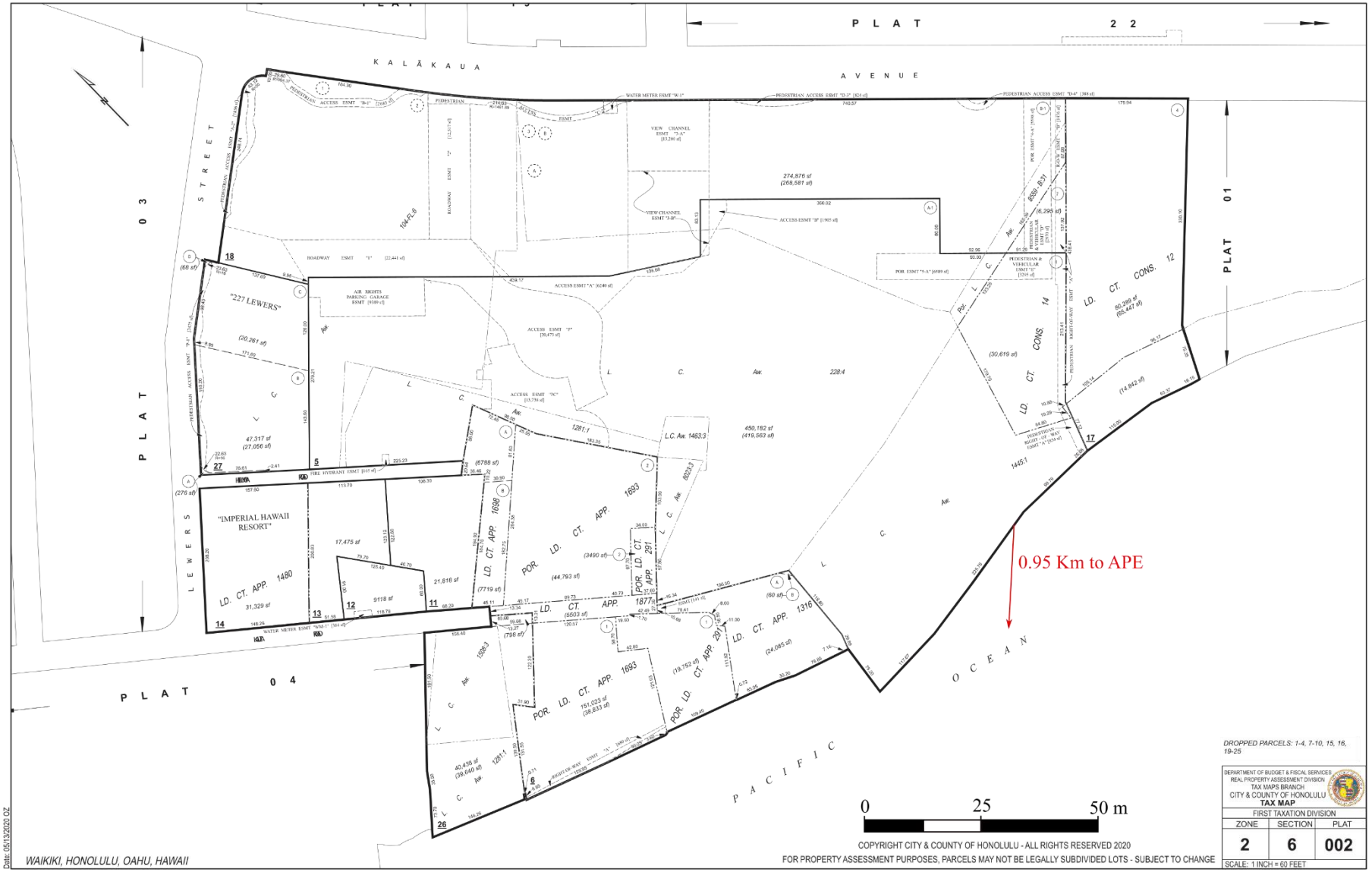


Figure 3. Tax Map Key (TMK) Plat Map (1) 2-6-002 (CCH 2020).

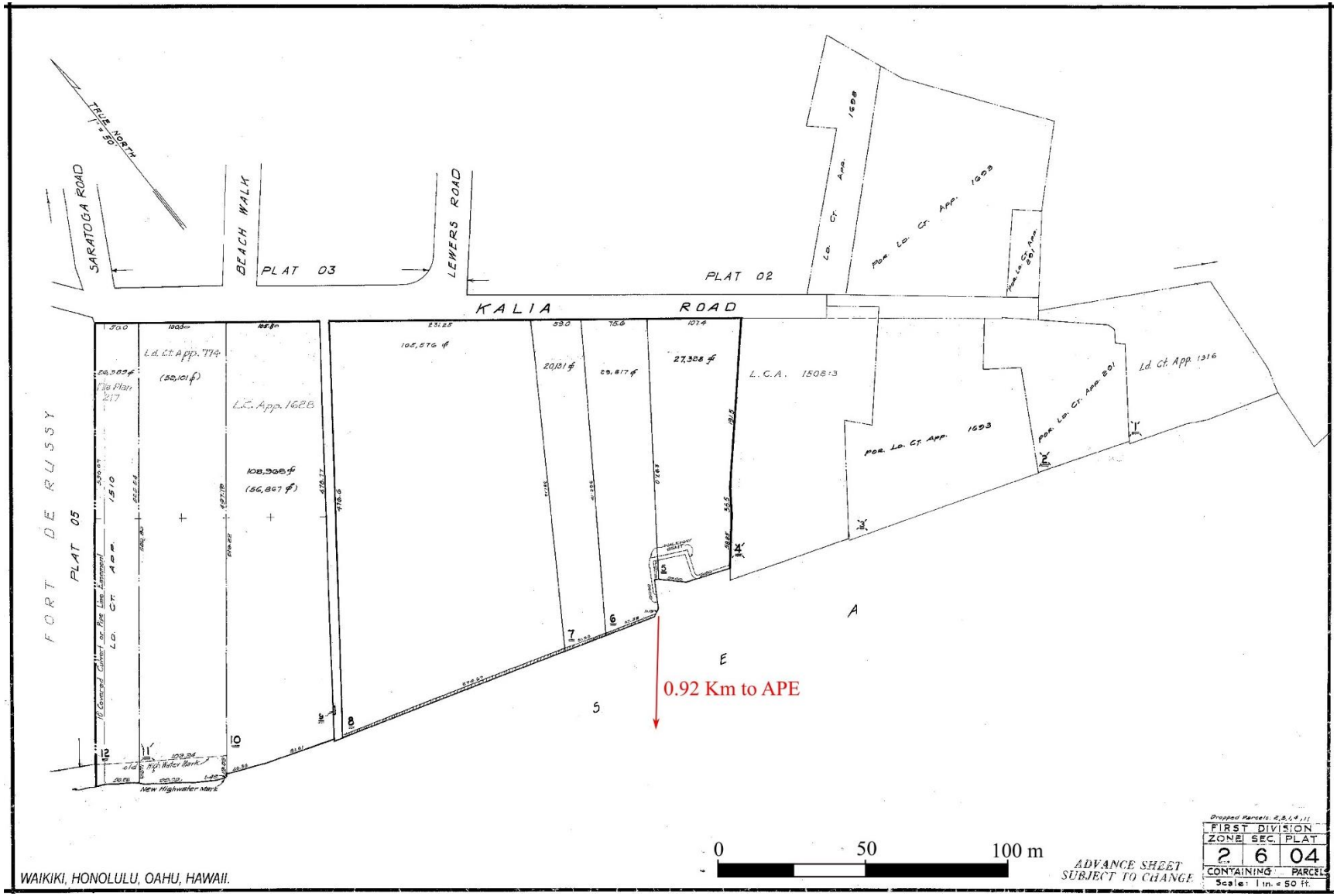


Figure 4. Tax Map Key (TMK) Plat Map (1) 2-6-004 (TH 1932b).

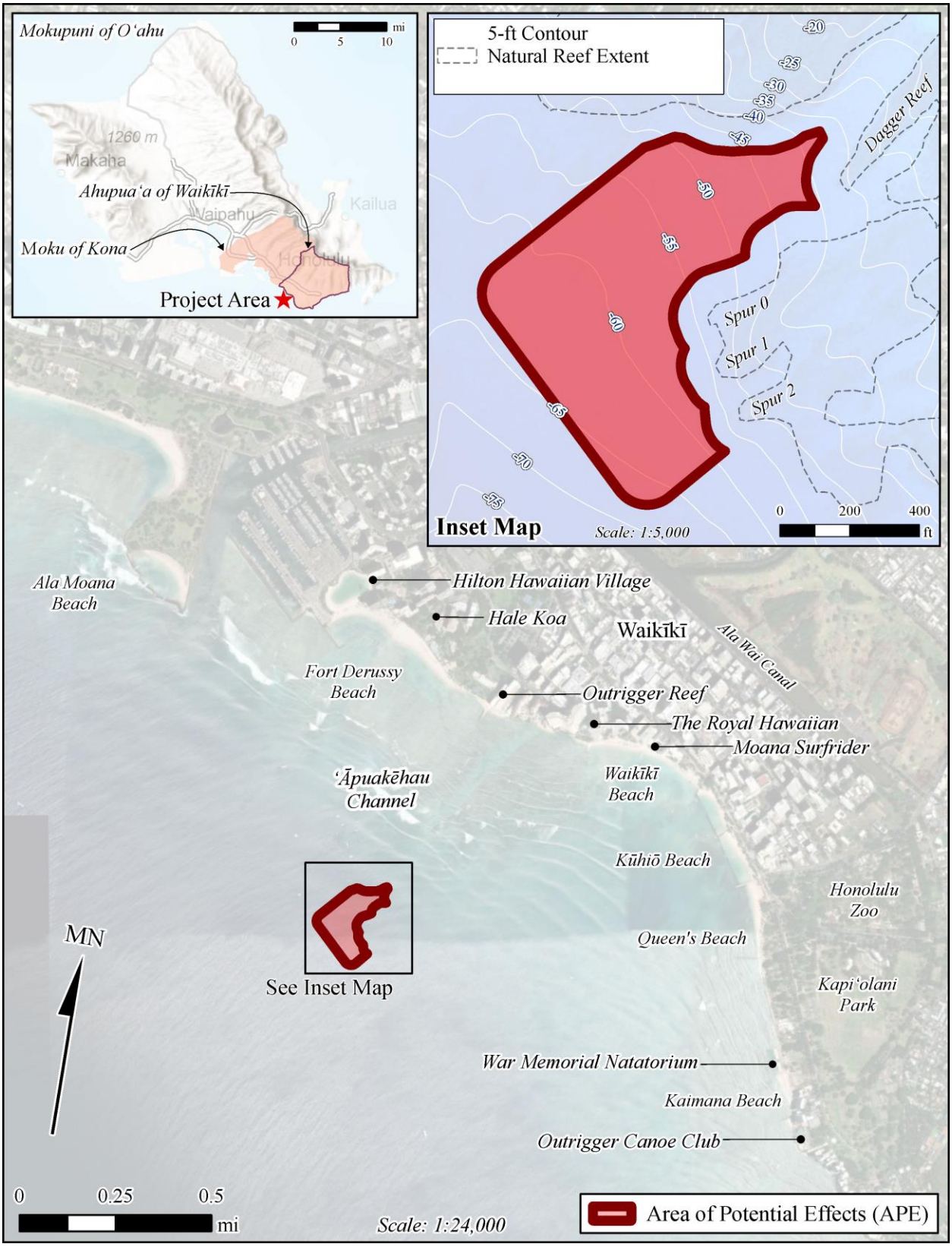


Figure 5. Aerial Imagery Showing APE in Relation to Coastal Waikīkī (ArcGIS Map Service 2025).

ENVIRONMENTAL SETTING

Waikīkī Ahupua‘a is located on the leeward side of O‘ahu and extends from the Ko‘olau mountain range through the coastal plain to the shoreline. Traditionally, the ocean rights of a *konohiki* (land manager) extended from the *ahupua‘a* shoreline to the outer edge of the reef or one mile offshore. The APE is situated in the reef zone roughly 0.6 miles offshore from Waikīkī Beach.

GEOLOGY AND HYDROLOGY

The APE is located within the larger area known as Māmala Bay, which spans from Barbers Point to Diamond Head. Underlying Waikīkī Beach and coastal waters is a fossil reef. Sand was naturally derived from the reef and, to a minor extent, from volcanics. The peak of sand deposition occurred during the Kapapa Stand (+2.0 m) at 1,500–4,000 bp.

The shoreline of Waikīkī is a narrow beach that has undergone extensive modifications since the early twentieth century. Previously, the coastal plain consisted of wetlands, mudflats, duck ponds, and fishponds, all fed by streams that emptied into the ocean. From the narrow carbonate sand beach, the fringing reef gently sloped seaward with few thin patches of sand (Wiegel 2008:3). In the 1880s and 1890s, residences, hotels, bathhouses, and piers were built on the limited shoreline. More drastic changes came in the 1900s, when sand was removed from a portion of the coast, and the reef was dredged for sand, coral rubble, and rock to fill the wetlands. In the 1920s, the Ala Wai Canal and Ala Wai Yacht Harbor were also constructed. Urban projects affecting the beach and reef at Waikīkī have continued into the twenty-first century:

> Channels, basins, and ponds have been dredged in the reef for several purposes; they front about one-half of the shore. These have caused changes in wave and current action, and in the transport and deposition of sand and silt. Much of the sand now on the beach segments between Diamond Head and Ala Moana Beach Park has been brought from other locations in Hawaii for beach fill, or for constructing a beach by placing sand on top of a base made of crushed coral rock dredged from the nearshore. Also, sand was dredged in 2000 and in 2006 from small deposits on the reef, pumped to shore at Kuhio Beach, and distributed along the section of beach which is protected by a shore-parallel breakwater (crib wall), elevation about MLLW, and groins connected to shore. Since Duke Kahanamoku's comments in the 1930s, guidelines governing beach nourishment have been to preserve the breakers for surfboarding, provide a sand blanket to cover the inshore coral, and stabilize a dry beach for sunbathing [Wiegel 2008:3].

Although most of the springs were filled during reclamation projects, spring water still surfaces in the ocean off Waikīkī in the shallow reefs along the beach, especially in winter and spring, and during periods of heavy rains in the inland valleys (Tilburg et al. 2017:101).

CLIMATE, WAVES, AND CURRENTS

Mean annual rainfall on the coast of Waikīkī is 25.5 inches, with most precipitation occurring between October and March (Giambelluca et al. 2013). Average temperatures range from 76° to 89° in August and 67° to 80° in February (NOAA 2025). Annual average ocean surface temperature in Māmala Bay ranges from 71° to 82° (PacIOOS 2025).

Seasonal wave variation includes waves affected by northeast Tradewinds, Kona (southwesterly) winds, and wind from the southern hemisphere (Sea Engineering 2010:38–39). Trade winds blow from the northeast and are more frequent in the dry season. Waikīkī is sheltered from a direct trade wind wave approach, but they can be refracted by Diamond Head and approach from the south. South swell waves are produced by winds from the Southern Hemisphere (Antarctic storms) and are more common during the dry seasons. Breaking south swell waves can reach one to two meters high. Local fronts and tropical storms produce Kona storm waves, which are year-round but infrequent, and can cause damaging wave action (Sea Engineering 2010:43).

Currents in Waikīkī are primarily tidal, but winds can also generate nearshore currents (Miller 2002:22). Currents in the nearshore and surf zones are driven by breaking waves.

ARCHAEOLOGICAL PERSPECTIVES AND HAWAIIAN CULTURAL HISTORY

Over the last century, archaeologists have proposed various Hawaiian cultural sequences subdivided into stages developed through archaeological research, paleoenvironmental, and chronometric data. More recently, these stages have proved problematic due to the validity of radiocarbon dates for certain samples, the variations in development over time throughout the archipelago, and the accepted nomenclature. Without adhering to specific temporal stages, the following section summarizes the cultural changes over time, beginning with the arrival of Polynesians to the islands.

EARLY PRE-CONTACT PERIOD

The coastal portions of wet, fertile windward valleys of the Hawaiian Islands are assumed by archaeologists to have been the first areas colonized by Polynesians, though the timing varied between islands (Athens and Ward 1993; Dye 1994; Emory 1968; Emory and Sinoto 1965; Hunt and Holsen 1991; Kirch and McCoy 2023; Sinoto 1970; Spriggs and Anderson 1993). Over the last two decades, analysis and reanalysis of paleoenvironmental and archaeological chronometric data have shown that the earliest settlement of the Hawaiian Islands occurred between AD 1000 and 1100 (Dye 2011; Kirch 2011; Kirch and McCoy 2007, 2023:81; Rieth et al. 2011; Wilmshurst et al. 2011).

There is only sparse evidence of the earliest human occupation in the Hawaiian Islands, and, in most cases, the radiocarbon data and the contexts from which they were derived have been debated (see Dye and Pantaleo [2010] and Rieth et al. [2011] for a summary). By the thirteenth century, the unique aspects of Hawaiian culture had developed, indicating a rapid adaptation to a new environment (Dye 1994; Dye and Komori 1992). Such adaptations included the expansion of the population inland and the exploitation of leeward resources such as salt, wood, grasses, lithic raw materials, birds, and marine life by windward inhabitants (Kirch 1984; Kirch and McCoy 2023). Oral histories indicate that O‘ahu was under the control of the Maweke-Kumuhonua lineage around AD 1300 (Cordy 1996), and Ko‘oloaupoko Moku was under the control of Kalehenui. Along with the rising population, there was increasing political and social complexity. By the 1400s, O‘ahu was unified by Kumuhonua, an ‘Ewa *ali‘i nui* (high chief).

LATE PRE-CONTACT PERIOD

The population continued to grow and expand into the interior of all islands after AD 1600, with the appearance of interisland polities and internecine warfare by Captain Cook’s arrival in AD 1778. At the time of European contact, and for some time before, Hawaiian society consisted of four or five hierarchically organized polities on the islands of Kaua‘i, O‘ahu, Mau‘i, and Hawai‘i (Cordy 2000; Earle 1991; Hommon 1976, 1989; Kirch and McCoy 2023; Malo 1951). Within each polity were two or three broad levels of social ranking legitimized by a system of stringent religious and ideological sanctions (Hommon 1976; Kirch 1984; Kolb 1994). The *ali‘i* constituted a group of chiefly levels that, among other things, held use rights over the land (Cordy 2004; Kirch 1984). The vast majority of Hawaiians belonged to local descent groups of commoners called *maka‘āinana*, who held usufruct land rights and lived and farmed within *‘ili ‘āina* (land division of an *ahupua‘a* paying tribute to the *ahupua‘a* chief).

Land and architectural hierarchies mirrored social hierarchies in late pre-Contact Hawai‘i (Kolb 1994). At the base were local residence groups composed of household clusters within *‘ili ‘āina* (Cordy 1981:55; Cordy and Kashko 1980; Kirch and Kelly 1975:178; Kolb et al. 1997; Weisler and Kirch 1985). Residence groups in traditional Hawaiian society were composed of one or more spatially distinct households called *kauhale*. The ideal *kauhale* was a spatially segregated compound composed of several structures with different functions, including men’s sleeping houses, women’s sleeping houses, cooking houses, women’s menstruating houses, and other special-use structures or activity areas (e.g., lithic workshops, garden plots, etc.). In addition, several *kauhale* may have shared a *mua* (men’s house) where community-integrating activities occurred.

Socially, residence groups were bilaterally organized; however, descent was reckoned (cognatically) through land tenure (Davenport 1959; Kirch 1971, 1984; Tainter and Cordy 1977:100). Residential groups were arranged into communities called *ahupua‘a*, and were controlled by *kaukauali‘i*

(lower chiefs) or *konohiki* (land managers). Within the *ʻiliʻāina*, and perhaps the *ahupuaʻa*, the *makaʻāinana* (commoner) likely continued to adhere to some ancestral principles of Polynesian social organization (Kirch 1984:31–34; Kirch and Green 2001).

CULTURAL BACKGROUND

Archival background research and literature review examined maps, ethnographic, historical, and archival documents, and previous archaeological studies from the coast to the outer reef of Waikīkī. Relevant historical maps were georeferenced to identify traditional Hawaiian or historic features in the area, and these were supplemented with nineteenth-century land and sea boundary descriptions. The information obtained from these sources was synthesized to present data findings and to evaluate the potential for archaeological and cultural resources in the APE.

MOʻOLELO AND WAHI PANA

The Hawaiian cultural landscape can be described through *moʻolelo* and *wahi pana* (significant Hawaiian place names). *Moʻolelo* may be myths, legends, proverbs, and events surrounding well-known individuals in Hawaiian history (Pukui and Elbert 1986:254). The APE is offshore from the coastal *ʻili* (from west to east) of Kālia, Keōmuku, Helumoa, Ulukou, Kapuni, Uluniu, Auʻaukai, Hamohamo, Kekio, Kāneloa, and Kapua in Waikīkī Ahupuaʻa. Waikīkī, which can be translated as "spouting water" (Pukui et al. 1974:223), is named for its former wetlands fed by numerous streams from the valleys of Makiki, Mānoa, and Pālolo. The *ʻili* are shown on the historical map in Figure 6 and listed in Table 1 along with other traditional places. Hawaiian historian John Papa ʻĪʻī mentions some of the places in a description of a traditional trail that crossed lower Waikīkī:

> A trail led out of the town at the south side of the coconut grove of Honuakaha and went on to Kalia. From Kalia it ran eastward along the borders of the fish ponds and met the trail from lower Waikiki. … The trail from Kawaiahao [the location of today's Kawaiahaʻo church] which led to lower Waikiki went along Kaananiau [today's King Street], into the coconut grove at Pawaa [Makiki area], the coconut grove of Kuakuaka, then down to Piinaio; along the upper side of Kahanaumaikai's coconut grove, along the border of Kaihikapu pond (today's Fort Derussy), into Kawehewehe; then through the center of Helumoa of Puaaliilii, down to the mouth of the Apuakehau Stream [ʻĪʻī 1959:92].

Traditional history tells of *aliʻi nui* Kalamakua-a-Kaipuholua **(**Kalamakua) of Halawa on Oʻahu and Keleanohoanaʻapiʻapi (Kelea) of Maui. Their daughter Lāʻielohelohe was born at Helumoa and raised at Kaluakau, in Waikīkī. She was betrothed to Maui *aliʻi nui* Piʻilani, and after marrying, she lived at Halehuki on Maui. During one of her pregnancies, she returned to Oʻahu, and Kihaʻapiʻilani, future Maui *aliʻi nui*, was born at ʻĀpuakēhau (*Ke Au ʻOkoʻa,* Dec. 15, 1870). According to Native Hawaiian historian Samuel Kamakau, a rock was placed at ʻĀpuakēhau to mark where he was born (Kamakau 1991:94).

There are many Hawaiian sayings associated with places and events in Waikīkī, several of which include Kālia ʻIli, which spanned the western half of coastal Waikīkī. For example, *Kāhunahuna paʻakai o Kālia*, or "Fine-grained salt of Kālia" (Pukui 1983:144). According to Pukui, Kālia was a place for gathering salt, and the name was used as "a derogatory term for the dried, viscid matter in the corners of the eyes of an unwashed face" (Pukui 1983:144).

Kālia was also a place to gather ʻ*alamihi* crabs. The crabs were abundant at Kālia, and there is the saying: *Hoʻi i Kālia i ka ʻai ʻalamihi*, or "Gone to Kālia to eat *ʻalamihi* crabs" (Pukui 1983: 110). Pukui (1983:110) explains that this saying means a person is in a repentant mood, as it plays on the word ʻ*alamini,* which may also be *ala mihi* (path of repentance).

Waikīkī was known for *limu līpoa* (*Dictyopterisplagiogramma* and *Dictyopterisaustralis*), a brown seaweed with a strong aroma and spicy flavor, traditionally preserved by salting (Aiona 2003). There is the Hawaiian saying: *Nā līpoa ʻala o Kawehewehe* (The fragrant *līpoa* of Kawehewehe), referring to the *līpoa* at Kawehewehe, which was fragrant from the shore. It was often mentioned in songs about Waikīkī (Pukui 1983:146).

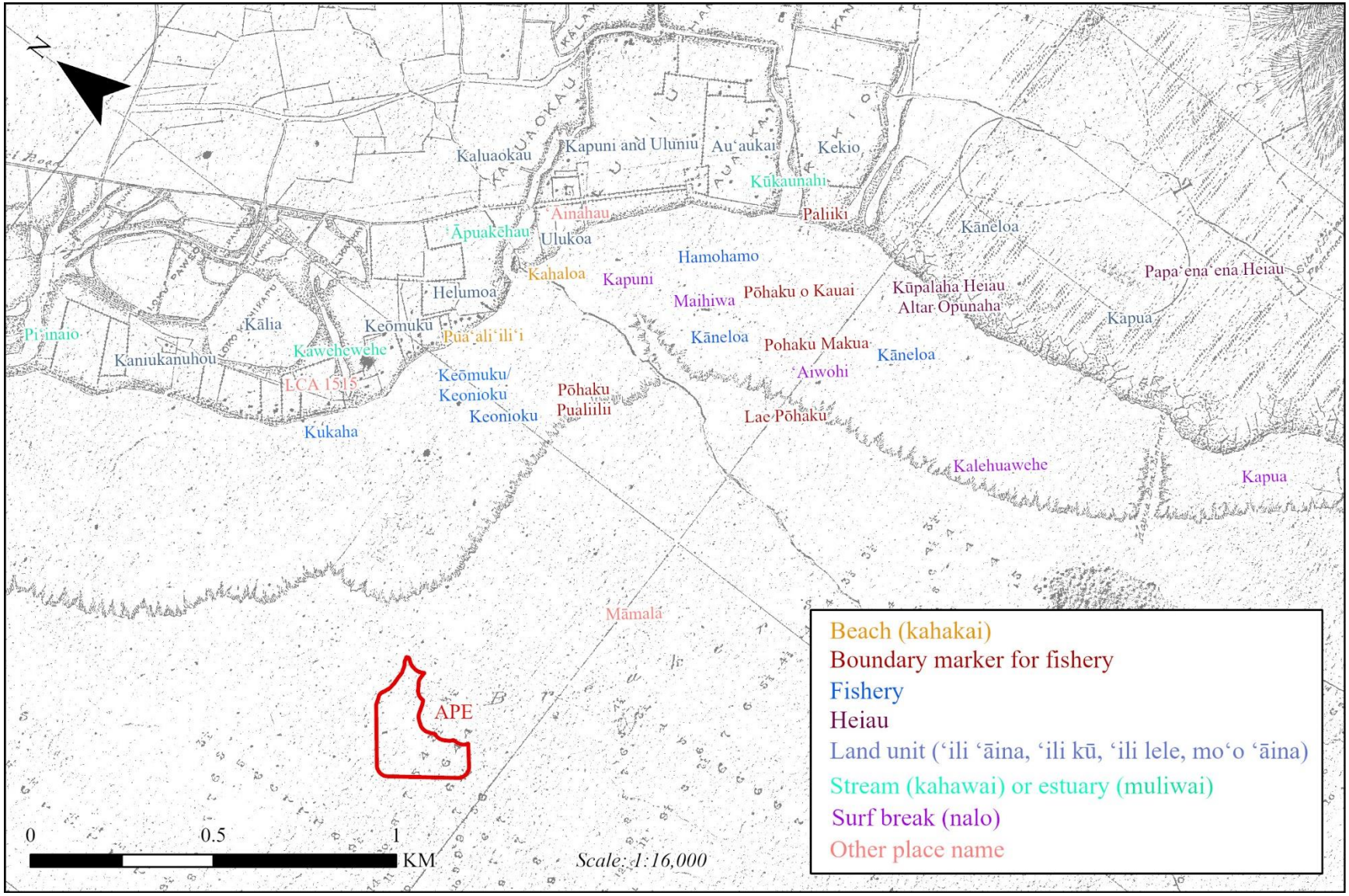


Figure 6. Traditional Place Names in Coastal Waikīkī Overlain on Portion of Map by Covington (1881). Places Names Added Based on Data from Mahele Testimony, LCA Descriptions, and Additional Historical Maps (Lyons ca 1876a,b).

Table 1. Coastal Waikīkī Traditional Place Names.

PLACE	MEANING	DESCRIPTION
ʻĀinahau *Royal Residence*	"*Lit.,* Hau tree land" (Pukui et al. 1974:7).	"Home and land of Princess Kaʻiulani at the site of the present Princess Kaʻiulani Hotel" (Pukui et al. 1974:7). "On the day of the baptism of Princess Ruth Keelikolani deeded to the Princess Kaiuani part of the homestead now known as Ainahau, on which the cocoanut grove was planted" (PCA 1899:1).
ʻAiwohi *nalo*	"*Lit.,* royal ruler" (Pukui et al. 1974:8).	"Ancient surfing area at Wai-kīkī, Oʻahu" (Pukui et al. 1974:8; see also (Kamakau 1991:44). "Today it is known as Publics" (Clark 2011:128).
ʻĀpuakēhau *muliwai, kahawai*	"*Lit.,* basket [of] dew" (Pukui et al. 1974:13)	"Old stream that debouched, near the present Moana Hotel, Wai-kīkī, probably named for a rain" (Pukui et al. 1974:13).
Auʻaukai *ʻili kū*	"*Lit.,* bathe [in the] sea" (Pukui and Elbert 1986:31)	"Kamaukoli, sworn. I came with Kaahumanu to Hamohamo. Kekupuohi, the other of Kaahumanu, gave Auaukai to Kaahumanu, Auaukai is an old name for that piece of land. I always understood that Kalia was a separate land" (Maly et al. 2013:254).
Hamohamo *ʻili kū*	"*Lit.,* rub gently (as the sea on the beach)" (Pukui et al. 1974:40).	"Area near ʻOhua Avenue, Wai-kīkī, Oʻahu, once belonging to Queen Liliʻu-o-ka-lani. . . *A ia akula paha i Wai-kīkī, i Hamohamo i ka ʻimi ʻahuʻawa,* maybe just at Wai-kīkī, at Hamohamo looking for *ʻahuʻawa* sedge (disappointment, failure; all one does is 'rub' and this is 'bitter' [*ʻawa*])" (Pukui et al. 1974:40).
Helumoa *ʻili ʻaina*	"*Lit.,* chicken scratch" (Pukui et al. 1974:44).	"Old land division near the Royal Hawaiian Hotel at Helu-moa Street, Wai-kīkī, and site of a *heiau* where Kahahana was sacrificed… (Chickens scratched to find maggots in the victim's body. The supernatural chicken, Kaʻau-hele-moa, flew here from Kaʻau Crater in Pālolo.)" (Pukui et al. 1974:44). Princess Pauahi inherited Helumoa from her cousin, Princess Ruth Keʻelikōlani, where she and her husband Charles Reed Bishop spent much time enjoying the sheltered *ulu niu* (coconut grove) (PCA 1899:1)."The sand of Helumoa was known as *Ke oneʻai aliʻi o Kakuhihewa* (The Chief Devouring Sand of Kakuhihewa) because of the curse placed by the prophet Kaʻopulupulu. When Kaʻopulupulu was brought with his son, Kahulupuʻe, to be executed at Waikīkī, he cursed the place where his *hinu* (body-grease) should drip upon the sand. This curse was upon the chiefs and the people" (Hibbard and Franzen 1986:5).
Kahaloa *kahakai*	"*Lit.,* long place" (Pukui et al. 1974:62).	"Beach area between the Royal Hawaiian and Hale-kū-lani hotels, Wai-kīkī, noted for its fragrant *līpoa* seaweed " (Pukui et al. 1974:62). Named for one of four stones believed to have been medical *kahuna* from Tahiti (Boyd 1906:140).
Kalehuawehe *nalo*	"*Lit.,* the removed lehua lei" (Pukui et al. 1974:76).	"Named for an ancient surfing area at Wai-kīkī . . , now called Castle's. Sick persons were brought here for cleansing baths. . . (Pīkoi, the rat killer, went to Waikīkī wearing a *lehua lei*. He asked a surfing chiefess for her board. She refused because the board was taboo. They surfed and he gave her his lei)" (Pukui et al. 1974:76).

PLACE	MEANING	DESCRIPTION
Kālia *ʻili kū*	"*Lit.,* waited for" (Pukui et al. 1974:77).	"Returned by Kamamalu at the Māhele, retained by the Gov. as Fort Land. Kāliaresembles an *ahupuaʻa* extending across Waikīkī from Makiki in the west to Kapahulu in the east, fragmented by many intervening *ʻili* and *kuleana*" (Ulukau 2025).
Kālia *kahawai*		Kālia Stream rises in Mānoa Valley, joins Pāhoa Stream near Pahupahuapuaʻa, and continues to the sea through Muliwai o Kūkaunahi, between Hamohamo and Kekio. Both streams have been realigned to form the Mānoa-Pālolo Drainage Canal, which flows to the Ala Wai Canal (Ulukau 2025).
Kāneloa *ʻili kū*	"*Lit.* tall Kāne" (Pukui et al. 1974:84).	"March 8, 1876: In lease from the Commissioners of Crown Lands to Mrs. Lilia K. Dominis showing that 20.85 acres of the above land [Kāneloa] had been granted to same [Mrs. Lilia K. Dominis], including the fishing rights" (HSA 2025). Kāneloa encompasses the Honolulu Zoo and much of Kapiʻolani Park. "There were sun worshippers among the original arrivals in Hawaii, and there were two temples dedicated to the sun on Oahu - - one at Kaneloa (a part of the present Kapiolani Park), and one at Kuaokala, Waianae..." (Sterling and Summers 1978:98; Ulukau 2025).
Kaniukanuhou *moʻo ʻaina*	[not translated]	"LCAw 2511 to Alapai: Kaniukanuhou ma Kālia" (Ulukau 2025).
Kapua *awa*	"Probably, *lit.*, the flower" (Pukui et al. 1974:89).	"Kapua Boat Entrance" appears on RM 1382; "Kapua Channel" outside the Outriggers Canoe Club.
Kapua *ʻili lele*		Includes the eastern part of Kapiolani Park, touching Papaenaena Heiau. Named for the adjoining *lele* of Kekio called Kapua (Ulukau 2025).
Kapua *nalo*		Ancient surfing area, Wai-kīkī, Oahu . . .; it is now filled in and a part of Ka-pio-lani Park" (Pukui et al. 1974:89).
Kapua *heiau*		Near Kapiolani Park, opposite Camp McKinley. *Heiau poʻokanaka*. Fragments of its walls, torn down in 1860, show it to have been about 240 square feet; said to be the place of sacrifice of Kaolohaka, a chief from Hawaiʻi, on suspicion of being a spy. Probably in the *lele* of Kapua (Ulukau 2025).
Kapuni *ʻili lele*	"*Lit.,* the surrounding (perhaps named for the spreading banyan tree on the ʻĀina-hau estate of A. S. Cleghorn)" (Pukui et al. 1974:89).	"Former land area" (Pukui et al. 1974:89).
Kapuni *nalo*		"Ancient surfing area" (Pukui et al. 1974:89). "Named for one of four stones, now at the Waikīkī Beach Center, which had been placed there to commemorate the four medical *kahuna* from Tahiti. See Paemahu for story. Today it is known as Canoes" (Clark 2011:128).

PLACE	MEANING	DESCRIPTION
Kawehewehe *awa*	"*Lit.,* the removal" (Pukui et al. 1974:99).	"Reef entrance and channel off Grey's Beach, just east of the Hale-kū-lani Hotel, Wai-kīkī, Honolulu. The sick were bathed here as treatment. The patient might wear a seaweed (*limu-kala*) lei and leave it in the water as a request that his sins be forgiven, the lei being a symbol" (Pukui et al. 1974:99).
Kawehewehe *muliwai, kahawai*		Muliwai o Kawehewehe drained several ponds in Kālia, below Kalākaua Avenue, following the present Saratoga Street (Ulukau 2025).
Kawehewehe *moʻo ʻaina*		Claim no. 1377 by Malo for his "pahale aia i Kawehewehe iloko o Kalia ma Waikīkī" was not awarded (Ulukau 2025).
Kekio *ʻili ʻaina*	[not translated]	A *lele* of *ʻili kūpono* Kekio in Palolo Valley (Ulukau 2025).
Keōmuku *ʻili ʻaina*	"*Lit.,* the shortened sand" (Pukui et al. 1974:99).	The *ō* is short for "one" (Ulukau 2025). Kahaleuliuli claimed land and fishery (Ulukau 2025).
Kūkaunahi *muliwai, kahawai*	[not translated]	Appears on RM 1952 (Bishop 1881); Kālia and Pāhoa fed into the Muliwai o Kūkaunahi between Hamohamo and Kekio and drained into the sea. Other maps label it as Hamohamo Stream.
Kuekaunahi *kahawai*	"Perhaps, *lit.*, to remove scales from fish" (Clark 2002:199)	"Small stream that paralleled Kapahulu Avenue and crossed Waikīkī Beach at the intersection of Kalākaua and Kapahulu Avenue. It was eventually enclosed in a culvert and at the shore its waters were channeled into the ocean through the Kapahulu Groin" (Clark 2002: 199).
Maihiwa *nalo*	[not translated]	Ancient surfing area, Waikīkī, Oʻahu (Kamakau 1991:44). Today it is known as Cunha's (Clark 2011:128).
Papanui *nalo*	"*Lit.,* big board" (Pukui et al. 1974:180).	"Deep-water summer surfing area about a mile seaward of Kū-hiō Beach, Wai-kīkī, Honolulu, named in 1930 by Duke Ka-hana-moku to honor the big boards that were ridden there" (Pukui et al. 1974:180).
Piʻinaio *muliwai, kahawai*	[not translated]	Muliwai was fed by ʻAuwai Alanaio and exited into the ocean near the ʻIlikai Hotel. The stream Piʻinaio fed the Loko Kaipuni. Has been filled in, and all flow has been channeled into the Ala Wai.
Puaʻaliʻiliʻi *kahakai*	"*Lit.,* little pig" (Pukui et al. 1974:190).	"Beach area at Wai-kīkī, Honolulu, approximately between ʻĀpuakēhau (site of the Moana Hotel) and Helu-moa (site of the Royal Hawaiian Hotel). Ka-mehameha I's houses were here" (Pukui et al. 1974:190).
Ulukou *ʻili ʻaina*	"*Lit.*, kou tree grove" (Pukui et al. 1974:215).	"Area in Wai-kīkī, Honolulu [near the Moana Hotel]" (Pukui et al. 1974:215).
Uluniu *ʻili ʻaina*	"*Lit.,* coconut grove" (Pukui et al. 1974:215).	LCAw 104FL to Kekuanaoa: "Aina ma Kalia, Waikiki, Kona, Oahu. Apana 5. Kahuahale ma Kapuni me Uluniu... 31 eka" (Ulukau 2025).

Kai

Kamakau described the many Hawaiian terms for specific places in the *kai* (sea), defined by the break of the waves and the activities or practices associated with the area. Based on his description, the APE perhaps falls within the *kua nalu* (back of the wave) or *kai kea* (white sea). Also in the depths of the APE are the *kai lu'u* (sea for diving) and *kai paeaea* (sea for pole fishing). Next beyond these zones are *kai 'o leho*[1] and *kai 'okilo*[2] *he'e* (sea for octopus fishing), the *kai kaka uhu* (sea for netting *uhu*), the *kai ka'ili* (sea for fishing with hook and line), and the *kai lawai'a* (sea for deep sea fishing) (Kamakau 1976:26–27).

> *Ka po'e kahiko* distinguished by name the waters along the coast, out to sea, and to the deep ocean. The place on land where waves break and spread is the *lihi kai* or *'ae kai*, edge of the sea. Where they wash over the land is called *pahola, hohola,* or *palaha* ("spread"), and the place where they break and spread toward land is called *pu'eone* or *po'ina nalu* or *po'ina a kai*.
>
> The overall term for a place where shallow seas come in without rising [into breakers] is *kai kohola* or just *kohola* (the shallow sea within the reef). The water on the *mauka*, or land, side of the *kohola* is called the *kai 'elemihi* [for the *'elemihi* crabs that are to be found there]; the *makai*, or seaward, side of the *kohola* is called the *kai haha papa'i* (the sea in which to feel for *papa'i* crabs). The mauka part is also called *kai kahekaheka* [because of the many small salt-collecting sea pools], or *kai ki'oki'o* [because water remains in the rocky basins after the tide goes down], or hapuna [for the puddles of standing water]. Seaward of this area are the *kai hele ku*, the sea for wading; the *papa he'e,* the octopus grounds; the *kai 'ohua*, feeding grounds of young fishes; and the *kai 'au kohana*, the sea for bathing naked.
>
> Then comes the *kai he'e nalu*, surf-riding sea, or *kua'au*, and the *po'ina nalu*, or *po'ina*, where the waves break. Just beyond this surf line is the area called *kua nalu*, back of the wave, or *kulana*, pitch and toss, and then the *kai kea*, white sea; or *kai lu'u,* sea for diving; or *kai paeaea*, sea for pole fishing. Outside of there are the areas of the *kai 'o leho* and *kai 'okilo he'e*, sea for octopus fishing; the *kai kaka uhu*, sea for netting *uhu*; the *kai ka'ili*, sea for fishing with hook and line; and the *kai lawai'a,* sea for [deep sea] fishing
>
> Just before the sea becomes very dark is the *kai lu he'e*, the sea in which to catch octopuses with lures, and where the sea is very dark blue is the *kai malolo* and *kai hi aku*, the sea in which to fish for *malolo* and *aku*. Outside of there are the *ko'a hi kahala* and *ko'a hi 'ahi*, the fishing grounds, *ko'a*, for *kahala* and *'ahi*. Beyond is the ocean, *moana*, called *lepo* or *lewa* or *lipo*—the dark blue-purple sea of Kane, *kai popolohua mea a Kane*—that extends to the clouds on the horizon [Kamakau 1976:26–27].

Native Hawaiian historian David Malo defined numerous Hawaiian terms for the physical characteristics of the *kai*. In the list below, Malo notes that *kai kohala* describes the area of reef at Waikīkī:

> 1. The ancients applied the name kai to the ocean and all its parts. That strip of the beach over which the waves ran after they had broken was called *a'e-kai*.
> 2. A little further out where the waves break was called *poi'na-kai* [*po'ina kai*]. The name *pue-one* was likewise applied to this place. But the same expressions were not used of places where shoal water extended to a great distance, and which were called *kai-kohala* (such as largely prevail for instance at Waikiki).
> 3. Outside of the *poi-na-kai* lay a belt called the *kai-hele-ku*, or *kai-papau*, that is, water in which one could stand, shoal water. Another name given it was *kai-ohua*.
> 4. Beyond this lies a belt called *kua-au* where the shoal water ended; and outside of the *kua-au* was a belt called *kai-au*, *ho-au*, *kai-o-kilo-hee*, that is, swimming deep or sea for spearing squid, or *kai-hee-nalu*. That is, a surf-swimming region. Another name still for this belt was *kai kohola*.

[1] *Leho* is a cowry shell lure for catching octopus.
[2] *Okilo* means to search for or look for, such as looking into the water for squid, octopus, or fish.

5. Outside of this was a belt called *kai-uli*, blue sea, squid-fishing sea *kai-lu-hee*, or sea-of-the flying-fish, *kai-malol*o, or sea-of-the *opelu*, *kai-opelu*.
6. Beyond this lies a belt called *kai-hi-aku*, sea for trolling the *aku*, and outside of this lay a belt called *kai-kohola*, where swim the whales, monsters of the sea; beyond this lay the deep ocean, *moana*, which was variously termed *waho-lilo*, far out to sea, or *lepo,* under ground, or *lewa* floating, or *lipo*, blue-black, which reaches *Kahiki-moe*, the utmost bounds of the ocean.
7. When the sea is tossed into billows they are termed *ale*. The breakers which roll in are termed *nalu*. The currents that move through the ocean are called *au* or *wili-au*.
8. Portions of the sea that enter into recesses of the land are *kai-hee-nalu*, that is a surf-swimming region. Another name still *kai-o-kilo-hee*, that is swimming deep, or sea for spearing squid, or called *kai-kuono*; that belt of shoal where the breakers curl is called *pu-ao*; another name for it is *ko-aka.*
9. A blow-hole where the ocean spouts up through a hole in the rocks is called a *puhi* (to blow). A place where the ocean is sucked with force down through a cavity in the rocks is called a *mimili,* whirlpool; it is also called a *mimiki* or an *aaka.*
10. The rising of the ocean-tide is called by such names as *ka-pii*, rising sea, *kai-nui,* big sea, *kai-piha*, full sea, and *kai-apo*, surrounding sea.
11. When the tide remains stationary, neither rising nor falling, it is called *kai-ku*, standing sea; when it ebbs it is called *kai-moku,* the parted sea, or *kai-emi*, ebbing sea, or *kai-hoi,* retiring sea, or *kai-make*, defeated sea.
12. A violent, raging surf is called *kai-koo*. When the surf beats violently against a sharp point of land, that is a cape, *lae*, it is termed *kai-ina-ka-ka-lae*.
13. A calm in the ocean is termed a *lai* or *a malino* or a *pa-e-a-e-a* or *a pohu* [Malo 1903:25–26]

Ka Lawai‘a

Ka lawai‘a (fishing) is the dominant theme in *mo‘olelo* related to Waikīkī. In a line from the *Chant for Kūali‘i* it is said (Fornander 1917:394–400): *He kai hului ko Kālia*, which translates as “A sea for fishing with a drawnet is the sea of Kālia” (Pukui 1983:74). Also speaking of fishing nets is the proverb*: Ka i‘a pīkoi kānaka o Kālia; he kānaka ka pīkoi, he kānaka ka pōhaku*. This translates as: “The fish caught by the men of Kālia; men are the floaters, men are the sinkers” (Pukui 1983:150). According to Pukui (1983:150), this saying describes how *‘anae* (mullet) were caught at Kālia:

> In ancient days when a school of mullet appeared at Kalia a bag net was set and the men swam around it in a row and surrounded the fish. Then the men would slap the water together and kick their feet, driving the frightened fish into the opening of their bag net. Thus the fishermen of Kālia became known as human fishnets [Pukui 1983:150].

Kālia is mentioned in *Ka makini kā‘ili aloha o Kīpahulu*, or “The love snatching wind of Kīpahulu.” The following excerpt from the story tells of how a woman fishing in Kālia finds an enchanted container in the sea:

> A woman of Kīpuhulu, Maui, listened to the entreaties of a man from O‘ahu and left her husband and children to go with him to his home island. Her husband missed her very much and grieved. He mentioned his grief to a *kahuna* skilled in *hana aloha* sorcery, who told the man to find a container with a lid. The man was told to talk into it, telling of his love for his wife. Then the *kahuna* uttered the incantation into the container, closed it, and hurled it into the sea. The wife was fishing one morning at Kālia, O‘ahu, when she saw the container floating in on a wave. She picked it up and opened it, whereupon a great longing possessed her to go home. She walked until she found a canoe to take her to Maui [Pukui 1983:158].

In 1902, an article on fishing by Judge Daniel Kahā‘ulelio of the Lāhainā area was published in *Nupepa Kuakoa*. He described a fishing method previously practiced by his *‘ohana* (family) in which a large quantity *iheihe* (half-beak; *Euleptorhamphus longirostris* and others), *puhiki‘i* (any species of young

flying fish), and *mālolo* (flying fish; *Parexocoetus brachypterus* and others) were caught and sold at an excellent price. *Puhiki'i* was a favorite fish for eating raw and with *līpoa*. So was *mālolo*, although it was sometimes cooked in *kī* (ti, *Cordyline terminalis*) leaves (Titcomb 1972:104). *Iheihe* was often broiled in *kī* leaves (Titcomb 1972:83). When Kahā'ulelio first visited Honolulu in 1848, he observed the same method of fishing at Waikīkī every year he traveled there for work. The technique required many hands to work up to fifty *hano* or *hano mālolo* (a type of net) from several canoes:

> When the canoes returned, they formed into a semicircle and the two end canoes directed the formation. Those on the inside canoes were ever watchful. The men on the outer canoes stood up and so did the head fisherman as he shouted the commands continuously. Thus did he shout, "Swing wide with your net, you in the center. You in that end lift it up." That was how the malolo were drawn in. When the semi-circle of canoes narrowed in close to the bag net, some of the canoes have moved on the left away from the rest. Then the swiftest of the canoes hurried to the edge of the net. That was the time when the puhikii and iheihe were drawn in by the side nets. When the edge of the bagnet was quietly lifted to see inside, it was thick with iheihe and puhikii. This was called a makahei. The fisherman kept a close watch lest the fish notice them and then there would be none to catch but the lifting of the net was an exciting occasion. If there was luck, one, two or three hauls filled a canoe. The fish was divided at sea; all one did was to take his catch ashore [Kahā'ulelio 1902:37].

Emma Ka'ilikapuolono Metcalf Beckley Nakuina, a Hawaiian judge, cultural historian, and writer, also described this method of fishing:

> The "hano" is a large bag net of very fine mesh, with a flaring mouth, used to capture flyingfish. There are two varieties of flying-fish here, entirely distinct from each other. The same net and method of capture is also employed for the "iheihe," a long thin fish, usually 1 ½ feet in length, with a very sharp-pointed snout, that generally arrives here at about the same time as the large flying-fish. . .
>
> For catching the large flying-fish the "hano" is piled on a double canoe or large single one, and a start is made early in the morning with an attending fleet of from twenty to forty canoes. Women very often go in this kind of fishing to help paddle the canoes, as no particular skill is called for on the part of the general hands, the success of the fishing depending altogether on the good judgment and sight of the lookout. This person is generally on a light canoe manned by only two or three hands, and he is standing up always on the cross-ties of the canoe looking for the fish. Whenever he discerns a strong ripple, he points it out to the rest of the canoes, who then surround the spot indicated while he confers with the head fishermen about the best place to drop the net, *ku'una* which depends upon which way the current sets. When the net is all ready the canoe paddles very quickly in towards it, splashing the water and driving the fish before them into the open net. [Beckley 1883:254].

Umu

Although the current project's APE is much farther offshore, it shares similarities with the traditional Hawaiian *umu*, also known as *imu* or *unu. Umu* were artificial fish shelters or reefs that functioned as fish aggregating devices. Dr. Kekuewa Kikiloi provides a description:

> [They were] common features along shorelines that helped provide protection and regulated the growth and reproduction of inshore fish species … These fish shelters were artificial reefs made of rock or coral piles with enough space between the rubble to allow for algal growth on the surfaces (Kikuchi 1973:78). These stones functioned in the same way that naturally occurring rock outcroppings and coral reef habitats do, by providing a hard substrate necessary for the basic formation of reef bottom communities. Besides providing stability and some protection from predators, these shelters also helped to regulate fish growth and potentially increase fish stocks by serving as artificial homes for fish to congregate and reproduce [Kikiloi 2003:5–6].

Fish most often attracted to *umu* were *u'u* (*Myripristis* spp.; squirrelfish), *kala* (*Naso unicornis;* unicornfish), *manini* (*Acanthurus triostegus;* surgeonfish), *moano* (*Parupeneus multifasciatus;* goatfish), *kahala* (*Seriola dumerili;* greater amberjack), *uhu* (*Scarus* spp.; parrotfish), and *puhi* (*Muraenidae*; eels)

Kikiloi 2003:6]. Margaret Titcomb, a librarian at the Bishop Museum in the mid-1900s, described underwater chambers constructed to attract and trap *uhu*. They were 8.0 square feet and built in water 1.5 to 5.0 feet deep along narrow reef channels. They were maintained, or "weeded," to only contain seaweeds edible to the *uhu.* One entrance was on the side where *uhu* could file through. Titcomb described how the method worked: "When the season came—May, June and July—the outer gate was opened, allowing the leader to come in with his followers. The gate was then shut and the other gate opened as soon as enough uhu had been taken for use. Many schools of uhu come during a season, so this trap could be used many times" (Titcomb 1972:149).

Kamakau used the term *unu* as one of three types of fishing shrines:

> In his fifth year Liholiho was declared Kamehameha's successor and was taught to observe the tabu of the *heiau* and the *waihau*[3], instructed in erecting the *unu, kuʻula,* and *koʻa* shrines, in observing the tabu of the *loulu* ceremony in the heiau, the offering of the ivory tooth, and the different types of prayers and offerings" [Kamakau 1992:221].

The three different terms for these artificial fish shelters may have been due to regional differences in terminology or whether they were placed in freshwater or saltwater. Titcomb's information came from William Watson of Kāneʻohe and named the chambers "ahu," the gates "ohiʻa," and the channels "kuʻuna*"* (Titcomb 1972:149). Other terms used when discussing *umu* are listed in Table 2.

Table 2. Hawaiian Terms Related to *Umu*.

TERM	DEFINITION	SOURCE
ahu	A traplike stone enclosure made by fishermen for fish to enter.	Pukui and Elbert 1986
ʻeho	Stone pile . . . especially as used to mark land boundaries; stone image; heap of stones under water (at times fishermen block one end with a net and drive the fish in from the other end), also *umu*, *imu*	Elbert 1959; Pukui and Elbert 1986
Imu	Rock and coral fish trap; the fisherman might insert a branch into an opening at one side to frighten the fish into a surrounding net. Also *ahu*, *umu*.	Pukui and Elbert 1986
hinakea	Type of stone laid near the coral pile (*umu*) to attract fish; it was flat on one side and rounded on the other, and was believed to attract manini and young of other fish which resembled it in color. Lit., white gray.	Pukui and Elbert 1986
lau ʻōpae	Shrimp net, about a fathom long, placed around a heap of rocks called *ahu* or *imu* (fish and shrimp were prodded and frightened from the rock pile into the net); this type of fishing.	Pukui and Elbert 1986
umu	A heap of rocks placed in the sea for small fish such as the manini to hide in: this was surrounded by a net and the fish were caught. More commonly called *imu*. *hoʻo.umu* To make an *umu*; to pile in a heap.	Pukui and Elbert 1986
unu	Small stone, pebble, stone chip… *hoʻo.unu* To place stones; to pave, macadamize.	Pukui and Elbert 1986

These terms are also found in Mahele land claim descriptions from the mid-1800s. In defining the boundary between Mapulehu and Kaluaʻaha on Molokaʻi, an *imu* in the sea is mentioned in three Native Testimonies. Quotations below highlight the reference to *imu* in bold, followed by the original Hawaiian text in brackets:

[3] A *heiau* where hogs, bananas, and coconuts were sacrificed, but not human beings; a *heiau* for *moʻo* spirits (Pukui and Elbert 1986).

> Aikake Lui (Isaac Lewis) Claim 3218, Mapulehu, Molokai
>
> Timoteo Keaweiui sworn: Work on Niaupala loko was done by the government at the time Liholiho went to Britain, and it has been secured to this day, and it is in the hands of the government. I have seen the opening of Huaea, and I have heard about it as follows. It is the boundary of Kaluaaha and Mapulehu. It runs from Hueea to the uplands to Kihele which is small point, then lying to the **imu of Kanealai. This is a large and long imu from one water hole to the other** [*ka imu ia o Kanealai, he imu nui keia loihi, mai keia kahawai a kela kahawai*] and just mauka of this area *is* the maika grounds.
>
> Pulehu sworn: Huaea is the boundary makai separating Mapulehu and Kaluaaha, from there to the house of Puhikea, then it comes back to Kahaluukou and Kuunalei and to this lower end. The sea is for Kaluaaha, the land for Mapulehu to the **imu of Kanealii** [*imu o Kanealii*], from there to below toward this way and running directly to the adobe which Timoteo has just mentioned. I have not known that this loko is for any other land.
>
> Ku sworn: I have seen the boundary of Mapulehu and Pukoo 3. Kepemanu is a rocky hill mauka of the government road, the boundary runs to the sea east of the **coral imu** [*imu puna*] to the beach, that is Pukoo. Mauka is the sea of Mapulehu [Avakonohiki 2025a,b].Claims also mentioned *umu ʻōhua* (stone mound fry fishery):
>
> 7702 Kooka at Kealia, Kona, Hawaii. An **umu ohua**
>
> 8758 Kaiolani at Ninole, Kau, Hawaii. An **umu ohua**
>
> 10510 Nawali at Ninole, Kau, Hawaii. An **umu ohua** [Maly and Maly 2003b].

Claims using the term *unu* were associated with *ʻoʻopu* (freshwater goby) fisheries:

> 11108 Kulu at Waipio, Hawaii. An **unu** (stone mound) for a fresh water oopu fishery.
>
> 11105 Naailuhi at Waipio, Hawaii. An **unu** (stone mound) for a fresh water oopu fishery
>
> 4696 Laauohala at Puueo, Hilo, Hawaii. "…an **unu oopu** (stone mound fishery) made by my own hands" [Maly and Maly 2003b].

In 1902, Hawaiian fishing expert Kahāʻulelio described using *lau ʻōhua liko*, a seine made of *kī lau* (ti leaves), to catch *ʻōhua liko* (manini fry) at *umu.* Around Lāhainā, where he was from, the term *ahu* was employed, while in Hāna they used the term *umu*:

> Lau Ohualiko—It is the same as the Lau-opae and is about a fathom in length. It was used for fishing around the ahu or imu as the people of Hana call it. We use the term ahu. In it are found the opae or shrimps and other small fish that could be quickly caught and eaten for breakfast. On a morning when the tide is low then the net that is fine meshed is used or mosquito netting can be used instead. The net is put around (the ahu) as far as the kuku or bracing sticks of the net, then the stones of the ahu are removed until there is none left. You will see the bag in the net well filled. With three stone ahus, one could fill a pail such as are bought in stores. Even small lobsters, that are very good eating are caught in this way [Maly and Maly 2003b:115].

Due to the scarcity of primary-source information on *umu*, similar practices in Oceania may offer more insight into the use of *imu*. This was noted by Kikiloi in his 2003 article on aquaculture in pre-Contact Oceania. He cited the *ulung* (piled-rock traps) used in Yap, which were described in a 1981 article by Dr. Roslind Hunter Anderson. Dr. Hunter-Anderson was not able to document an *ulung* firsthand but gathered information from a local informant. In her article, the description and *ulung* illustration, shown below in **Error! Reference source not found.**, are similar to Hawaiian *umu*. The following is Dr. Hunter-Anderson's discussion of *ulung* in Yap:

> Mueller described the piled-rock trap *(ulung)* as an adjunct to a combination fishing method using an anchored net covering the pile of rocks and attached to a basket with net tubing . . . I was not able to observe directly the use of *ulung,* but informants described the operation somewhat differently than Mueller. This may reflect differing practices due to varying local conditions within Yap's

lagoon; Mueller observed *ulung* use in Gachpar, Gagil, while my information comes from northeastern Map.

Contemporary use of *ulung* is rare. One built in Map a few years ago involved the skillful piling of coral and stone to create openings in which reef fish could take refuge during low tides but which still allowed the fisherman to spear them readily. Ideally, the piled rock traps were located in coral-free areas in mid-lagoon, where there were no other places for fish to retreat to. Spearing rather than using nets and baskets was indicated by Map residents.

Prehistoric use of piled-rock traps in Map's northeastern lagoon was reportedly extensive. Although no clear forms can be discerned today, some rubble is present in this area and may represent former *ulung.* This area now has large patches of living coral which have completely overgrown and obscured several stone traps within the last 30 years or so. It is said that when *ulung* were built, the lagoon was clear of live coral, already taken for building house foundations and other construction.

The lagoon where *ulung* were built was partitioned into family plots, each with three or four of these traps. A family would own or gain permission to build them on a plot, harvesting the traps at will. Access to these traps was controlled, and infringements by nonowners could result in the loss of the trespasser's land or similar severe sanction. No data exist on *ulung* yields fished with spears, but they were likely to have been relatively small. In Map, taking of fish from one of these traps seems to have been limited to one fisherman at a time for the use of his family. This use contrasts with the anchored net and basket technique described by Mueller. In that case, several men were involved,

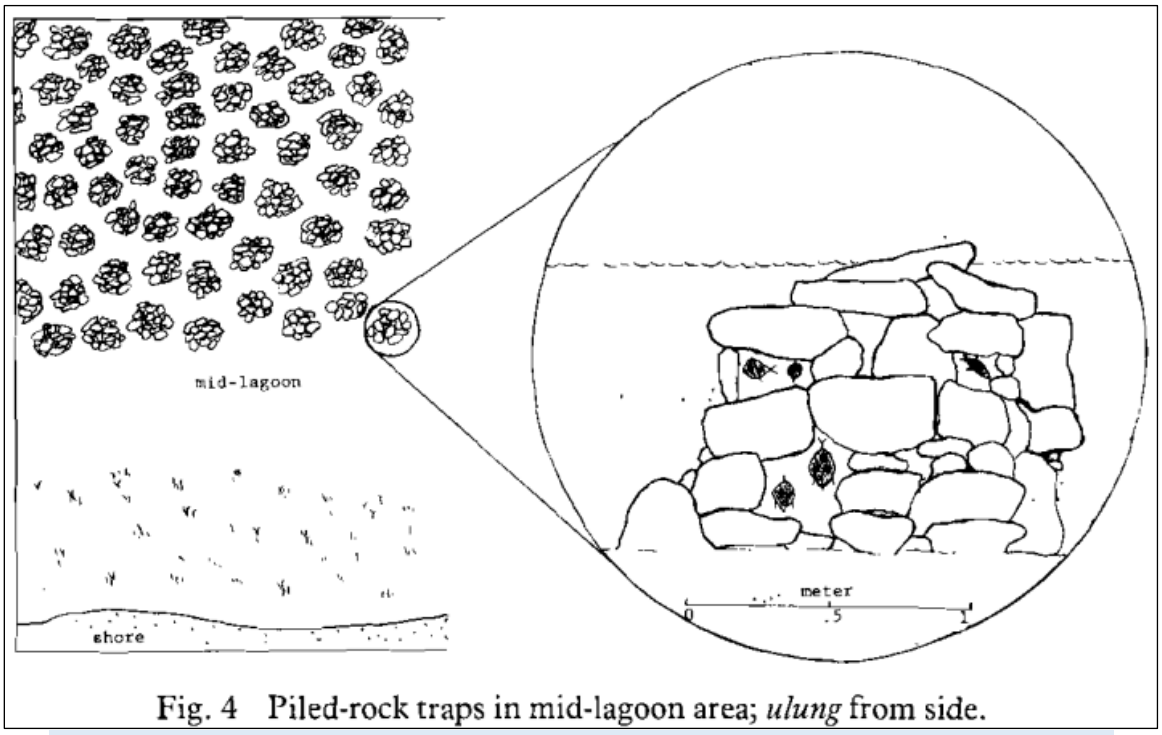


Fig. 4 Piled-rock traps in mid-lagoon area; *ulung* from side.

and the catch was brought to the village (Gachpar) for division [Hunter-Anderson 1981:86–87].

The term *imu* also appears in *Kaao Hooniua Puuwai no Ka-Miki* (*The Heart-Stirring Legend For Kamiki*), which was published in *Ka Hoku o Hawaii* between 1914 and 1917. In the *mo'olelo*, Kamiki (The quick, or adept, one) and his brother Maka'iole (Rat [squinting] eyes) journey all around the island of Hawai'i. While traveling south on the leeward side of the island, they are warned of a family of fierce

Figure 7. Illustration of Ulung from Yap, Similar to Umu used in Hawai'i (Hunter-Andersen 1981: Figure 4).

ʻōhole[4] who waylaid travelers as they passed through their residential compound, which spanned both sides of the trail. They kept an *imu* hot and ready to bake any traveler who lost a competition to them. The victims' bones were fashioned into fishhooks (Maly and Maly 2003:15). To each warning, the brothers replied that they were well trained in *ʻōhole* practices and their purpose was to track down such people (Maly and Maly 2003:15).

> Ka-Miki and Makaʻiole arrived at the compound of Omokaʻa and Okoe *mā*, and indeed the famed *imu* in which they baked their victims glowed red hot with its fire. Omokaʻa sat on the *mauka* side and Okoe on the *makai* side of the *imu*, and upon seeing Ka-Miki *mā* they both reached for their tripping clubs. The four competitors exchanged taunts and riddles. And Ka-Miki warned the couple that they would be the ones baked in their own *imu*. Seeing that Ka-Miki *mā* were versed in riddling, Omokaʻa and Okoe started their efforts at defeating Ka-Miki *mā*, in hopes of baking them in the *imu* [Maly and Maly 2003:16].

Okoe challenged Kamiki to solve several riddles, one of which includes the multiple interpretations of *imu*:

> *Aia la! Aia hoʻi! Kuʻu imu aʻohe ahi, kuʻu imu uwahi ʻole, kuʻu imu hoʻokāhi no pōhaku, kuʻu imu ʻelua no peʻa kauwawe, kuʻu imu e ...*
>
> *Behold, behold indeed!* ***My imu has no fire****, no smoke, my imu has one stone, and two ti leaf bundle covers, yet it is my imu...*[Maly and Maly 2003:17].

Kamiki responded to Okoe correctly, winning the contest:

> ***He imu manini ko kai, aʻohe ahi pau no naʻe ka manini i ka ʻai ʻia.*** *He imu maiʻa ko uka ua* moʻa *pala kupule iloko o ka lua, aʻohe ahi pau no naʻe i ka ʻai ʻia…*
>
> **The rock mound an imu for the manini in the sea, has no fire, yet it is consumed.** The smokeless imu is in the uplands, is an over ripened banana, and it too is consumed... [Maly and Maly 2003:17].

Similar to an *umu* is a pebble ridge described in the *moʻolelo* of ʻAiʻai, as told by Moke Manu and translated by S. N. Emerson. In the following excerpt, ʻAiʻai builds a resting place for *aweoweo* with pebbles:

> Aiai's good work did not stop at this point, but proceeding to Honomaele he picked up three pebbles at the shore and going into the sea, out beyond the breaking surf, he placed them there. In due time these three pebbles gathered others together and made a regular ridge, and when this was accomplished the aweoweo gathered from the far ocean to this ridge of pebbles for rest, whereupon all the people came with nets, hook, and line and caught them as they desired. The writer witnessed this in 1845 with his own eyes. This koʻa for aweoweo is still there but difficult to locate from the fact that all the old residents are gone; either dead or moved away [Manu 1901:116].

Limu

Traditionally, numerous types of *limu* were gathered at Waikīkī for food, medicine, and spiritual practices. In the shallow waters off the coast, a map dated 1825 is labeled, "Reef dry at low water, and is then covered with the Natives in search of shellfish etc." (Malden 1825). This would have included multiple types of *limu*. Reed described the ubiquity of *limu* in 1907:

> Nearly all the limu is sold in the market by native women, who have other Hawaiian delicacies, as sea urchins, roasted kukui nuts, crabs, cocoanut pudding, small cubes of raw beef liver, ready to serve with limu, etc. The amount of limu sold in Honolulu does not, of course, include nearly all that is actually consumed either on these islands, on Oahu, or even in Honolulu, as every native

[4] Experts skilled in fighting or in other competitions, such as running, fishing, debating, or solving riddles, that were practiced by the ancient Hawaiians (Maly and Maly 2003:15).

> family living on or near the beach gets its own supply of algae fresh from the sea whenever it is desired [Reed 1907:74–75].

Queen Liliʻuokalani owned the Hamohamo fishery located on the front of her property at this time. In 1906, a notice ran in Hawaiian newspapers prohibiting anyone from taking *limu pakaeleawaʻa*[5] or *limu huluhuluwaena*[6] (*Grateloupia filicina)*, *ʻopihi (Cellana sp.), pūpū ālealea (Turbo sandwicensis), ʻina (Echinometra sp.), hāʻueʻue* (slate pencil sea urchin, *Heterocentrotus mammillatus),* and *pipipi (Nerita picea)* from the shores of Hamohamo, which belonged to Queen Liliʻuokalani. She propagated limu by transplanting samples collected from locations across all the main islands.

> HOOLAHA HOOKAPU. Ke hoike ia aku nei ka lohe i na mea apau, e hele nei ka auau kai, a lawaia paha ma ke kai o Hamohamo, ma Waikiki-kai, Honolulu, Oahu, ke hookapu nei ka Moiwahine Liliuokalani aole e kii i ka Limu Pakaeleawaa, me ka Limu Huluhuluwaena, Opihi, Pupualealea, I-na, Haueue, ame Pipipi, ma ke alo ponoi iho o ka Pa Alii. Na kona mau lima alii ponoi no i kanu a hookawowo i kela mau mea apau i hoike ia ae la maluna, a o ka mea e kii ana i keia mau mea e hookapu ia nei, e hopu ia no oia, a hoopai ia e ke kanawai. O keia mau mea apau i kanu ia e ka Moiwahine mai Hilo i lawe ia mai ai kekahi no Lahaina kekahi, no Molokai kekahi, no Kauai kekahi, no Waialua, Oahu nei, kekahi [Carter 1906].
>
> NOTICE OF PROHIBITION Public notice is given to all who swim or fish in the ocean at Hamohamo, Waikīkīkai, Honolulu, Oʻahu. Her Royal Highness Liliʻuokalani has prohibited the gathering of Limu Pakaeleawaa, as well as Limu Huluhuluwaena, ʻOpihi, Pūpū Ālealea, ʻIna, Hāʻueʻue, and Pipipi in the area immediately in front of the Royal Grounds. Her own royal hands planted and cultivated all of these creatures identified above, and anyone who gathers these things currently placed under prohibition will be arrested and charged according to the law. All of these creatures were established here by Her Majesty. Some were from Hilo, others were brought here from Lāhaina, others from Molokaʻi, some from Kauaʻi, others were from Waialua, here on Oʻahu as well [Gomes 2024:48].

Minnie Reed, a teacher at Kamehameha Schools, published her study of limu in 1907. She noted that transplanting *limu* was an ancient practice:

> There are. . . several places where a certain favorite limu has been transplanted from other islands and guarded carefully until it could get established. Limu pakaeleawaa was transplanted from Hawaii to Molokai by an old chief, who planted it on the inner edge of his fish pond, where it is now growing luxuriantly. This same limu has also been transplanted to the beach in front of the residence of ex-Queen Liliʻuokalani, near Diamond Head, and also in front of her Waikiki place. It is thriving in both places, so the writer has been told.
>
> . . . There may have been more attempts at cultivating or transplanting seaweeds by the natives of the past, for no doubt when a chief moved from one island to another, he brought with him his best taro and yam plants for his lands; why not his favorite limus to his fish ponds or beach? [Reed 1907:73].

Manō

In ancient times, the *manō kumupaʻa* (ancestral sharks) Kanehunamoku and Kamohoaliʻi, declared a *kānāwai* (law) on Oʻahu that made it *kapu* (taboo) for any shark there to bite people (Kamakau 1964:73). According to Kamakau, this held true until more recent times, except for ʻUnihokahi (One-toothed), an *akua manō* (shark god) who had only one tooth. One of the Oʻahu places he swam was in the waters off Kahaloa [beach at today's Royal Hawaiian Hotel] in Waikīkī:

---

[5] "*Limu huluhuluwaena* is the native name for *Grateloupia filicina*, generally used on the island of Hawaii and in frequent use on Kauai and Oahu, while *limu pakaeleawaa* is the name always used on Kauai and in common use on Molokai, Maui, and Oahu" (Reed 1907:64, footnote b).

[6] Bushy, pyramidal plants with flattened stems and fine branches in one plane. Grows as small groups on rocks covered with fine sand. After washing, plants are usually finely chopped and lightly salted. Eaten with raw liver, raw fish; added to cooked beef at serving time; or eaten with dried or broiled *heʻe* (octopus) (Reed 1907:65).

> *Malihini* [foreigners] may be skeptical that he had only one tooth, but this was known to everybody. We all know that sharks have rows and rows of teeth, but this shark, called ʻUnihokahi (One-toothed), had but one tooth. He was known to Peleioholani, Kahekili, and Kamehameha I. When the chiefs went surfing at Kapua in Waikiki, if a man was bitten by this particular shark that left a single toothmark, it was a warning that an enemy of the sea was approaching. Chiefs and people went hurriedly to shore; it would not do to hesitate, for soon the dorsal fin and side fins of an approaching shark would be visible [Kamakau 1964:73].

At Waikīkī, *akua mano* protected the ocean from the *malihini* (foreign) sharks looking to eat humans. Kamakau tells of a *malihini* shark that was caught at Kapua (the vicinity of today's Outrigger Canoe Club) in 1834:

> In 1834, during the time of Kaomi, a *malihini* shark came to Waikiki in search of food. When he reached Kaʻalawai and Kaluaahole, he was refused by the guardian sharks of that place (*ka poʻe kamaʻaina kiaʻi o ia wahi*) and then he came to Kapua, where the guardians of Waikiki were, and argued with them. They decided to kill him and to leave visible proof of it, so they forced his head into a cleft in the rocks at Kukaʻiunahi, *makai* of Kupalaha. It could not get free, and there it was with its tail—two or more *anana* in length—flapping in the air, and a little companion shark swimming around it. If this had been done by men it would have been impossible to hold it fast without tying it with ropes, but as it was done by those whom men had made into supernatural beings, the shark was made fast without ropes. When this wondrous sight was seen, men ran with ropes and tied them to the tail and dragged the shark ashore, still alive, with its eyes blinking and its body turning from side to side. It died from being dragged here and there, and by the time they reached Honolulu it was all flabby [Kamakau 1964:74].

Heʻe Nalu, Pākākā Nalu, and Kaha Nalu

Waikīkī has always been known for surfing. This includes *heʻe nalu* (board surfing), *pākākā nalu* (outrigger canoe surfing), and *kaha nalu* (body surfing). The *kai heʻe nalu* (surf-riding sea) at Waikīkī was one reason *aliʻi* found it an attractive place to live (Handy and Handy 1991:268). This is stated by Kamakau, along with the names of the surf spots at Waikīkī:

> Waikīkī sits proudly in the calm of the Kaʻao breeze… Waikīkī was a land beloved of the chiefs and there many of them lived from remote times to the time of board surfing could be indulged in there, and for this reason the chiefs liked the place very much. At Waikīkī are the surfs of Ka-lehua-wehe, ʻAiwohi, Maihiwa, and Kapuna [Kamakau 1991:44].

ʻĪʻī wrote of *pākākā nalu* and mentions Kamerhameha I at Kapuni in Waikīkī:

> About canoe surfing. There are many ways to show skill in canoe surfing. The king [Kamehameha I] was especially noted for it, and so was his pupil, Gideon Laanui. They were often seen together gliding on the surf outside of Haleumiumiiole at Kawaihae and at Kapuni, outside of Kiikiiakoi. They would allow waves to go by until they saw the one they wished to glide on, then ride it to the spot where they chose to land. There are ways of selecting waves which will go all the way to shore, and the king and his pupil were unusually skillful at this. Such things were actually taught [ʻĪʻī 1959:135].

Kaha nalu was briefly mentioned as a footnote by Thrum in his translation of Fornander (1916):

> Surf riding has a wider range of sport than shown above for canoe surfing is also very generally practiced, and occasionally body surfing. This requires strong, expert swimmers to attain sufficient momentum to ride in on the surf without a board or other support. This, termed *kaha nalu*, is still practiced [Thrum 1916, Footnote 26 in Fornander 1916:206].

Kamakau (1991) wrote that the wives of ʻUmi enjoyed *kahu nalu*, and mentions "'Umi's skill in surf-riding," which implies this was the type of surfing ʻUmi competed in against Paiʻea, chief of Laupāhoehoe. Malo (1951) also cited the race as *kaha nalu*. In contrast, Fornander used the term "*heenalu"* ("board-surfing") as the type of race they engaged in, but quotes ʻUmi as challenging Paiʻea to a race in "*kaha nalu"* ("surf riding"). The following account is from Kamakau's *Story of ʻUmi*:

> ‘Umi and his wives went sea bathing, surfing (*he‘e nalu*), riding on the surf (*kaha nalu*), and a certain chief of Laupahoehoe noticed ‘Umi's skill in surf-riding. His name was Pai‘ea, and he knew all the surfs and the best one to ride. It was the one directly in front of Laupahoehoe, facing Hilo. It was a huge one which none dared to ride except Pai‘ea, who was noted for his skill. Gambling on surfing was practiced in that locality. All of the inhabitants from Waipunalei to Ka‘ula placed their wages on ‘Umi, and those of Laupahoehoe on Pai‘ea. The two rode the surf, and while surfing Pai‘ea noticed that ‘Umi was winning. As they drew near a rock, Pai‘ea crowded him against it, skinning his side. ‘Umi was strong and pressed his foot against Pai‘ea’s chest and then landed ashore. ‘Umi won against Pai‘ea, and because he crowded ‘Umi against the rock with the intention of killing him, Pai‘ea was roasted in an imu (in later years) [Kamakau 1992:10–11].

There is a Hawaiian saying that refers to the most famous break at Waikīkī, Kalehuawehe (Take-off-the-kehua): *Ka nalu ha‘i o Kalehuawehe* (The rolling surf of Kalehuawehe). The name is from *He Kaao no Pikoiakaalala: Ke Keiki Akamai i ka Pana,* published in a series from 1865 to 1866 in *Ka Nupepa Kuakoa*, as told by S.M. Kaui. Pīkoiaka‘alalā (Pikoi-son-of-the-crow) was a renowned rat shooter and the son of ‘Alalā and Koukou. The family were *kūpua* (beings with supernatural powers and multiple body-forms). In part three of the story, published in December 1865, Pīkoiaka‘alalā plans to travel from his home at Kahaloa in Mānoa, along with people from Kaapakahua, Kawailele, Puahia, Kānewai, Kamō‘ili‘ili, and Kāmoku, to spend the day at Waikīkī (Kaui 1865).

Before leaving, he has his sister, Kau‘iomānoa, gather lehua flowers for lei. Kau‘iomānoa was the wife of Pāwa‘a, a Mānoa chief. She knew there were lehua at Kaho‘iwai, further inland. She gathers enough to make four lei: two for Pīkoiaka‘alalā’s neck and two for his head.

At the beach, he sees Kahamalu‘ihi and her *kuhu* out in the *kulana-nalu* (lineup). When she comes ashore, Pīkoiaka‘alalā asks to use her board, but that is *kapu*, and she offers the board belonging to her *kuhu*. Out in the ocean, he is warned that one side of *nalo o Kapuni* is reserved for the chieftess. But on the side that is not *kapu*, no waves were passing, so he paddled further out. Kahamalu‘ihi followed him, and they both arrived at a place offshore from Kapua. Pīkoiaka‘alalā asked her why she was next to him when she had her own *kapu* wave. She replies that perhaps there were no waves on her side of *nalu o Kapuni*. They ended up in an unnamed spot that no one ever surfed. The chieftess admired Pīkoiaka‘alalā and asked to have one. He gave her one of his lehua lei, and that spot is now known as *nalo o Kalehuawehe*.

Pīkoiaka‘alalā said to the chieftess that she could have the first wave, and he would take the second. When the first wave came, she did not move. When the second wave came, he caught it, as did the chieftess, and they rode the same wave to shore. Chief Kakuhihewa saw the two together and ordered his men to kill the surfer riding with his wife as soon as he came to shore. On the beach, Pīkoiaka‘alalā resisted the arrest and asked to speak to Kakuhihewa before they killed him. He was taken to Helumoa where Kakuhihewa and Kahamalu‘ihi lived. As Pīkoiaka‘alalā was speaking to the chief, Kahamalu‘ihi’s *kuhu* entered and recognized him as the famous rat-shooter boy who beat the high chief Mainele on Kulaokahua plain. To prove his identity, he again competed with Mainele, this time in the house at Helumoa. Pīkoiaka‘alalā won with his archery skills and solidified his reputation as a famous rat shooter.

Malo described *he‘e nalu* as the national sport of Hawaiians and mentioned betting on competitions, as Kamakau did in the *Story of ‘Umi* (see Kamakau 1992). The following is from Malo (1903):

> 1. Surf-riding was a national sport of the Hawaiians, on which they were very fond of betting, each man staking his property on the one he thought to be the most skillful.
> 2. When the bets were all put up, the surf-riders, taking their boards with them, swam out through the surf, till they had reached the waters outside of the surf. These surf-boards were made broad and flat, generally hewn out of koa; a narrower board, however, was made from the wood of the wiliwili.
> 3. One board would be a fathom in length, another two fathoms, and another four fathoms, or even longer.
> 4. The surf-riders, having reached the belt of water outside of the surf, the region where the rollers began to make head, awaited the incoming of a wave, in preparation for which they got their

boards under way by paddling with their hands until such time as the swelling wave began to lift and urge them forward. Then they speeded for the shore until they came opposite to where was moored a buoy, which was called a *pua*.

5. If the combatants passed the line of this buoy together it was a dead heat; but if one went by it in advance of the other he was the victor.

6. *A i ka an hou ana, o ka mea i komo i ka pua hoomawaena wai oia, aole e hiki i ke kulana, o ka eo no ia nana; pela ka he'e nalu* [untranslated; perhaps, " In the next heat (to break a tie), the one who places second loses; that is surfing" [Malo 1903:293–294].

There is a *mo'olelo* that tells of the skilled surfer Keleanuinohoana'api'api (Kelea), the Great-Kelea-Who-Flutters, and how Waikīkī became her home. Kelea was the sister of the *mō'ī* of Maui, Kawaokaohele (Kamakau 1991:88). In addition to being extremely beautiful, she was an excellent surfer and often rode with the chiefs. Lō Lale, chief of Līhu'e, was in need of a wife and had sent men to find someone suitable. By canoe, they searched other islands and, at Hāna on Maui, learned of Kelea. Hearing of her beauty and how she surfed every morning, the men set off for Hāmākuapoko, Kelea's home. They spotted her surfing and approached her in their canoe. They convinced her to ride with them to shore, not knowing it was a "wife-snatching" canoe, *he wa'a kā'ili wahine* (Kamakau 1991:88). They rode the waves to shore twice and then vanished out to sea heading for Wai'alua on O'ahu.

After ten years of marriage and living in the uplands of Līhu'e, Kelea asked Lō Lale if she could visit the coast, and he granted permission. So, she traveled south with her companion toward the seashore. After the channels of Pu'uloa were in view, they went to Hālawa, and Kelea asked what else was before them to the east. One replied, "It is dense with *kou*[7] and coconut trees, and it is also a place where one may watch the chiefs enjoying surfing," which excited Kelea, and on they went to Waikīkī:

> They went along until they entered the coconut grove of Kawehewehe in Waikīkī. The kama'āina of the place saw this beautiful woman and welcomed her and shook down coconuts for the three to eat. They asked, "Where are you from? And where are you going?" "We have come from 'Ewa from the upland of Līhu'e because we wanted to go sightseeing. This is the most pleasant place we have seen." The *kama'āina* said, "This is a place for enjoyment. Over there is the *kou* grove of Kahaloa where one may view the surfing of the chiefs and of the *ali'i nui* Kalamakua."
>
> Joyful at the thought of surfing, Kelea said to her companions, "Let us go on." They entered the *kou* grove of Kahaloa and watched the chiefs surfing in. Kelea inquired of the *kama'āina,* "Is it possible to obtain a surfboard for the asking?" "Ka! Are you skilled at surfing?" "Who would not be if one had a board?" retorted Kelea. When the *kama'āina* heard these words, they were astonished; those of Līhu'e were accustomed to slicing *mo'okīlau*[8] ferns and *pōpolo*[9] stalks, but of surf riding these people knew nothing. The *kama'āina* thought that Kelea had been born at Līhu'e; they did not know she came from Maui.
>
> The *kama'āina* said that a surfboard could readily be obtained. So she asked them for a board, and perhaps because she was so beautiful a woman, someone gave her one. When she received it, she went to the edge of the sea and rubbed off the red dirt of 'Ewa from her feet so as to look fresh. When she had finished, she dipped into the sea, then jumped upon her board and paddled off like an expert. Those who were watching saw that she managed her board like one trained, moving along easily and noiselessly without the least heeling over.
>
> When Kelea reached the place where the surf broke, she left that place to the *kama'āina* and paddled on out to wait for a wave to rise. As she floated there, the first wave rose up but she did not take it, nor did she take the second or third wave, but when the fourth wave swelled up, she caught it and rode it to shore. As she caught the wave, she showed herself unsurpassed in skill and grace. The chiefs and people who were watching burst out in cheering—the cheering rising and falling, rising and falling.

[7] A tree, *Cordia subcordata*, much used by the early Hawaiians for cups, dishes, and calabashes (Kamakau 1991: 261).
[8] General name for ferns on a single stem (Kamakau 1991:262).
[9] The black nightshade, *Solanum nigrum*. In Hawai'i, young shoots and leaves may be eaten as greens (Kamakau 1991:264).

> While Kelea was surfing, the chief Kalamakua was working in his fields. When he heard those loud shouts he was startled and asked his men, "What is that shouting reverberating from the seashore?" "It is probably because of a skilled woman surfer," they answered. The chief remembered the chiefess of Maui, Kelea. He left off his work and went to stand on the shore to watch. As Kelea rode in on a wave, the *mōʻī* ran to the edge of the sea and stood there. When the chiefess reached the sand, he took hold of her board and asked, "Are you Kelea?" "Yes," she answered. She stood up, naked. The *mōʻī* removed his *kihei* shoulder covering and wrapped it around her as a *pāʻū* and took her to a *kapu* place. That was the beginning of her life as the *aliʻi wahine mōʻī* and she married (*hoʻāo mare*) the *mōʻī* Kalamakua [Kamakau 1991:90–91].

At the east end of Waikīkī is a surf break traditionally called Kapua (today known as Tongg's). In 1809, Kaʻahumanu surfed at Kapua to temper her anger after the execution of her lover, Kanihonui, a nephew of Kamehameha (ʻĪʻī 1959:51). She was planning to make war with Kamehameha and place young Liholiho on the throne. Liholiho, along with other chiefs and chiefesses, accompanied Kaʻahumanu on the holiday she proclaimed, when conditions for surfing were good at Kapua:

> It was where one could look up directly to the heiau on Leahi, where the remains of Kanihonui were, all prepared in the customary manner of that time. It was said that only Kaleiheana, who was a Luluka, watched over the corpse from the time of death until it was decomposed. The chiefess had heard something about her lover's remains being there, and perhaps that was why the proclamation was made.
>
> On the appointed day, chiefs, chiefesses, prominent people, and the young chief Liholiho went to Kapua. When all had assembled there, the king gathered his men together in readiness for trouble. He sent a messenger, Kinopu, after Kaahumanu's followers to find out what they were planning. It is said that three things were done at Kapua: surfing, lamenting, and more surfing; and it is said that they had intoxicants with them. Thus they whiled away the time until evening.
>
> Before the company returned to Honolulu, Kaahumanu, surrounded by the chiefs, kept crying and looking up at Leahi [ʻĪʻī 1959:51].

Traditional history suggests multiple *kapu* concerning surfing. These include *makaʻāinana* and *aliʻi* sharing waves and specific boards exclusive to *aliʻi*. The waves at Waikīkī can be very long, and are called *nalu ʻopuʻu,* which is described below:

> *Ka nalu ʻōpuʻu* is a long-period wave, one of great magnitude but not necessarily large by definition—this is groundswell, and the term *haʻi* references the shoaling process, when a wave gathers and breaks, thus turning over on itself. An *ʻōpuʻu* wave is best termed an open ocean wave that rolls in towards and spills over like a long-period wave at Waikīkī, a wave that breaks and spreads. That is not to say that this wave does not have the potential to be large, as these waves were also known to break at Waimea on the north shore of Oʻahu. With *kakala* and ʻōpuʻu, the key is the recognition of wavelength as affecting the characteristics of the wave, which we categorize today as short-period and long-period waves, respectively [Finney and Houston 1996:]

Another surf spot in Waikīkī was Kawehewehe, which was where Lunalilo surfed in 1886, according to a *Ka Nupepa Kuokoa*: "News from the Royal Court. The Prince W. C. Lunalilo is still enjoying himself in Waikīkī, spending a lot of time relaxing and surfing in the waves of Kawehewehe [*i ka heenalu mau i na nalu o ka wehewehe*], riding in a slide and returning to the curl" (Clark 2011:13). Photographs of surfing and canoeing at Waikīkī around 1900 are shown in Figure 9 and Figure 10.

Later in the year an article titled "A Kind Request" appeared, inviting military leaders to Lunalilo's home at ʻĀpuakēhau to watch surfing at Kāhala: "Last Saturday, His Highness ... W.C. Lunalilo, made a request to his military leaders to visit his home thatched with coconut fronds at Apuakehau to pass the time and to relax watching the surfers on the slippery waves at Kahala"(Clark 2011:126).

Additional Waikīkī surfing references appear in newspaper articles in 1886 and 1887. In 1886, George Macfarlane hosted guests from San Francisco at his seaside home, which is depicted on the map in Figure 10:



Figure 8. West End of Waikīkī Beach in 1904 (HAS 2025).

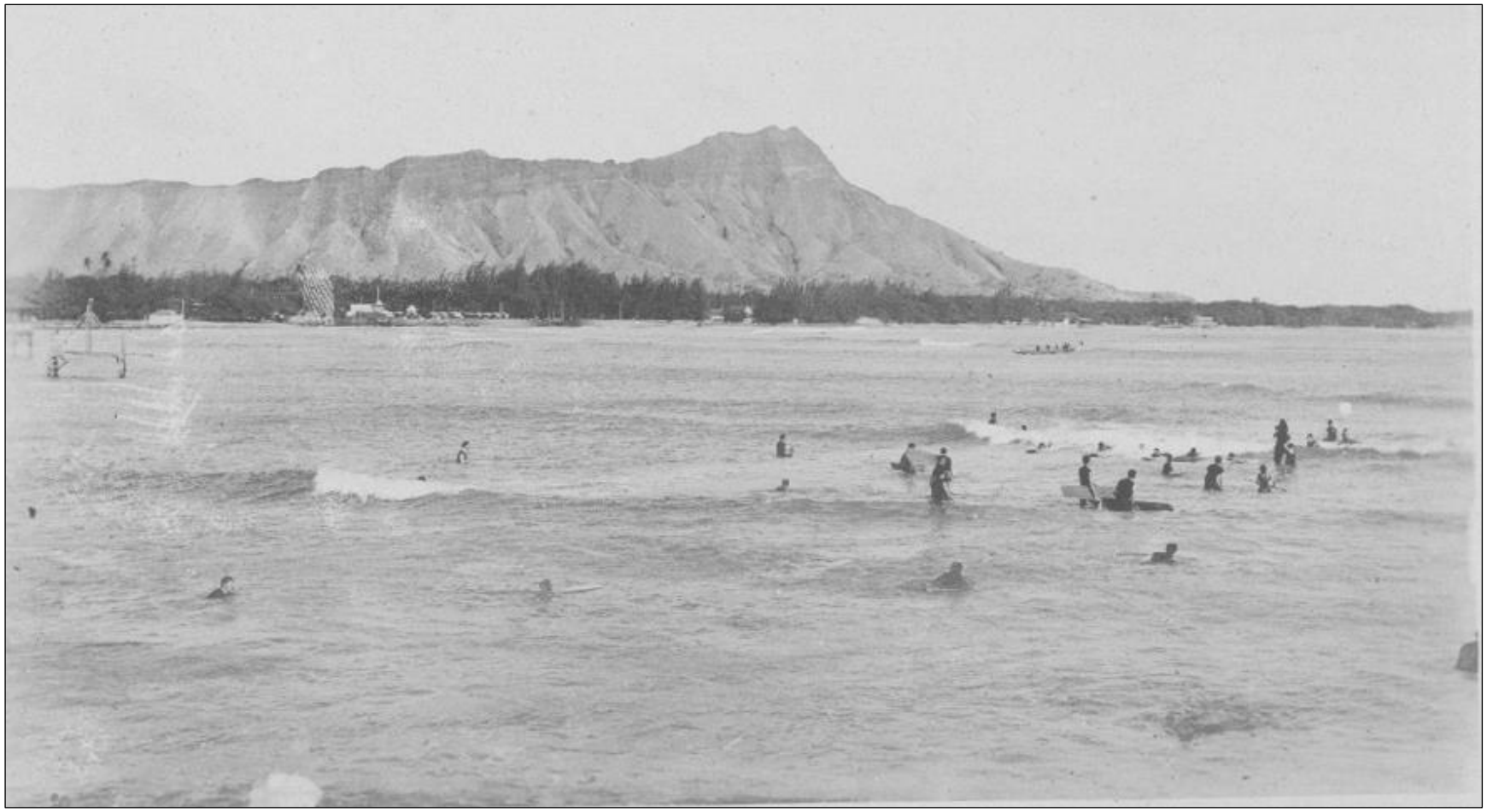


Figure 9. Surfers at Waikīkī in ca 1900 (UHM 2025d).

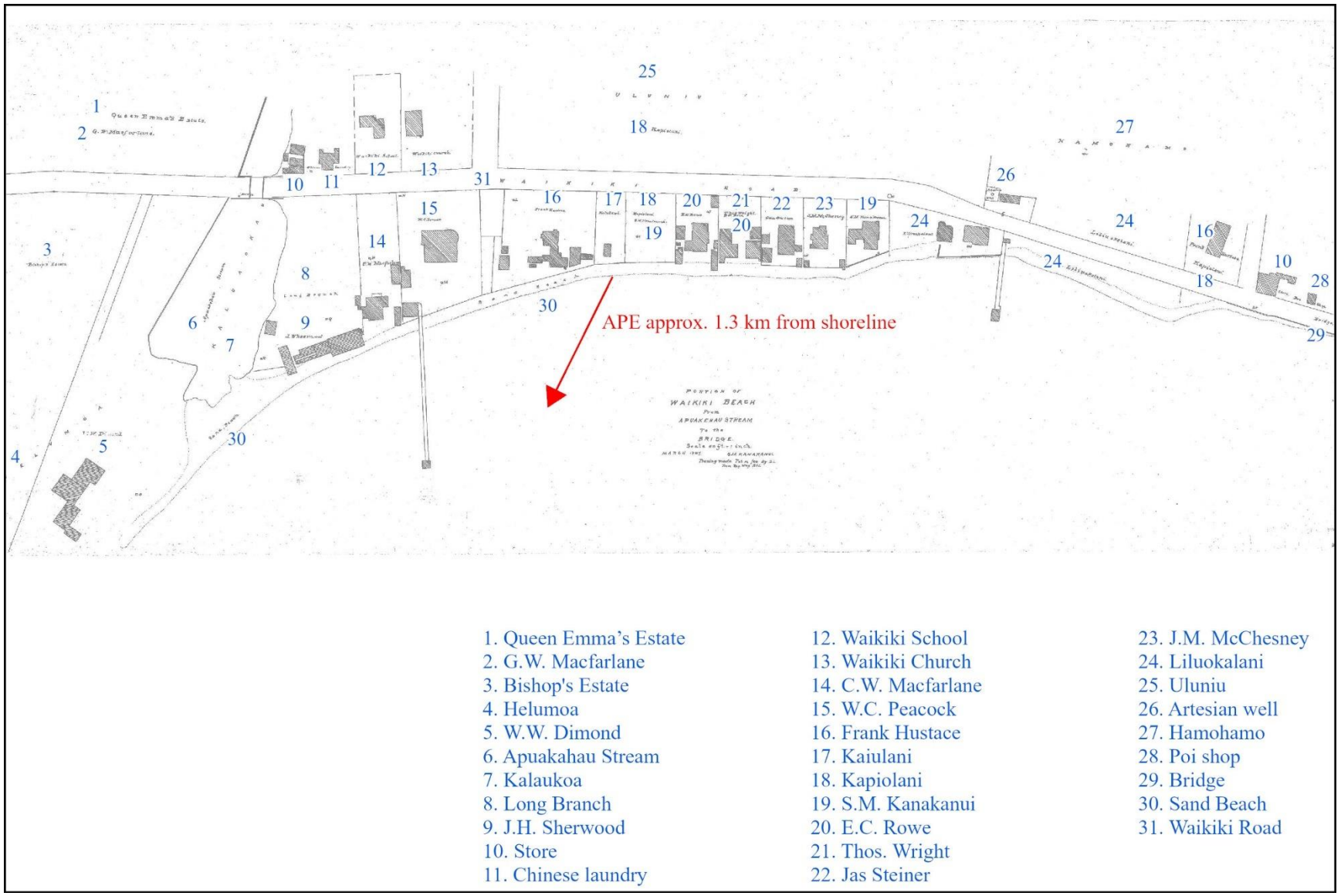


Figure 10. Residences, Businesses, and Place Names Circa 1897 (Kanakanui 1897). Blue and Red Text Added.

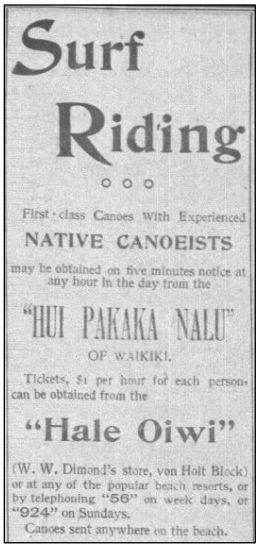
> The Misses Hooker, Miss Nina Adams. Miss Grace Eldridge, Mr. Hooker, Mr. Knowles and Mr. Watson were entertained at Col. G.W. Macfarland's seaside residence on Wednesday afternoon at sea bathing and canoe riding on the surf. The novelty of the entertainment was most enjoyed by the distinguished strangers [PCA 1886:2].

In 1887, Lunalilo hosted Freemasons from Sacramento. Events included watching surf riding:

> On Saturday afternoon His Majesty the king gave a luau at his summer residence, Waikiki, in honor of Grand Master E.C. Atkinson and his visiting Masons. A large lanai had been erected on the grounds, the interior of which was tastily decorated. The Royal Hawaiian Band was present and discoursed sweet music throughout the afternoon. Soon after the guests arrived they went down to the beach and witnessed some surf-riding. This was followed by a luau [PCA 1887:2].

By the late 1800s, elite residences lined Waikīkī Beach, which included high-ranking Hawaiians and affluent white residents, as shown on the annotated map above (see Figure 10). In 1897, a group of Hawaiians formed Hui Pākākā Nalu, a canoe surfing club in Waikīkī, and catered to tourists wishing to try the sport (Clark 2011:69). The manager of the club was W.W. Dimond, whose residence is shown on the map in Figure 10 above. The following is an article announcing the new beach concession and the accompanying advertisement:

> Hui Pakaka Nalu
>
> A number of Hawaiians living near the beach at Waikiki, and owning canoes, have formed a hui for the purpose of giving tourists and others a chance to enjoy it a surf ride. The men, who will paddle the canoes, are expert surf riders and anyone who can swim and is not afraid of a dipping in the briny deep can safely risk the experience of the peculiar sensation which a surf ride causes.
>
> Mr. W Dimond, who is one of our most celebrated canoe steerers, has kindly agreed to act as manager of the Hui Pakaka Nalu. Canoes can be obtained at all the bathing resorts at Waikiki, managed by "professionals." All the timid little girls and the bold mashers want to do is to dig $1.00 an hour for the pleasure of riding on the surf, and it is safe to predict that even the elderly "new woman" in the scientific "profession," will take a chance at riding on the foam-crested waves of the Pacific Ocean, under the guidance of the expert boat steers.
>
> And what tales will be unfolded when our tourists after their experience on the surf meet at the fireside in New England. We wish the Hui Pakaka Nulu all possible success and many bright dollars [PCA 1897:2].



Missionaries had scorned Hawaiian *he'e nalu* since their arrival before the Mahele, but the sport persisted in Hawaiian culture through the end of the century despite oppression (Finney and Houston 1966). Those who frequented Waikīkī waves in the 1890s included Princess Victoria Ka'iulani, niece of Queen Lili'uokalani, and her cousin, Prince Jonah Kūhiō Kalaniana'ole (Blake 1983:60; Walker 2008:94). After annexation, there was an increased interest by Hawaiian and new foreign residents in Waikīkī.

At this time, renowned surfer and swimmer Duke Kahanamoku, his siblings, and other Native Hawaiians frequented the waves at Waikīkī. In 1908, newcomer Alexander Hume Ford founded the exclusive Outrigger Canoe Club at the east end of the beach, and by 1915, had 1,200 members and a whites-only policy. In response to the blatant racism of the Outrigger cohort, the Hui Nalu surf club was formally organized in 1911[10] by William "Knute" Cottrell, Duke Kahanamoku, Kenneth Winter, Edward Kaleleihealani "Dudie" Miller, and other Hawaiians (Walker 2008:96). As Hui Nalu grew, elite Hawaiians joined, including Prince Jonah Kūhiō Kalaniana'ole.

In 1915, Hui Nalu surfers opened their first concession stands and took jobs as lifeguards, bodyguards, instructors, entertainers, and tour guides for tourists in Waikīkī. They became known as Waikīkī beachboys and their work was profitable (Walker 2008:98). As poignantly stated by Isaiah

[10] The group was informally organized in 1905 (Walker 2008:96).

Helekunihi Walker, surfer and Professor of History and Academic Vice-President at Brigham Young University-Hawai'i: "Rather than exploited laborers who commodified their own surfing culture, these Hawaiian surfers operated their own businesses in the 1920s and 1930s as historical agents who made a decent living in Waikīkī, often at the expense of haole" (Walker 2008:2005).

Kahalaopuna

Kahalaopuna was the daughter of the twins Kahaukani (a name for Mānoa wind) and Kauakuahine (the name of a famous Mānoa rain), who were the children of Akaaka and Nalehuaakaaka in Mānoa Valley. When Kahalaopuna grew up, she lived in the valley with her attendants in a house at Kahaiamano on the road to Waiakekua. Her house was surrounded by a fence of *'au kī* (stalks of ti [*Cordyline terminalis*]), and there were *pūlo'ulo'u* (*kapu* sticks) on each side of the gate, which warned people that it was forbidden ground. She was extremely beautiful and "of a semi-supernatural descent" (Nakuina 1907:119). From a young age, she had been betrothed to Kauhi, a young chief of Kailua, whose family regularly sent her poi from their land and fish from Kawainui. People passing near her home would try to catch a glimpse of her. The wedding was drawing near, and not yet having seen Kahalaopuna in person, Kauhi went to Waikīkī on a day when the surf was good at Kalehuawehe. People had come from all parts of the island to surf. Kauhi overheard two men bragging about their affairs with Kahalaopuna. The men were "Kumauna and Keawaa, both of whom were disfigured by a contraction of the lower eyelids, and were known as *makahelei* (drawn eyes)" (Nakuina 1907:120). They falsely bragged of their "conquest of the famous beauty, representing the leis with which they were decked as love-gifts from Kahalaopuna" (Nakuina 1907:120). As the men continued talking about Kahalaopuna, Kauhi began to believe them and became enraged at her purported betrayal of him just prior to their marriage.

Determined to kill Kahalaopuna, Kauhi left Waikīkī and set out for his betrothed's house in Mānoa:

> He started for Manoa at dawn, and proceeded as far as Mahinauli, in mid-valley, where he rested under a hala (*Pandanus odoratissimus*) tree that grew in the grove of wiliwili (*Erythrina monosperma*). He sat there some time, brooding over the fancied injury to himself, and nursing his wrath. Upon resuming his walk he broke off and carried along with him a bunch of hala nuts. It was quite noon when he reached Kahaiamano and presented himself before the house of Kahalaopuna. The latter had just awakened from a sleep, and was lying on a pile of mats facing the door, thinking of going to the spring, her usual bathing-place, when she perceived a stranger at the door [Nakuina 1907:125].

Kahalaopuna recognized Kauhi from the descriptions people had told her. Trusting her betrothed, she agreed to follow him into the forest. After confronting her, he struck her with a heavy bunch of *hala* nuts (screw pine; *Pandanus odoratissimus*), which killed her. He buried her body nearby, and then he headed down the valley to Waikīkī.

A great *pueo* (owl), an *'aumākua* (ancestor spirit) of Kahalapuna's family, witnessed the murder and flew to the grave and unburied her. The *pueo* then breathed life back into her and healed her wounds. Kauhi had not yet traveled far and realized Kahalaopuna was resurrected when he heard her singing a song of lament for his actions and saw the *pueo* overhead. Kauhi went back and, a second time, ordered her to follow him. When they reached the summit of the ridge separating Mānoa and Nu'uanu, Kauhi again murdered her with a blow from a heavy bunch of *hala* nuts and buried her body. Again, the *pueo* resurrected her, and Kauhi heard her song. Once more, he ordered her to follow him and then led her into Nu'uanu valley at Kaniakapupu, and then over to Waolani ridge, where he killed and buried her. She was resurrected again, and then a fourth time murdered and buried, this time in Kalihi.

On Kauhi's fifth and last attempt to murder Kahalaopuna, he decided to thwart the *pueo* from resurrecting her:

> He this time took her across gulches, ravines, and plains, until they arrived at Pohakea, on the Ewa slope of the Kaala Mountains, where he killed her and buried her under a large *koa* (*Acacia koa*). The faithful owl tried to scrape the dirt away, so as to get at the body of the girl, but his claws became entangled in the numerous roots and rootlets which Kauhi had been careful not to cut away.

> The more the owl scratched, the more deeply tangled he got, and, finally, with bruised claws and ruffled feathers, he had to give up the idea of rescuing the girl; and perhaps he thought it useless, as she would be sure to make her resurrection known to Kauhi. So the owl left, and followed Kauhi on his return to Waikiki [Nakuina 1907:125].

However, an *ʻelepaio* (a monarch flycatcher; *Chasiempis sandwichensis*), who was a cousin of Kahalaopuna, saw what happened and flew to tell her family. At the same time, her spirit caught the attention of a group of people passing by on the road. The following excerpt tells of how she was rescued by a young man. He took her to Mōʻiliʻili and, with his family's help, she was resurrected and healed through *kakelekele* (hydropathic cure) at Puna o Mauʻoki:

> In the meantime, the spirit of the murdered girl discovered itself to a party who were passing by; and one of them, a young man, moved with compassion, went to the tree indicated by the spirit, and, removing the dirt and roots, found the body, still warm. He wrapped it in his *kihei* (shoulder scarf), and then covered it entirely with *maile*, ferns, and ginger, and, making a *haawe*, or back-load, of it, carried it to his home at Kamoiliili. There, he submitted the body to his elder brother, who called upon two spirit sisters of theirs, with whose aid they finally succeeded in restoring it to life. In the course of the treatment she was frequently taken to an underground water-cave, called Mauoki, for the *kakelekele* (hydropathic cure). The water-cave has ever since been known as the "Water of Kahalaopuna" [Nakuina 1907:126].

The man who found Kahalaopuna was intent on marrying her, but she refused because she and Kauhi were still betrothed. A plot was hatched to keep her last resurrection a secret and then fool Kauhi into his own death. The man learned all the songs that Kahalapuna sang to the murderous Kauhi. He then attended the *kilu*[11] house, where Kauhi was enjoying games. Over three nights, the man attended the games and sang Kahalaopuna's *mele* (song):

> On the third night, the third song having been sung, the dispute between the young men became so violent that Kauhi told the young man that the Kahalaopuna he knew must be an impostor, as the real person of that name was dead, to his certain knowledge. He dared him to produce the young woman whom he had been representing as Kahalaopuna; and should she not prove to be the genuine one then his life should be the forfeit, and on the other hand, if it should be the real one, then he, Kauhi, should be declared the liar and pay for his insults to the other with his life.
>
> This was just what the young man had been scheming to compass, and he quickly assented to the challenge, calling on the King and chiefs to take notice of the terms of agreement, and to see that they were enforced.
>
> On the appointed day Kahalaopuna went to Waikiki, attended by her parents, relatives, servants, and the two spirit sisters, who had assumed human form for that day so as to accompany their friend and advise her in case of necessity. Akaaka, the grandfather, who had been residing in Waikiki some little time previous to the dispute between the young men, was appointed one of the judges at the approaching trial.
>
> Kauhi had consulted the priests and sorcerers of his family as to the possibility of the murdered girl having assumed human shape for the purpose of working him some injury. Kaea, a famous priest and seer of his family, told him to have the large leaves of the a-pe (*Calladium costatum*) spread where Kahalaopuna and party were to be seated. If she was a spirit, she would not be able to tear the a-pe leaf on which she would be seated, but if human, the leaf or leaves would be torn. With the permission of the King, this was done. The latter, surrounded by the highest chiefs and a vast assemblage from all parts of the island, was there to witness the test.
>
> When Kahalaopuna and party were on the road to the scene of the test, her spirit friends informed her of the a-pe leaves, and advised her to trample on them so as to tear them as much as possible, as they, being spirits, would be unable to tear the leaves on which they should be seated, and if any one's attention were drawn to them, they would be found out and killed by the poe po-i uhane (spirit

[11] "Kilu game: the player chanted as he tossed the kilu towards an object placed in front of one of the opposite sex; if he hit the goal, he claimed a kiss" (Pukui and Elbert 1986).

> catchers). The young girl faithfully performed what was required of her. Kaea, on seeing the torn leaves, remarked that she was evidently human, but that he felt the presence of spirits, and would watch for them, feeling sure they were in some way connected with the girl. Akaaka then told him to look in a calabash of water, when he would in all probability see the spirits. The seer, in his eagerness to unravel the mystery, forgot his usual caution and ordered a vessel of water to be brought, and, looking in, he saw only his own reflection. Akaaka at that moment caught the reflection of the seer (which was his spirit), and crushed it between his palms, and at that moment the seer dropped down dead. Akaaka now turned around and opened his arms and embraced Kahalaopuna, thus acknowledging her as his own beloved granddaughter.
>
> The King now demanded of the girl and of Kauhi an account of all that had happened between them, and of the reported death of the maiden. They both told their stories, Kauhi ascribing his anger to hearing the assertions of the two disfigured men, Kumauna and Keawaa. These two, on being confronted with the girl, acknowledged never having seen her before, and that all their words had been idle boastings. The King then said: "As your fun has cost this innocent girl so much suffering, it is my will that you two and Kauhi suffer death at once, as a matter of justice; and if your gods are powerful enough to restore you, so much the better for you."
>
> Two large imus (ground ovens) had been heated by the followers of the young men, in anticipation of the possible fate of either, and Kauhi, with the two mischief-makers and such of their respective followers and retainers as preferred to die with their chiefs, were baked therein [Nakuina 1907:127–128].

Kauhi and his companions were baked in two *imu* on the side of ʻĀpuakēhau stream in Ulukou. After, Kauhi's people were so enraged by his actions that they gave their allegiance to Kahalaopuna. The *mōʻī* (king) granted the man who saved her and avenged her murder permission to marry her. The next night, a *manō kumupaʻa* of Kauhi's family sent a great tidal wave over Waikīkī to wash out his bones from the *imu* into the sea and transform Kauhi and his men into sharks. Knowing this, Kahuapuna's grandfather forbade her from ever going into the sea. She obeyed her grandfather for two years.

One day, when all the men went to Mānoa to cultivate *kalo* (taro), Kahalaopuna was left alone with her servants in Waikīkī. That day, the surfing was quite good:

> The surf on that day was in fine sporting condition, and a number of young women were surfriding, and Kahalaopuna longed to be with them. Forgetting the warning, as soon as her mother fell asleep she slipped out with one of her maids and swam out on a surf-board. This was Kauhi's opportunity, and as soon as she was fairly outside the reef he bit her in two and held the upper half of the body up out of the water, so that all the surf-bathers would see and know that he had at last obtained his revenge.
>
> Immediately on her death the spirit of the young woman went back and told her sleeping mother of what had befallen her. The latter woke up, and, missing her, gave the alarm. This was soon confirmed by the terrified surf-bathers, who had all fled ashore at seeing the terrible fate of Kahalaopuna. Canoes were launched and manned, and chase given to the shark and his prey, which could be easily tracked by the blood.
>
> He swam just far enough below the surface of the water to be visible, and yet too far to be reached with effect by the fishing-spears of the pursuers. He led them a long chase to Waianae; then, in a sandy opening in the bottom of the sea, where everything was visible to the pursuers, he ate up the young woman, so that she could never again be restored to this life.
>
> Her parents, on hearing of her end, retired to Manoa Valley, and gave up their human life, resolving themselves into their supernatural elements. Kahaukani, the father, is known as the Manoa wind, but his usual and visible form is the grove of ha-u (hibiscus) trees, below Kahaiamano. Kauakuahine, the mother, assumed her rain form, and is very often to be met with about the former home of her beloved child.

> The grandparents also gave up their human forms, and returned, the one to his mountain form, and the other into the lehua bushes still to be met with on the very brow of the hill, where they keep watch over the old home of their petted and adored grandchild [Nakuina 1907:131–132].

Heiau and Koʻa

Several *heiau* (traditional Hawaiian temples) and *koʻa* (fishing shrines) were once located in Waikīkī Ahupuaʻa. Malo wrote, "The heiaus or altars, at which fishermen performed their religious ceremonies, were of a class different from all others" (Malo 1903:274). He described *koʻa* as a term for the altar at a *kuʻula*:

> Kuula: this was generally a mere rude pile of stones, often placed on a promontory or elevation overlooking the sea. Coral or some sort of limestone was preferred to any other variety of stone. The altar itself was commonly called a koʻa, Kuula being the name of the chief patron deity of fishermen. The number of gods and godlings worshipped by fishermen is too numerous for mention [Malo 1903:278–279].

Kamakau described the types of *koʻa*: "*koʻa* shrines set up for the increase of deep sea fishes (*koʻa kuʻula hoʻoulu iʻa*) and the *koʻa* to the god Kanekoʻa set up along the banks of rivers, streams, and shore and inland ponds (*kuapa me na loko*) for the increase of *ʻoʻopu* fishes (*koʻa hoʻoulu ʻoʻopu*)" (Kamakau 1961:33). Prior to a fishing, *poʻe lawaiʻa* (skilled fishermen) would gather for a ceremony:

> Before starting out to fish for the *opelu* the fishermen would assemble at the kuula heiau in the evening, bringing with them their nets, of the sort called *aei*, pigs, bananas, coconuts, poi, and their sleeping apparel, that they might spend the night and worship the god of fishing.
>
> While engaged in this ceremony, all the people sat in a circle, and the kahuna, bringing a dish of water that had in it a coarse sea-moss, limu kala, and turmeric, stood in their midst and uttered a prayer for purification (*pule huikala*) [Malo 1903:274].

Fishermen worshipped "a number of other fishing-gods," and "Hina-hele was a female deity worshipped both by women and fishermen" (Malo 1903:113). Depending on the god of a fishman, there would be certain *kapu*. For example, the color *ʻeleʻele* (black, from *paʻu*, soot), *ʻōlena* (yellow, from turmeric), or ʻ*alaea* (reddish brown, from *ʻalaea lepo*, clay containing iron) are cited by Malo (1903). The *kapu* would apply to the clothing of the fisherman and his wife, items in his home, his fishing gear, and anyone entering their home who had with them what was *kapu* (Malo 1903:274).

In Thrum's Hawaiian Annual for 1907, *heiau* in Waikīkī included Papaʻenaʻena Heiau, Kapua Heiau, Kūpalaha Heiau, Helumoa or Āpuakēhau Heiau, Makahuna Heiau, Kamauakapu Heiau, Kulanihakoi Heiau, and Pahu-a-Maui Heiau (Thrum 1906a:44–45; Thrum 1906b: 49–69). Not noted by Thrum is Hale Kumukaʻaha Heiau, which was mentioned by Hawaiian historian Samuel Kamakau in the Hawaiian newspaper *Kuakoa* (McAllister 1933:78).

The best-known *heiau* among those mentioned above is Papaʻenaʻena Heiau. Numerous accounts of this *heiau* from early voyagers were compiled by McAllister (1933:71–74). The *heiau* was located on the west side of Lēʻahi (Diamond Head) and visible from Waikīkī (McAllister 1933:71). Thrum further offered that it was "at the foot of Diamond Head slope, rear of Douglas' premises [Between Paki Avenue and La Pietra]" (Thrum 1906a:44). It was a *heiau poʻokanaka* (*heiau* where human sacrifices were made) and known for the number of sacrifices carried out by Kamehameha I. A description of Papaʻenaʻena Heiau during this early period is from the journal of Tyerman and Bennet (1832:48–49):

> In the year 1804, when the late king, Tamehameha, was on his way from Hawaii, to invade Tauai, he halted with an army of eight thousand men at Oahu. The yellow fever broke out among the troops, and in the course of a few days swept away more than two-thirds of them. During the plague, the king repaired to the great marae at Wytiti, to conciliate the god, whom he supposed to be angry. The priests recommended a ten day' tabu, the sacrifice of three human victims, four hundred hogs, as many cocoanuts, and an equal number of branches of plantains. Three men, who had been guilty of the enormous turpitude of eating cocoa-nuts with the old queen (the present king's mother), were accordingly seized and led to the marae. But there being yet three days before the offerings could

> be duly presented, the eyes of the victims were scooped out, the bones of their arms and legs were broken, and they were then deposited in a house, to await the coup de grace on the day of sacrifice. While these maimed and miserable creatures were in the height of their suffering, some persons, moved by curiosity, visited them in prison, and found them neither raving nor desponding. But sullenly singing the national *huru*---dull as the drone of a bagpipe, and hardly more variable-as though they were insensible of the past, and indifferent to the future. When the slaughtering time arrived, one of them was placed under the legs of the idol, and the other two were laid, with the hogs and fruit, upon the altar-frame. They were then beaten with clubs upon the shoulders till they died of the blows. This was told us by an eye-witness of the murderous spectacle [Tyerman and Bennet 1832:48–49].

A chief named Kaolohaka is also said to have been sacrificed at this *heiau*: "Fragments of its walls, torn down in 1860, show it to have been about 240 feet square; said to be the place of sacrifice of Kaolohaka, a chief of Hawaii, on suspicion of being a spy" (Thrum 1906a:44).

Based on various accounts, McAllister determined that the *heiau* was "a quadrangular paved terrace, with walls on three sides, but open on the west side, which faced the village of Waikīkī and the sea" (McAllister 1933:74). Multiple step-like terraces led to the open side of the *heiau*. Averaging measurements from first-hand accounts, McAllister estimated that the *heiau* was approximately 128.0 ft. by 68.0 ft., with walls 6.2 ft. high and 3.0 ft wide. According to Thrum (1906a:44), the *heiau* was destroyed by Kanaʻina in 1856, and the stones were used to enclose Queen Emma's premises and for road work.

Kapua Heiau was located somewhere in or near Kapiʻolani Park and is mentioned in the *Legend of Pumaia* (Fornander 1917:470–476). Pumaia was a pig farmer who lived in Pukaola in the Kona District of Oʻahu. The *mōʻī* of Oʻahu, Kūaliʻi, was building Kapua Heiau, "east of Leahi Hill overlooking Māmala Bay" (Fornander 1917:470). When the *heiau* was complete, Kūaliʻi repeatedly ordered pigs from Pumaia until one day, Pumaia refused to oblige him. The *mōʻī* sent soldiers to fight Pumaia over one of the pigs, and Pumaia killed all the men but one. Kūaliʻi then declared war on Pumaia. Pumaia won multiple battles against the soldiers until finally Kūaliʻi prayed to his god to capture Pumaia. Only then was he caught and bound: "Kualii was so incensed at Pumaia that he was immediately killed and was dragged to Kapua, where his dead body was thrown into the pit with the men he had killed. During the ill treatment given to his body, the jaws were crushed and cut up into fragments" (Fornander 1917:474).

Makahuna Heiau was once located on the south side of Diamond Head, overlooking "Aqua Marine" and near the former residence of Honorable Sanford B. Dole (McAllister 1933:196). According to a historical map by Wall (1893), the *heiau* was west of Diamond Head Lighthouse. McAllister offers the following account:

> Thrum writes: "A large heiau enclosure dedicated to Kane and Kanaloa, of Kuula character, so said." Tucker reports: "Opposite the residence of the Honorable Sanford B. Dole. The ruins of a heiau of the Pookanaka class. Was located at this place in order to propitiate, by human sacrifice, the departure of the Aliis to foreign shores, and Black Point, between that and Kahala, was called Keala o Kahiki. These ruins are mostly all overgrown and have been used probably to make fences or for road purposes. A dense growth of lantana and kiawe, scrub kiawe, covers the ruins" [McAllister 1933:196].

Kūpalaha Heiau was located near Emmanuel S. Cunha's estate, near the intersection of Kapahulu and Kalākaua Avenues (Pukui et al. 1974; Thrum 1906a). The location of this estate is shown in Figure 11, at the shoreline boundary of Hamohamo and Kāneloa fisheries. In his description, Thrum wrote: "Entirely obliterated. Class unknown, but said to have had connection in its workings with Papaenaena" (Thrum 1906a:44). In an archaeological monitoring report for utilities work on Kalākaua Avenue, Hammatt and Chiogioji (2002:9) located Kūpalaha Heiau "on or adjacent to Kalākakua Ave., just southeast of the intersection with Monsarrat Ave."

The *kuahu* (altar) at Kūpalaha Heiau was called Opunaha, as shown on a historical map by C.J. Lyons labeled "Altar of Opunaha." In modern times, Opunaha is associated with a seasonal ceremony practiced where Kūpalaha Heiau once stood:

> Each year we gather at the site, just ʻEwa of the Waikiki Aquarium before sunset, on May 2. Therefore, we invite any of you who are interested to join us, as we celebrate those dates that are truly of our place, in the places at which they were marked in ancient times. It is for us kānaka who live in these times, to continue the ancient observances, lest they disappear into obscurity.
>
> We gather at the water's edge at the site of Kūpalaha, the luakini heiau of the Oʻahu Aliʻi, the sibling heiau of Papaʻenaʻena (portions of which still grace the base of Lēʻahi) where, from its kuahu (altar), named Opunaha, the setting sun would be observed by the kahuna kilolani, and on a specific day, the sun would set into the bowl of Puʻu o Kapolei in the Waiʻanae Range, when seen from Opunaha, marking the end of the Hoʻoilo (Hawaiian Winter) and the start of the Kauwela (Hawaiian Summer) for Oʻahu, and the reactivation of the luakini of Kū.
>
> We chant the exit of Lono and the entrance of the time of Kū, the prowess of warriors and mahiʻai (farmers) who prayed to Kūnuiākea (the god of chiefly governance) and Kūikeolowalu (Kū of combined effort). We tell the story of a famous battle between pueo (owls) and kānaka (people) that took place exactly where we gather. And as the sun sets, we share a chant to the setting sun:
>
> Ke aui nei ka lā -- Welo! Welo!
> Ke mōlehulehu mai nei -- Nakolo! Nakolo!
> ʻO ka napoʻo ana i lalo -- I ka mole o Lehua!
> Ma ʻalihilani -- E moe! E moe!
> Aloha e, kukulu o ka lani
> Aloha e kukulu o ka honua
> ʻAuē! Anuanu oʻu mau iwi hilo nei --
>
> The sun is lowering -- Setting! Setting!
> Dusk approaches -- Crawling! Crawling!
> Sinking below -- at the base of Lehua!
> On the horizon -- To sleep! To sleep!
> Aloha to the foundations of the heavens
> Aloha to the foundations of the world
> Aue! I am chilled to the core --
>
> [Gon 2025].

Kūpalaha Heiau was associated with a legend involving Kākuhihewa, *mōʻi* (king) of Oʻahu circa 1540–1634, and Pueo Aliʻi (king of the owls). In the legend, a man named Kapoi went to gather pili grass at a marsh near the beach. He found seven owl eggs, which he collected, intending to eat them later (Thrum 1907:200–202). After returning home, an owl arrived at his fence and cried out, "O Kapoi, give me my eggs!" Hearing the repeated pleas, Kapoi returned the eggs. The owl became his *ʻaumakua* (family god) and instructed him to build Manua Heiau (situated on the southwest side of Pūowaina [Punchbowl Crater]). After building the *heiau,* he offered bananas and set the *kapu* days for its dedication. At the same time, Kākuhihewa was building a *heiau* in Waikīkī, and he made a law that if any person built a *heiau* and set the *kapu* before him, that person would be put to death. Kapoi was arrested and taken to the Kūpalaha Heiau in Waikīkī. Kapoi's *ʻaumakua pueo* tried to help him by calling on all of the *pueo* in the islands to gather and fly to Kūpalaha Heiau to battle the soldiers. The soldiers surrendered then surrendered to the *pueo*. Since that day, the *pueo* is considered a powerful *akua* (god), and the location of the battle was known as Kukaeunahio-ka-pueo, which means "the confused noise of owls rising in masses" (Thrum 1907:200–202).

A Hawaiian saying associated with Kākuhihewa and Kūpalaha Heiau, which is explained by Pukui below:

> *Ke one ʻai aliʻi o Kakuhihewa.*
>
> The chief-destroying sands of Kakuhihewa.
>
> The island of Oʻahu. When the priest Kaʻopulupulu was put to death by the chief Kahāhana for warning him against cruelty to his subjects, he uttered a prophecy. He predicted that where his own corpse would lie in a heiau at Waikīkī, there would lie the chief's corpse as well. Furthermore, he said, the land would someday go to the sea — that is, to a people from across the sea. This was felt

> to be a curse. When Kamehameha III was persuaded by a missionary friend to move the capital from Lahaina to Oʻahu, a kahuna, remembering the curse, warned him not to, lest the monarchy perish. The warning was ignored, and before the century had passed, the Kingdom of Hawaiʻi was no more [Pukui 1983:190].

Makahuna Heiau was once located on the south side of Diamond Head, overlooking "Aqua Marine" and near the former residence of Honorable Sanford B. Dole (McAllister 1933:196). According to a historic map by Wall (1893), the *heiau* was located west of Diamond Head Lighthouse. McAllister offers the following accounts:

> Thrum writes: "A large heiau enclosure dedicated to Kane and Kanaloa, of Kuula character, so said." Tucker reports: "Opposite the residence of the Honorable Sanford B. Dole. The ruins of a heiau of the Pookanaka class. Was located at this place in order to propitiate, by human sacrifice, the departure of the Aliis to foreign shores, and Black Point, between that and Kahala, was called Keala o Kahiki. These ruins are mostly all overgrown and have been used probably to make fences or for road purposes. A dense growth of lantana and kiawe, scrub kiawe, covers the ruins" [McAllister 1933:196].

Nā Pōhaku Ola o Kapaemahu

Four sacred stones near Kūhiō Beach in Waikīkī were dedicated as Nā Pōhaku Ola o Kapaemahu in 1997. For over 100 years, the story of the stones has unfolded, including their history of relocation (Fernandez-Akamine 2023). Briefly, they are a remembrance left by four *kāhuna* from Tahiti who lived in Waikīkī sometime between 1200 and 1500 AD. Regarding their arrival in the islands: "From the land of Moaulanuiakea (Tahiti) there came to Hawaii long before the reign of King Kakuihewa, four soothsayers from the Court of the Tahitian King. Their names were: Kapaemahu, Kahaloa, Kapuni and Kinohi" (Boyd 1906:140). The four were much loved by the people of all the Hawaiian Islands for their grace, healing powers, and wisdom:

> They were received as became their station, and their tall stature, courteous ways and kindly manners, made them soon loved by the Hawaiian people. The attractiveness of their fine physique and kindly demeanor was overshadowed by their low, soft speech which endeared them to all with whom they came in contact. They were unsexed by nature, and their habits coincided with their feminine appearance, although manly in stature and general bearing. After a long tour of the islands this quartette of favorites of the gods settled at Ulukou, or Kou, Waikiki, near where the old time Maikai house stood, which location is within a few lots of the Moana Hotel.
>
> The wizards or soothsayers proved to be adepts in the science of healing and many wonderful cures by the laying on of hands are reported to have been effected by them so that their fame spread all over this island (Oahu), as the ancients say, "from headland to headland." Their wisdom was shown by many acts which gave them fame among the people [Boyd 1906:140].

Years later, before leaving the island, they selected four stones to be brought from Kaīmuki to Waikīkī. Two were placed at their home, and two were placed in the sea where they bathed. The leader of the four, Kapaemahu, transferred his power into the stones during a one-month ceremony. Afterward, the four *kāhuna* disappeared.

The sacred stones were uncovered at ʻĀinahau, once the property of Princess Victoria Kaiʻulani, daughter of Princess Miriam Likelike and Governor Archibald Scott Cleghorn. Cleghorn noticed one of the *pōhaku* partially protruding from the sand for some time before having it excavated. Another *pōhaku* was uncovered on the property to the east. Two more stones were then located and excavated. According to Cleghorn, the four *pōhaku* were found in a straight alignment (PCA 1905). However, the legend states, "Four large selected rocks, weighing several tons each, were taken to the beach lot at Ulukou, Waikīkī, two of which were placed in the position occupied by their hut and the other two were placed in their bathing place in the sea" (Boyd 1906:141). During the Mahele, testimony concerning fisheries' boundaries described several *pōhaku*, either on the shoreline, the inner reef boundary, or the outer reef. These *pōhaku* are shown in Figure 6: Paliikii, Pōhaku o Kauai, Pōhaku Makua, Lae Pōhaku, and Pōhaku Pualiilii (possibly Puʻliʻiliʻi). One could speculate that some of these *pōhaku* are related to *Nā Pōhaku Ola o Kapaemahu*.

Cleghorn had the *pōhaku* displayed at ʻĀinahau, and in his will, he requested that they be protected after his death, which occurred in 1910. Somehow, they were later misplaced. In 1963, they were again uncovered after the demolition of commercial structures built on and adjacent to the former Cleghorn property. They were displayed at the beach with a plaque that referred to the *pōhaku* as "Wizard Stones." In 1994, the *pōhaku* were moved and rearranged for new construction. In 1997, they were moved to their current location, enclosed with a fence for protection, and a new plaque was installed, partially telling the significance of Nā Pōhaku Ola (Fernandez-Akamine 2023).

TRADITIONAL HISTORY AND LOKO IʻA

Waikīkī became the seat of royal power in the 1400s when Māʻilikūkahi, *aliʻi nui* (high chief) of Oʻahu, moved his court to the south side of the island. Māʻilikūkahi was born at Kūkaniloko and was chosen to be *mōʻī* at age 29 (Kamakau 1991:53). According to Kamakau, "Soon after he became *mōʻī* the chiefs took Māʻili-kūkahi to Waikīkī to live; he was perhaps the first of the ruling chiefs to live there. Until then, the chiefs had lived in Waiʻalua and ʻEwa" (Kamakau 1991:53). Handy and Handy noted that Waikīkī, with its sheltered bay and nearby valleys of Pālolo, Mānoa, and Nuʻuanu, was an ideal settlement location (Handy and Handy 1991:268).

Māʻilikūkahi is attributed with creating the land division system, enacting just laws, and bringing peace and prosperity to the island (Kamakau 1991:54–56). According to Kamakau (1991):

> When the kingdom passed to Māʻili-kūkahi, the land divisions were in a state of confusion; the *ahupuaʻa*, the *kū* [ʻili kūpono], the *ʻili ʻāina*, the *moʻo ʻāina*, the *paukū ʻāina*, and the *kīhāpai* were not clearly defined. Therefore Māʻili-kūkahi ordered the chiefs, *aliʻi*, the lesser chiefs, *kaukau aliʻi*, the warrior chiefs, *pūʻali aliʻi*, and the overseers, *luna* to divide all of Oʻahu into *moku* and *ahupuaʻa*, *ʻili kūpono*, *ʻili ʻāina*, and *moʻo ʻāina*. There were six districts, *moku*, and six district chiefs, *aliʻi nui ʻai moku*. Chiefs were assigned to the *ahupuaʻa*—if it was a large *ahupuaʻa*, a high chief, an *aliʻi nui*, was assigned to it. Lesser chiefs, *kaukau aliʻi*, were placed over the *kūpono* lands, and warrior chiefs over *ʻili ʻāina*. Lands were given to the *makaʻāinana* all over Oʻahu [Kamakau 1991:54–55].

Another Oʻahu chief known for ruling during a time of prosperity on Oʻahu was Chief Kalamakua-a-Kaipūhōlua. He ruled around the sixteenth century (based on Stokes' [1933] 20 year-count; Kelly 1989) and was the first to build an extensive irrigation system of *loko ʻai* (fishpond) and *loʻi* (irrigated taro field) in Waikīkī. Kamakau wrote:

> Kalamakua-a-Kaipūhōlua was a good chief. He was noted for cultivating, and it was he who constructed the large pond fields Keʻokea, Kūalulua, Kalāmanamana, and other *loʻi* in Waikiki. He traveled about his chiefdom with his chiefs and household companions to cultivate the land and gave the produce to the commoners, the *makaʻāinana* [Kamakau 1991:45].

The plains and coast of Waikīkī contained *loko iʻa kalo* (fishpond with *kalo*), connected to *loko puʻuone* (dune bank fishpond) and *loko kuapā* (walled fishpond on the shoreline). The network was integrated with the natural landscape. Kapaʻakea was favorable for *loko wai* and *loko iʻa kalo* because of the numerous freshwater springs and streams. Streams that followed from the mountains transported nutrients to the *loko and loʻi*, which were connected by *ʻauwai* (channels one to two meters wide). *Loko iʻa kalo* could be near the shore or further inland, and like *loʻi*, watered via irrigation ditches. Salinity would vary by location due to tidal action. Typically, *loko iʻa kalo* contained *āholehole (Kuhlia sandvichensis*) and *ʻoʻopu (Eieotridae* and *Gobiidae* families), and of course *kalo* (taro).

Kamakau (1992) described the initial creation of various pond types:

> Fishponds, *loko iʻa*, were things that beautified the land, and a land with many fishponds was called a "fat" land (*ʻaina momona*). They date from very ancient times. Some freshwater ponds, *loko wai*, were made when the earth was made, but most of the *loko iʻa* and the shore ponds, *loko kuapa*, were made by *ka poʻe kahiko* [Kamakau 1992:66].

In *Native Planters in Old Hawaii* (Handy and Handy 1991), the various applications of the term *wai* are discussed:

> *Wai* is fresh water. *Puna* is a spring, or *puna wai*, fresh-water spring. *Wai puna* is spring water. *Kaha wai* is a stream or river (*kaha* meaning place), and the same applies to the ravine, gulch, or valley cut by the stream, or which contains the stream. The artificial diversion of "a flow" of fresh water by means of a ditch or channel, for purposes of domestic use and irrigation, is *ʻauwai* (*au* meaning a flow or current). A fresh-water pond or lake, whether filled by surface drainage, a spring or springs, stream or ditch water, is *loko wai*, or commonly just *loko* (meaning inside, within) [Handy and Handy 1972:101–102].

Inland fishponds were fed by springs, streams and/or ditches which could be route for the *ʻoʻopu nakea* (Hawaiian goby; *Chonophorus stamineus*), and various shrimp (*ʻōpae*), which were then another food source to harvest (Kelly 1989:83). For example, at the large *loko wai* Kawainui in Kailua, three endemic *ʻoʻopu* (*Eleotris sandwicensis, Awaous stamineus, and Stenogobius hawaiiensi*) and the two endemic crustaceans *ōpae kalaʻole* (*Atyoida* bisculata) and *ʻōpae ʻoehaʻa* (literally, crooked-walking shrimp; clawed shrimp; *Marcrobrachium grandimanus*), have been documented in the modern era (HHF Planners 2019:3-123; Kelly 1979:17; Pukui and Elbert 1986:291).

What we know of the *loko iʻa* from late-1800s maps and descriptions is not indicative of their condition in the previous century or earlier. By the 1830s, the Hawaiian population had drastically decreased due to the spread of Western diseases, and traditional Hawaiian culture was upended by Western influence. Not only did large *loko iʻa* lack the workforce needed for operation and maintenance, but the social structure they were built around was altered (Drigot 1982:23). Kikuchi argues that "it seems very likely that selected fishponds played an important symbiotic role in the nature and development of the chiefdom, in particular, of the royal court (Kikuchi 1976:198).

Apple and Kikuchi (1975) classified several types *loko iʻa* as royal fishponds, which were "owned exclusively by ruling chiefs" and managed by the *konohiki,* who was a resident and acted as a representative of the *aliʻi nui*; *haku ʻohana* (senior male of an extended family of commoners), who reported to the *konohiki*; and a *kiaʻi loko* (caretaker, guardian of the pond), who may have communicated with the *aliʻi nui* directly or through the *konohiki* (Apple and Kikuchi 1975:8, 43–44). Traditionally, prior to the 1800s, all the resources of the land were owned by the *aliʻiʻai-moku* (paramount chief). This extended to important *loko iʻa* that were connected deep in the past or those that were highly productive, which Kikuchi argues were "manifestations of his supreme rights, including his right of ownership and his right to rule" (Kikuchi 1976:197).

In addition to the *loko iʻa* on the landscape, there were *heiau* of *aliʻiʻai-moku*, many of which were destroyed in the 1800s. Mauʻoki Heiau, was adjacent to the large *loko wai* in upper Kapaʻkea. Both *heiau* and *loko iʻa* were constructed under the supervision of a *kuhikuhi puʻuone* (site expert [*kahuna*]). The *kuhikuhi puʻuone* decided the location and dimensions and was knowledgeable in the "geography of the land, the nature of the resident spirits of the site, and the total lore of the native religion" (Kikuchi 1976:199). In the construction of *loko iʻa*, the *kuhikuhi puʻuone* ensured balance with the gods and guardian spirits, which was needed for successful productivity.

The operation of *loko iʻa* was led by the *konohiki* and the *kiaʻi loko,* who were tasked with "instructing the tenants of the land when and where to construct, repair, and clean the different aquacultural structures" (Kikuchi 1976:199). Like a *kiaʻi loko*, the *konohiki* also guarded against poaching. The following is a description of caring for the 450-acre Kawainui from Kekoowai (1922) in Summers 1964:

> This being communal work, the *konohiki* (land agent) commanded the men, women, and children of Maunawili, Kailua, and Waimanalo to come to Kawainui. The people went into the pond, and with their hands, broke the limu (algae) loose, piling it up and twisting it under as it was gathered. After a quantity of limu had been piled and twisted under, the workers formed it into a ring. "Then the limu that was broken off was pressed (*pili*) down like a dish, and all the fish that were caught in this limu dish were for the limu breakers." The workers put these fish into *lauhala* bags which were

> tied behind them, for the fish in the "limu dish" were no longer the property of the *konohiki*. Breaking of the limu was continued until the pond was clean and "the food of the fish clean," which for Kawainui Pond, required three days [Summers 1964:22].

The *loko iʻa* were also protected by *moʻo*, who kept the water clean from pollution by humans to ensure abundant productivity (Kikuchi 1976:199). However, the purpose of the *loko iʻa* was not to feed the population, but to allow the harvesting of particular fish as needed or desired. As discussed above, certain *loko aʻi* were symbolic of the *aliʻiʻai-moku*. This is explained by Kikuchi (1976): "Fishponds became symbols of the chiefly right to conspicuous consumption and to ownership of the land and its resources. They were manifestations of the chief's political power and his ability to control and tap his resources" (Kikuchi 1976:199).

In contrast to Apple and Kikuchi (1975), Handy and Handy (1991) attributed *loko wai, loko iʻa kalo,* and *loko ʻumeʻiki* to the *makaʻāinana*. Apple and Kikuchi posited that *loko kuapā*, *loko puʻuone*, *loko wai,* and perhaps larger *loko iʻa kalo* (integrated fishpond and *loʻi*) and *loko ʻumeʻiki* (shore fishpond with lanes leading in and/or out of the pond, used for trapping fish) were royal, meaning owned by paramount chiefs, while the *loko iʻa kalo* and *loko ʻumeʻiki* were typically used by the *makaʻāinana.* This variation between authors is likely a consequence of defining *loko iʻa* in Western terms. The following is an excerpt from Handy and Handy that discusses the symbiotic benefits of aquaculture:

> Although the *loko kuapa* just described belonged to the *aliʻi* and was cared for by his *konohiki*, the planters and common fisherfolk also carried on fish farming for themselves, in natural fresh-water ponds (*loko wai*, inside-water) and shore ponds called *puʻu one* (literally sand-heap ponds). In areas of wet-taro cultivation, young mullet were placed in the liquid mud of taro patches and there thrived. It is not unlikely that this latter custom came about as a result of placing the smaller fish in the *loʻi* when a netful was caught, in order to keep them fresh. It was discovered that they not only kept fresh, but thrived and grew. The mullet (*ʻamaʻama*) is a grazing fish, and when the fingerlings (*pua ʻama*) were put into *loʻi* their stirring about and grazing helped keep the water fresh [Handy and Handy 1991:391–392].

Kamakau wrote of the abundance that various types of *loko iʻa* provided, specifically mentioning *ʻōpae*, *limu kalawai* (fresh-water algae; *Spirogyra* spp.), *ʻoʻopu* roe, and *luʻau* (young taro crops) from *loko wai*:

> Thus they lived in the old days, and that is why the "native sons" (*keiki papa*) of places that had taro patches and *puʻuone* [dune bane brackish fishpond] fishponds loved the lands where they dwelt. There would be salted fish, too, in containers of large taro leaves. When one awoke in the morning and was ready to eat, the fish was brought forth and the wrappings opened up; the taro leaves would have wilted and the fish would be shaped like pig tusks. They were laid in a food bowl and one ate until he was full. So too did the native sons love the lands where the freshwater ponds, *loko wai*, were, for they furnished them with fresh *ʻopae*, crisp *limu kala-wai*, reddish *ʻoʻopu* roe, and *luʻau*. The people of the old days who lived on such lands lacked nothing [Kamakau 1976:50].

LATE PRE-CONTACT WARFARE

In 1780, the army of Maui chief Kahekili landed at Waikīkī "carpeting the beaches from Kaʻalawai (near Diamond Head) to Kawehewehe (next to the Halekulani Hotel)" (Kanahele 1995:79). According to Thrum (1925:109), Kahekili dedicated Papaʻenaʻena Heiau, formerly located in the vicinity of Diamond Head, following his victory. Many people were slaughtered during the fighting, including chiefesses. The chiefess Kekela managed to abscond to Kauaʻi, carrying sands from ʻApuakehau, Kahaloa, Waiaʻula, and Kūpalaha at Waikīkī, and deposited them at Hulaia, Kulana, and Kane in Kauaʻi (Kamakau 1992:140). At the time, Kahekili's nephew Kahahana was *aliʻi nui* of the island. Kahahana, along with his wife Kekuapoʻiʻula and his retainer Alapaʻi, fled to the mountains where they were cared for by sympathetic *makaʻāinana* (Kamakau 1992:136). They hid successfully for two and a half years but were then found out. Kahekili had Kahahana and Alapaʻi killed at Waikele and their bodies taken to him in Waikīkī.

In July 1794, Kahekili died at Ulukou, Waikīkī, at over eighty years of age and was succeeded by Kalanikupule (Desha 2000:349). The next year, Kamehameha invaded Oʻahu and made his army base on the sandy beaches from Waiʻalae to Diamond Head to Kālia (Kanahele 1995:87). The final battle ended at Nuʻuanu when Oʻahu warriors became trapped between Kamehameha's warriors and the *pali* (cliff) and chose to leap to their deaths (Tomonari-Tuggle and Blankfein 1998:13). After the battle of Nuʻuanu, Kalanikūpule fled but was later captured and then scarified. Kamakau summarizes the end of the battle and Kamehameha's victory:

> At Laʻimi in Nuʻuanu Ka-lani-ku-pule's side was routed, and there Kaʻi-ana died. The chiefs and warriors of Ka-lani-ku-pule were slaughtered, but Koa-lau-kani escaped and fled to Kauai, and Ka-lani-ku-pule hid in the underbrush for a little over a year and then was captured mauka of Waipiʻo in ʻEwa and killed. His body was brought to Kamehameha and offered in sacrifice to his god, Ku-kaʻili-moku [Kamakau 1992:172].

Kamehameha made his capital at Waikīkī, and the area became the chiefly center of the south coast where the ruling chief and subordinate *aliʻi* (chief or chiefess) resided (Cordy 1996; Nāpōkā 1986; Tomonari-Tuggle 1994). Hawaiian historian John Papa ʻĪʻī (1959) describes Kamehameha's residence in Waikīkī:

> Kamehameha's houses were at Puaaliilii, makai [toward the sea] of the old road, and extended as far as the west side of the sands of Apuakehau [vicinity of Moana Surfrider Hotel]. Within it was Helumoa [vicinity of Royal Hawaiian Hotel], where Kaahumanu *ma* [and company] went to while away the time. The king built a stone house there, enclosed by a fence; and Kamalo, Wawae, and their relatives were in charge of the royal residence. Kamalo and Wawae were the children of Luluka and Keaka, the childhood guardians of Kamehameha.
>
> This place has long been a residence of chiefs. It is said that it had been Kekuapoi's home, through her husband Kahahana, since the time of Kahekili. Haalou, a *makuahine* [female relative] of Kamehameha, lived there with her younger daughter Kekuapoi while en route from Hawaii to Kauai to consult Kapoukahi, a seer of Kauai, for means whereby Kamehameha would gain victory over Keoua Kuahuula [ʻĪʻī 1959:17].

EARLY POST-CONTACT DESCRIPTIONS OF WAIKĪKĪ

Waikīkī is described as a richly productive area in accounts by early European explorers. An early map by Lieutenant C. R. Malden of the Royal Navy shows cultivated land, "Ruins of a Morai," "Fresh Water Ponds," and a coconut grove in Waikīkī (Malden 1825). In 1792, Captain George Vancouver of the HMS Discovery arrived at "Whyteete" and noted the field systems:

> On the shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the sea-side, presented a high degree of cultivation and fertility.
>
> This opened to our view a spacious plain, which, in the immediate vicinity of the village, had the appearance of the open common fields in England; but, on advancing, the major part appeared divided into fields of irregular shape and figure, which were separated from each other by low stone walls, and were in a very high state of cultivation. These several portions of land were planted with the eddo or taro root, in different stages of inundation; none being perfectly dry, and some from three to six or seven inches under water. The causeway led us near a mile from the beach, at the end of which was the water we were in quest of. It was a rivulet five or six feet wide, and about two or three feet deep, well banked up, and nearly motionless; some small rills only, finding a passage through the dams that checked the sluggish stream, by which a constant supply was afforded to the taro plantations.
>
> In this excursion we found the land in a high state of cultivation, mostly under immediate crops of taro; and abounding with a variety of wild fowl, chiefly of the duck kind, some of which our sportsmen shot, and they were very fine eating. The sides of the hills, which were at some distance, seemed rocky and barren; the intermediate vallies, which were all inhabited, produced some large trees, and made a pleasing appearance. The plains, however, if we may judge from the labour

> bestowed on their cultivation, seem to afford the principal proportion of the different vegetable productions on which the inhabitants depend for the subsistence [Vancouver 1798:161–164].

Also aboard the HMS Discovery was surgeon and naturalist Archibald Menzies. He echoed Vancouver's description of a bountiful land:

> The verge of the shore was planted with a large grove of coconut palms, affording a delightful shade to the scattered habitations of the natives. Some of those near the beach were raised a few feet from the ground upon a kind of stage, so as to admit the surf to wash underneath them. We pursued a pleasing path back into the plantation, which was nearly level and very extensive, and laid out with great neatness into little fields planted with taro, yams, sweet potatoes and the cloth plant. These, in many cases, were divided by little banks on which grew the sugar cane and a species of Draecena without the aid of much cultivation, and the whole was watered in a most ingenious manner by dividing the general stream into little aqueducts leading in various directions so as to be able to supply the most distant fields at pleasure, and the soil seemed to repay the labor and industry of these people by the luxuriancy of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with water fowl of various kinds such as ducks, coots, water hens, bitterns, plovers, and curlews [Menzies 1920:23–24].

Several others followed Vancouver and Menzies in describing Waikīkī over the next few decades. Peter Corney wrote of Waikīkī between 1813 and 1818:

> On rounding Diamond hill the village of Wyteetee (Waikiki) appears through large groves of cocoanut and bread-fruit trees; it has a most beautiful appearance, the land all round in the highest state of cultivation, and the hills covered with wood; a beautiful plain extending as far as the eye can reach. A reef of coral runs along the whole course of this shore, within a quarter of a mile of the beach, on which the sea breaks high; inside this reef there is a passage for canoes [Corney 1965:193].

Otto von Kotzebue, commander of the Russian ship Rurick, viewed Waikīkī from the sea in 1816. His description of the land is as follows:

> . . . but you have scarcely sailed round the Yellow Diamond Hill, when you are surprised by the most beautiful landscape. Close to the shore you see verdant valleys adorned with palm and banana-trees, under which the habitations of the savages lie scattered; behind this, the land gradually rises, all the hills are covered with a smiling verdure, and bear the stamp of industry [von Kotzebue 1821:320].

Finally, the naturalist Andrew Bloxam was ashore from the HMS Blonde in 1824–1825 when he noted the abundance of Waikīkī:

> I walked along shore towards the bay of Whyteete to see if I could procure any shells, but I found none worth picking up. The whole distance to the village of Whyteete is taken up with innumerable artificial fishponds extending a mile inland from the shore, in these the fish taken by nets in the sea are put, and though most of the ponds are fresh water, yet the fish seem to thrive and fatten. Most of these fish belong to the chiefs, and are caught as wanted. The ponds are several hundred in number and are the resort of wild ducks and other water fowl. I found it very difficult to get out of the labyrinth of paths which lead among them. Whyteete is about four miles east of Honoruru [Honolulu]. It is pleasantly situated and built along the shore among numerous groves of coconut and other trees, and in this respect far better than Honoruru, as scarcely any trees are to be found there [Bloxam 1925:35–36].

This period of political importance ended for Waikīkī in 1809, when Kamehameha moved his capital to Honolulu, which was more accessible to Western visitors (Tomonari-Tuggle and Blankfein 1998:13). In 1829, Kamehameha III funded fifty percent of the construction cost for a new Kawaiahao Church, much grander and stronger than the prior three structures. Related to the current APE offshore, the lime for the church was sourced from the reef:

> The material at this time was largely from the coral reef abreast of the town where there were large fields of it growing in varied thickness. The coral was cut in blocks two to three feet long, two feet in width, and larger and smaller sizes, in blocks weighing from two hundred to twelve hundred

> pounds. Lime was procured by burning the coral, which gave an excellent quality of the product [Gilman 1903:86].

Following this move, traditional agriculture in Waikīkī waned. The population in the area drastically decreased due to economic changes and the devastation caused by Western diseases. The missionary Levi Chamberlain noted these changes when writing in 1828:

> Our path led us along the borders of extensive plats of marshy ground, having raised banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having once been under cultivation. I entered into conversation with the natives respecting this present neglected state. They ascribed it to the decrease in population [Chamberlain 1957:26].

In 1837, Gideon Laʻanui, a grandnephew of Kamehameha I, wrote of *ʻōkuʻu* (dysentery) spreading in Waikīkī. Several in his family contracted the disease, and some died:

> We returned with my father to Waikiki where we remained. The disease called okuu (dysentery) appeared. Kanahoahoa died, her ashes were taken. My elder caught the disease. We took him with our father to Ewa for intended burial on a small piece of land owned by Kekaulike. When we arrived there, he recovered and the disease went to our father. The sickness grew much worse. We took him back to Honolulu, up to Kaalaa and there our father died. My mother was taken by the younger brother of my father [Laʻanui 1937:1].

The pond dune banks of Kālia were one of many burial grounds for victims of the 1853 smallpox epidemic (and likely other epidemics as well). ʻĪʻī mentions the deaths when describing a traditional trail through Kālia:

> The trail from Kalia led to Kukuluaeo [immediately east of Kālia], then along the graves of those who died in the smallpox epidemic of 1853, and into the center of the coconut grove of Honuakaha [near today's Punchbowl and Queen streets]. On the upper side of the trail was the place of Kinau, the father of Kekauonohi. His houses were made kapu after his death, and no one was permitted to pass in front of them. Piopio and others were in charge [ʻĪʻī 1959:89].

First reported in February of 1853, the epidemic was full-blown by early May, and by the end of the year, between 3,000 and 6,000 people—predominantly Hawaiian in ancestry—had died (Greer 1969). The removal and burial of bodies became an immediate sanitary crisis (Daws 1968:141):

> Teams of wagon drivers patrolled the town, picking up the sick and the dead...they...became so hardened to death that they were able to stop at a tavern for a drink, leaving their load of corpses outside...At the height of the epidemic forty or fifty bodies were buried each day at Kakaako, and before the worst was over more than a thousand corpses were packed into the ground there, many of them laid on their sides to save space, in graves just wide enough to admit a body and only three feet deep.

While some of these burials were in known cemeteries, most were not. Furthermore, because the burial program was expedient and chaotic, burials outside the existing cemeteries were poorly documented. As Kālia, Kewalo, and Kakaʻako undergo urban redevelopment, some of these burials have been located; the highest densities to date appear to be in the vicinity of Sam's Club and the adjacent Walmart, at Sheridan and Makaloa streets.

FISHING GROUNDS IN BEFORE THE MAHELE

David Keliʻipiʻo of the Board of Health was appointed Fish Inspector in 1895. It was a new position, created to enforce fishing restrictions in polluted areas and ensure that all fish and other seafood were transported and sold at the fish market in Honolulu, where they could be inspected (PCA 1895). Initially, there was public opposition to the new rules, but his work was soon appreciated. A new market was built with a cement slanted floor, which was thoroughly cleaned every evening (HAS 1985:2). As Inspector, Keliʻipiʻo recorded the types of fish brought to the market, where they were caught, and the

quantities, and could order catches destroyed if inspection found them unsuitable. He also wrote articles on traditional fishing and associated spiritual beliefs (Keliʻipiʻo 1900a), shared information on fish, shellfish, crabs, and the identification of edible seaweed (Keliʻipiʻo 1899, 1900b), and recommended techniques for preparing certain fish, which appeared in newspapers and Thrum's Hawaiian Annual. In an article translated and published in the Annual, Keliʻipiʻo described traditional Hawaiian fishing restrictions, particularly in near-shore areas similar to Waikīkī:

> In the olden time certain varieties of fish were tabued and could not be caught at all times, being subject to the kapu of Kuula, the fish-god, who propagated the many tribes of Hawaiian waters. While deep sea fishing was more general, that in the shallow sea, or along-shore, was subject to the restrictions of the konohiki of the land, and alii's, both as to certain kinds as well as periods. The sign of the shallow sea kapu prevailing was by branches of the hau tree placed all along the shore. The people seeing this token of the kapu respected it, and any violation thereof in ancient time was said to be punishable by death. While this kapu prevailed, the people resorted to the deep sea stations for their food supply. With the removal of the hau branches, indicating the kapu was lifted, the people fished as they desired, subject only to the makahiki tabu days of the priest, or alii, when no canoes were allowed to go out upon the water [Keliʻipiʻo 1900:111–114].

In 1839, Kamehameha III issued a written constitution and code of laws in *An Act to Regulate the Taxes*. It included rules for free and prohibited fishing grounds. At Kālia, the fishery was held by the Crown, which divided its use into a part for the *moʻi*, a part for the *konohiki* and tenants, and a part for the *makaʻāina* (Jordan and Evermann 1902: 361). The *makaʻāina* were also given "the fishing grounds without the coral reef, viz., the Kilohee grounds, the Luhee ground, the Malolo ground, together with the ocean beyond" (Chapter III, Section 8, of Laws of 1840 in Kosaki 1954:2). Native Testimony in 1851 noted that Kaʻahumanu lived on the east side of the mouth of ʻĀpuakēhau in several small houses. Upon her death, Kekuanaoa "occupied that part of the land as a *kuleana*" and the *hoʻoʻāina* had the right to fish in the *mulilwai* of ʻĀpuakēhau (Volume No. 1:13).

Within the *konohiki* fishing grounds, the *konohiki* could designate a fish *kapu*:

> But the fishing grounds from the coral reef to the sea beach are for the landlords and for the tenants of their several lands, but not for others. But if that species of fish which the landlord selects as his own personal portion should go on to the grounds which are given to the common people, then that species of fish, and that only, is tabooed; if the squid, then the squid only; or if some other species of fish, that only and not the squid. And thus it shall be in all places all over the islands; if the squid, that only; and if in some other place it be another fish, then that only and not the squid [Jordan and Evermann 1902:361].

Kālia was a fishing ground subject to seasonal *kapu*: "Those fishing grounds which are known by the people to have shoals of fish remaining upon them shall, at the proper season for fishing, be placed under the protective taboo of the tax officers for the King. The fishing grounds on Oahu thus protected are: 1, Kalia" (Jordan and Evermann 1902:362).

In 1845, King Kamehameha III established the Board of Commissioners to Quiet Land Titles. The purpose of the Land Commission was "the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any landed property acquired anterior to the passage of this act" (Kingdom of Hawaiʻi 1846:107). The Land Commission's authority was restricted to determining the "validity of a [land] claim and to bind both the claimant and the government to its verdict" (Chinen 1958:9). On 26 October 1846, the "*Principles adopted by the Board of Commissioners to quiet land titles"* were approved by the Legislative Council, which identified three stakeholders with rights to land: "1st, the government, 2nd, the landlord, and 3rd, the tenant." To retain a property, adult males had to file a claim, provide testimony, pay for a survey, and obtain a Royal Patent. Additional legal clarification was required to resolve "the undivided interests of the King, the chiefs and *konohikis*, and the tenants [*makaʻāinana*]…in the lands" (Chinen 1958:12). This resolution came between 1847 and 1848, when the Privy Council established the Mahele, which "divided the vested rights that Kamehameha III and 245 chiefs had in the ʻāina [land]" (Stover 1997:11).

For *konohiki* land claims, approval by the Land Commissioners was required before the award was made. If approved, then the awardee obtained a Royal Patent (RP) from the Minister of the Interior, which indicated that the government's interest in the land had been settled with a commutation fee. This fee was typically no more than one-third of the value of the unimproved land. This fee was paid either in cash or, more commonly, the return of one-third of the awardee's lands of equal value (King 1945).

In 1845, the boundaries of fisheries ownership were more clearly defined. The people were granted rights to waters seaward of the reefs, and where there was no reef, waters beyond one mile offshore. Likewise, the waters from the seaward edge of the reef to the beach, or, where there was no reef, waters within one mile of the beach.

> The entire marine space without and seaward of the reefs upon the coasts of the several islands comprising the several fishing grounds commonly known as the Kilohee grounds, Luhee grounds, the Malolo grounds, and the fishery of the ocean from said reefs to the limit of the marine jurisdiction in the first article of this chapter defined shall be free to the people of these islands. The people shall not be molested in the enjoyment thereof except as hereinafter provided.
>
> The fishing grounds from the reefs, and where there happen to be no reefs from the distance of one geographical mile seaward to the beach at low water mark, shall in like manner be considered private property of the landlords whose lands by ancient regulation belong to the same; in the possession of which private fisheries the said landlords shall not be molested except to the extent of the reservations and prohibitions hereinafter set forth [Jordan and Evermann 1902:363].

In 1845, revisions made to the constitution were intended to be more specific, but also became more restrictive, complex to interpret, and difficult to enforce:

> These shall be divided equally between the King and fishermen. But on all the prohibited fishing grounds the landlords shall be entitled to one species of fish and [page 12] those who have walled fish ponds shall be allowed to scoop up small fish to replenish their ponds. If the prohibited fish of the landlord be mingled with the royal fish, then the landlord shall be entitled to one-third of the whole of the fish taken, though this applies only to Molokai, Oahu, and the reefs of Kauai.
>
> All which shall be yearly protected by the king's taboo, to be imposed by the minister of the interior by means of circular from his department, as prescribed in the act to organize the executive ministry; and during the specified season of taboo they shall not be subject to be taken by the people [Jordan and Evermann 1902:363].

Following the Mahele of 1848, two acts were passed in 1850 that changed land ownership in Hawai‘i. On 10 July 1850, the Alien Land Ownership Act was adopted, which allowed foreigners to own land. On August 6, 1850, the Kuleana Act of 1850 was adopted, which allowed *hoa‘āina* (common people of the land, native tenants) to make claims to the Land Commission. The new Western system of ownership led many people to lose their land. Often, *kuleana* (property) claims would be made for discontiguous cultivated plots with varying crops, but only one parcel would be awarded.

In 1850, the government loosened people's fishing rights due to difficulties collecting its share and because the restrictive rights were "a source of trouble and oppression to the people." The new law stated that government fisheries, excluding fishponds, were free to the people, but that the Minister of Interior could impose seasonal taboos. A complication arose regarding coastal land purchased or leased from the government that assumed fishing rights. So, in 1851, a clear statement regarding the limits of private fishing grounds:

> That no person who has bought or who may hereafter buy any Government land, or obtain land by lease or other title from any party, has or shall have any greater right than any other person resident in this Kingdom over any fishing ground not included in his title, although adjacent to said land. The fish in said fishing ground shall belong to all persons alike, and may be taken at any time, subject only to the taboos of the minister of the interior [Jordan and Evermann 1902:366]

The Civil Code of 1859, passed by the Hawaii Legislature, reiterated the existing rights and restrictions. These laws remained throughout the rest of the nineteenth century, with only additions. For

example, in 1872, a law was passed that prohibited the use of dynamite (Jordan and Evermann 1902:368), and in 1888, age and length restrictions were placed on *ʻawa* (kava) (Jordan and Evermann 1902:369).

The Crown Lands became Government Lands when the Hawaiian Government was overthrown in 1895, making them public domain for sale by fee simple (Alexander 1920). Patents were certificates issued for the sale of such lands. Beginning in 1900, when Hawaii became a U.S. territory, the certificates were known as Land Patents or Land Patent Grants (Alexander 1920). The Organic Act abolished private fishing rights, required registration of any private fisheries within a two-year window, and granted the attorney general the right to condemn privately owned fisheries (Kosaki 1954:4).

NAMED FISHERIES

Along the coast in Waikīkī, the fisheries' boundaries changed from the early 1800s to 1900. This was due to boundary disputes between landholders and the government's acquisition at the Mahele, as well as the overthrow of the Hawaiian Kingdom. Four fisheries near the APE are discussed below, and landmarks mentioned in claims, testimonies, and awards are depicted on a map in the previously referenced Figure 6.

Keonioku (Keomuku) Fishery

In 1846, Samuel Kuluwailehua objected to the boundaries of Claim 228 by Kalaiheana. ʻĪʻī testified on behalf of Kalaiheana that after the Battle of Nuʻuanu, Kamehameha I gave the coconut grove at Helumoa to Kalaiheana. Kuluwailehua counterclaimed that he received the land from his mother. In 1851, Kahiaweawe testified on behalf of Kuluwailehua that Kanekoa, Kuluwailehu's mother, gave him several pieces of land in 1840, which she had received from Keopulani during the time of Kamehameha I. She lived there until 1848 (the house was *mauka* of today's Ala Wai Canal), which was when King Kamehameha III awarded her the land. No one objected, and the *hoʻoʻāina* retained their *kuleana* (N.T. 738-739v3 in Hammatt and Shidler 2007:Appendix A).

On the coast at Keomuku, Kuluwailehua claimed:

> 1 cocoanut grove and Keomuku sea;
>
> The boundaries are:
> Mauka, land of Kekuanaoa
> Waikiki, land of Keohokalole named Hamohamo
> Makai, the surf's breaking point
>
> Ewa, land of Kekuanaoa. February 23, 1851, from page 242, No. 1281, S. Kuluwailehua [Hammatt and Shidler 2007:Appendix A].

According to Native Testimony in 1851, the sea west of Hamohamo was called Keonioku and belonged to Keakuanoa, indicating that the sea beyond Keomuku did not belong to Kuluwailehua. Both the *ʻili* and the fisheries described as between Hamohamo and Kālia were later absorbed into Kālia, as shown in Figure 11. This included Keomuku and the sea of Keomuku.

Hamohamo Fishery

Testimony states that the Hamohamo fishery extended from the southwest corner of the *ʻili* at a rock called Paliki above the high tide (near a cattle pen), then seaward to a coral rock called Pōhaku o Kauai on the inner reef, then along the inner surf or reef to a rock called Puʻaliʻiliʻi, and to the east side of the *muliwai* of ʻĀpuakēhau. The squid taken by the women belonging to other lands, on the inner reef, were divided with the *Luna* of Hamohamo" (Maly and Maly 2003b:256). J.O. Dominis was awarded the land of Hamohamo, but not the sea. The Hamohamo fishing privilege was determined by the Boundary Commission to be as described above.



Figure 11. Portion of 1909 Map of Oʻahu Fisheries by M.D. Monsarrat. Kālia Absorbed pre-Mahele Fisheries.

Kaneloa Fishery

The Kāneloa fishery followed the east boundary of Hamohamo to Pōhaku o Kauai and then to a rock on the outer reef called Lae Pōhaku. On the west side, the boundary began at the *muliwai*, then straight out to Puʻaliʻiliʻi, and then to the outer reef (corner unnamed). The fish caught between the inner and outer reefs were divided between the *konohiki* of Hamohamo and Kāneloa. Other testimony stated that the outer reef belonged to the government, but "heard that the Konohiki of Kaneloa, claimed a right to fish on the outer reef. I did not claim the squid taken on the outer reef. I have heard that the sea of Hamohamo is on the inner reef & that Kaneloa runs along outside of it. The persons who told me so are dead. Kailielulu was one" (Maly and Maly 2003b:257).

Kālia Fishery

Kālia Fishery and much of the *ʻili* land, including 23 *kōʻele*, 39 *loko*, and eight *ulu niu* (coconut groves), were claimed by Mahuka, the *konohiki.* In testimony, the shoreline belonging to Kālia was described as from the west side of Hamohamo to ʻĀpuakēhau and included "Olowalu coconut grove to the breaking sea of Kahaone [sandy beach]." It then broke inland, excluding the *muliwai*, Helumoa, and Keomuku, until the west side of Keomuku, where it returned to the shore and continued east to Kukuluaeo (N.T. 275-277 v10 No. 35 FL, Mahuka 12 January 1852 in Waihona Aina 2025). Mahuka was only awarded a fraction of the claim, which did not include the sea. There was also another claim for the sea, Claim 1515 by Kaihuolua, for a *kai* (ocean fishery) called Kukaha at Kālia. In Figure 6, previously referenced above, LCA 1515 (ʻĀpana 2) is slightly west of the *muliwai* of Kawehewehe.

THE DREDGING AND EROSION OF WAIKĪKĪ

During the 1880s, development intensified in Waikīkī, and the area underwent rapid transformation. By the end of the nineteenth century, many *loko* were filled, and rice was planted in place of taro. The productive wetlands came to be seen by some, particularly potential developers, as "deleterious to the public health in consequence of being low, and at times covered or partly covered by water, or of being situated between high and low water mark, or of being improperly drained, or incapable by reasonable expenditure of effectual drainage" (Pinkham 1906:3). This viewpoint would culminate in the dredging of the Ala Wai Canal and the filling of land that had a long history of productive wetland agriculture and aquaculture (Nakamura 1979).

In 1876, a group of prominent businessmen, which included Archibald Cleghorn, John O. Dominis, and James Makee, formed the Kapiʻolani Park Association. Mōʻī David Kalākaua offered a 30-year lease of Kāneloa and Kapua for the endeavor on the east side of Waikīkī, which was at the time crown land. According to the association's charter, the park would serve the purpose "of adorning and putting in order, a tract of land in the vicinity of Honolulu as a place of public resort, and of promoting Agricultural and Stock Exhibitions, and healthful exercise, recreation and Amusements" (Abel 1992:3–4). Kalākaua dedicated the park in June of 1877 in honor of Queen Kapiʻolani. At this time, the eastern portion of the park was sparsely vegetated and sandy, while wetlands and streams characterized the western portion. Consequently, the park's development entailed road building, drainage, and extensive plantings of ironwood, banyan, date palm, and other trees (Abel 1992:4). At the location of today's Honolulu Zoo, Makee and Cleghorn created a water landscape from the existing ponds. The following is a description of this development:

> Through construction of a system of ditches and canals, they drained sufficient water from this portion of the park to create a collection of small islands and shallow ponds. Although the waterways were routinely criticized as stagnant breeding grounds for "limu moss," the general effect was considered agreeable. Erecting rude wooden bridges enabled visitors to meander among the islands. The largest piece of dry land created from the former swamp was called Makee Island after the first Association present, and it became a favorite spot for picnics. [Weyeneth 1991:12].

In 1912, Walter F. Dillingham purchased 84.41 acres in Kālia from the Bishop Estate, which he used as a dump site for coral dredged during the construction of the Ala Wai Canal (Nakamura 1979:70, 111). This major undertaking, called the Waikīkī Land Reclamation Project, began in 1921 and was



Figure 12. Oblique Photography Kālia Area Prior to the Waikīkī Land Reclamation Project (UHM 2025).

completed in 1928 (Nakamura 1979; Stephenson 2008:28). An oblique aerial photograph of Waikīkī prior to the construction of the Ala Wai Canal is shown in **Error! Reference source not found.**.

The reclamation project was bounded by Sheridan, South Beretania, and South King streets, Kapahulu Avenue, and the ocean (Stephenson 2008:46), and resulted in the draining and filling-in of 1,400 acres, which were once productive ponds, irrigated fields, and home sites. Burned rubbish was also used as a fill material. The city used the wetlands as free dumping sites for incinerated rubbish, without compensating landowners, and justified the practice by arguing that filling the land would increase its value (Department of Environmental Services 2015). According to Nakamura (1979), state laws were passed that forced property owners to pay for the filling of their land, a matter in which they had no choice (Nakamura 1979). Many Hawaiians and other locals who live on the land were displaced. The following account is from Georgette Meyers, a resident of Nanakuli, whose family was evicted from Kālia in the 1920s:

> In the early 1920s, my mother and her ‘ohana moved to the Kalia area on O‘ahu, where Ala Moana is today. They planted taro, bananas, coconuts and vegetables. They raised ducks, chickens and other animals and harvested fish from their pond. Food came from their gardens, and life was pretty good, our kupuna say. In those times, our ‘ohana worked together, always sharing what they had. My

> parents' stories taught me respect for malama -- taking care of the 'aina. They also know what happened to it.
>
> One day, some foreigners came to their house. They said that a big tidal wave was coming. Everybody should move up to the hills near Punchbowl, they said. Many families left their homes. When they came back, their taro lo'i and fishponds and food gardens were filled with coral rocks and salt water. But it wasn't from a "tidal wave." It was from Dillingham's dredge. The dredge had chewed up the fishing reefs along the shore. They dumped the coral in our taro fields and ponds. The salt water killed everything. Many families were forced to leave [Meyers 1981:2–3].

Until 1913, Kapiolani Park was managed by the Honolulu Park Commission, whose mission was to operate the park as a public space (Abel 1992:5). During this early period, the oceanfront parcels were sold to private individuals in an effort to raise money for the Association through the subleasing of beachfront lots for residences. Some of these lots were reacquired in 1905; however, others became private property with the overthrow of the monarchy in 1893 (Hibbard and Franzen 1986:43). Many were built directly on the beach, and some extend past the shoreline on piers, as shown in Figure 13. The beach infringement led to erosion, which was combated with seawall construction (**Error! Reference source not found.** and **Error! Reference source not found.**); however, the seawalls only worsened the erosion. In 1917, the Territorial government prohibited seawall construction due to its adverse effects, but enforcement was lacking. As of 1920, there were roughly 37 seawalls spanning most of the shoreline. A photograph from 1926 shows the narrow beach at Waikīkī (Figure 16**Error! Reference source not found.**), which appears renourished in 1928, along with a new groin (Figure 17**Error! Reference source not found.**). Extensive seawalls can be seen in a photograph from 1931 (Figure 20).

Multiple sand renourishment projects were undertaken throughout the twentieth century. The following is a summary of events from the late 1800s to 2006 by Dr. Robert L. Wiegel, a civil and environmental engineer who studied the urban coastline:

> A century ago, most of the shore was a narrow, thin ribbon of carbonate sand lying between wetlands, mudflats, duck ponds, fishponds, and a gently sloping fringing reef a few thousand feet wide. Not much sand was in the beach or the thin patches of sand on the reef. Several small streams flowed into the sea. The first encroachment onto the beach with buildings and other works occurred in the 1880s and 1890s — a few homes, several bathhouses, and small hotels, some built partly on piles. Seawalls, groins, and several piers were constructed. The Natatorium was built from shore 200 feet onto the reef in 1927. The Ala Wai Canal and Ala Wai Yacht Harbor were also constructed. Of great importance was the removal of many truckloads of sand from the premises of Queen Lili'uokalani circa 1909, and the dredging of sand, coral rubble, and rock from the reef for fill of portions of the wetlands at Fort DeRussy in 1909. A dredge was used to clear a channel through the reef to the shoreline, and then parallel to the shore. In 1913, additional dredging was done to permit a 69-ton coast artillery gun to be brought by barge to the reservation. Channels, basins, and ponds have been dredged in the reef for several purposes; they front about one-half of the shore. These have caused changes in wave and current action, and in the transport and deposition of sand and silt. Much of the sand now on the beach segments between Diamond Head and Ala Moana Beach Park has been brought from other locations in Hawaii for beach fill, or for constructing a beach by placing sand on top of a base made of crushed coral rock dredged from the nearshore. Also, sand was dredged in 2000 and in 2006 from small deposits on the reef, pumped to shore at Kuhio Beach, and distributed along the section of beach which is protected by a shore-parallel breakwater (crib wall), elevation about MLLW, and groins connected to shore. Since Duke Kahanamoku's comments in the 1930s, guidelines governing beach nourishment have been to preserve the breakers for surfboarding, provide a sand blanket to cover the inshore coral, and stabilize a dry beach for sunbathing [Wiegel 2008:1].

In 1929, sand was pumped from a "reef flat" through the Halekulani Channel to the beach at the Halekulani Hotel. The current APE includes the Halekulani Sand Channel, also known as 'Āpuakēhau Channel, and other sources have cited the APE location as a sand source for beach replenishment, which suggests the APE is the "reef flat" source for sand in 1929. Photographs from 1938 and 1940 show the

renourished beach and a new groin at the Royal Hawaiian, just west of Halekulani (Figure 21, Figure 22, and Figure 21**Error! Reference source not found.**).



Figure 13. Ca 1916 Photograph Showing Buildings Extending to the Water (UHM 2025f).



Figure 14. Oblique Photography of the West End of Waikīkī Beach Prior to Ala Wai Canal Construction (U.S. Air Corps 1920).

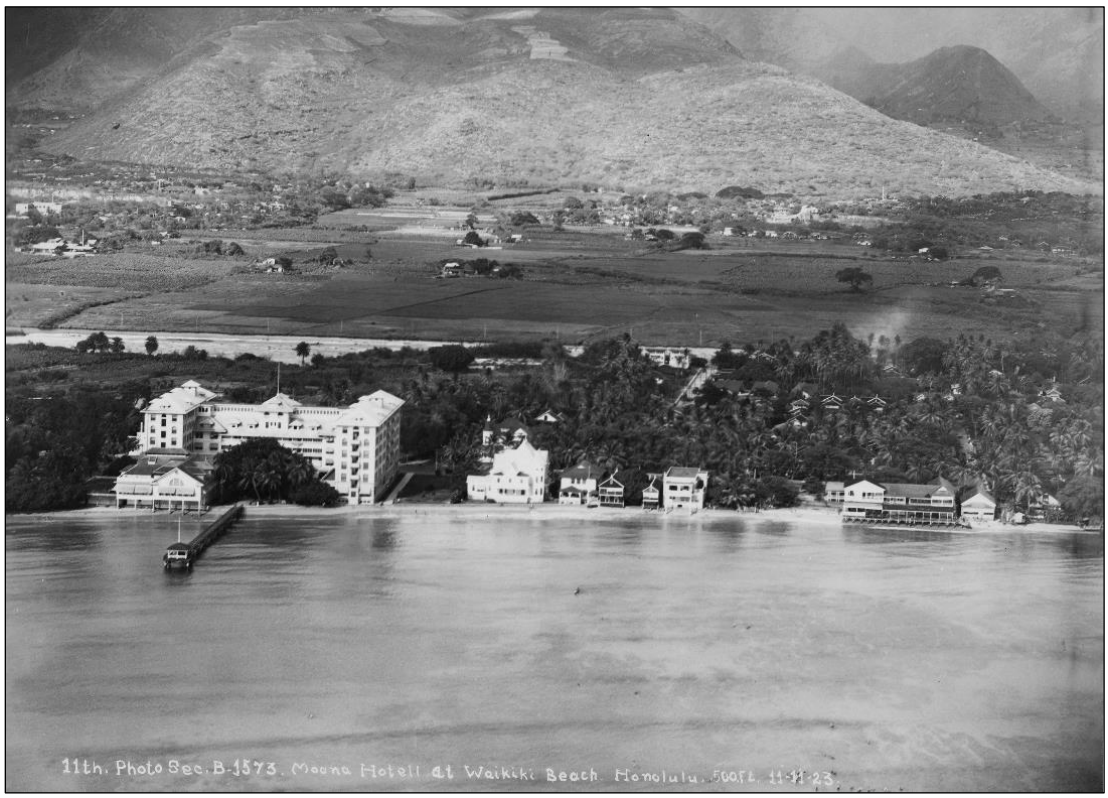


Figure 15. 1923 Oblique Photography of the West End of Waikīkī Beach (U.S. Air Corps 1923).



Figure 16. 1926 Oblique Photography of Waikīkī Facing West Showing Royal Hawaiian Hotel with Seawall at Water's Edge (U.S. Air Corps 1926).



Figure 17. 1928 Oblique Photography of Waikīkī Facing West Showing New Groin and Renourished Beach at Royal Hawaiian Hotel (U.S. Air Corps 1928).



Figure 18. Coast of Waikīkī 1931, facing Diamond Head, Showing Seawalls and Thin Patches of Beach (U.S. Air Corps 1931).

1



Figure 19. 1938 Oblique Photography of West End of Waikīkī Beach (U.S. Air Corps 1938).



Figure 20. Beach East of Royal Hawaiian Hotel in 1940 (UHM 2025).

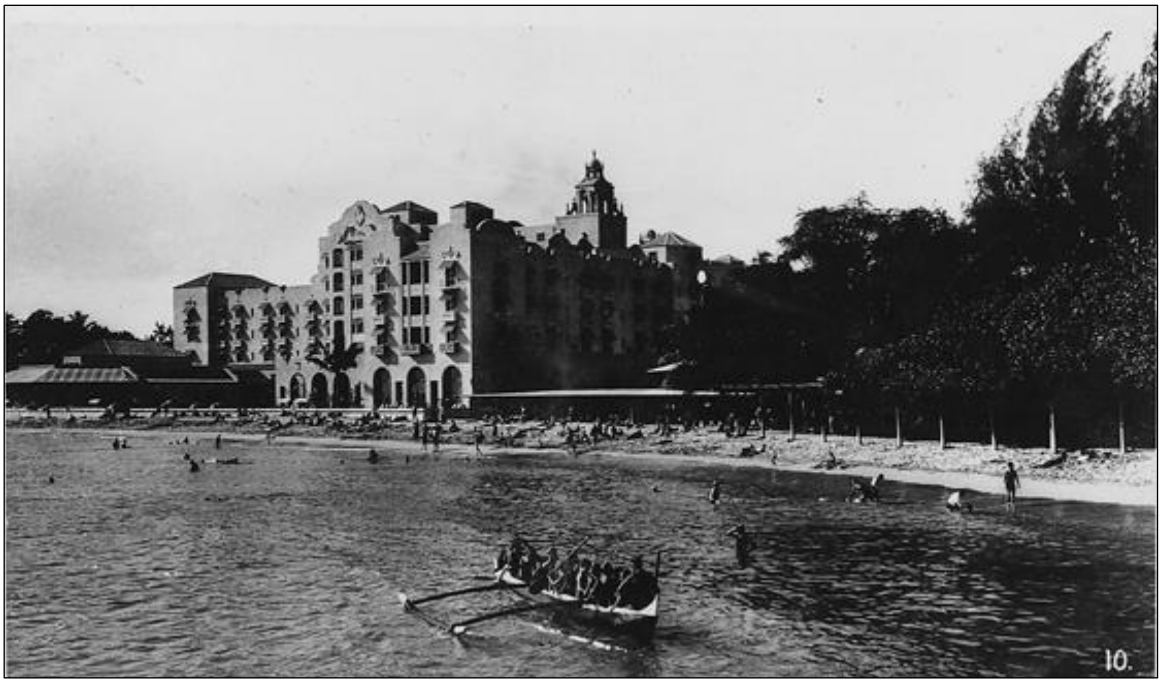


Figure 21. Outrigger Canoe and Beach Goers at the Royal Hawaiian Hotel in 1940 (UHM 2025).

By the 1950s, it was clear that shoreline construction, bay dredging, and wetland loss were impacting the Waikīkī coastline. A 1949 study undertaken by the U.S. Beach Erosion Board cost $42,240.58. Beach restoration was estimated to be $6,000,000.00 (Board of Harbor Commissioners 1949). Ironically, the study was named the Waikīkī Beach Reclamation Survey, in contrast to the 1920s Waikīkī Land Reclamation project. The photograph in**Error! Reference source not found.** Figure 22 shows the beach after it was renourished in the 1950s.

Money was appropriated in 1959 to create an easement focused on Kūhio Beach, but property owners opposed the appropriation, and it lapsed (Gill 1963). In the early 1960s, the erosion extended from Duke Kahanamoku Beach to the Elks Club (Williams 1963). According to state rep Kobayashi, "The crucial provision in the proposed agreement would require the owners to quitclaim to the State their interests in the beach makai of the 1928-29 line together with all littoral rights, assuming that the line is acceptable to the State" (Kobayashi 1963). The problem with various bills was the ambiguity of the property line. If the beach grew seaward, then the hotels would gain land. After an erosion study prepared by the USACE in 1963, Act 631 was passed, "to improve Waikiki Beach from Duke Kahanamoku Beach to the Elks Club. The project comprises widening of the beach and groin construction" (MacDonnell 1963).

Waikīkī beach improvement and maintenance in the late twentieth century included the construction and repair of seawalls and groins, and the placement of sand either brought in from another beach source or mined offshore at Waikīkī. More recently, sand was siphoned from offshore onto Waikīkī beaches in 2000. In 2006, 10,000 cubic yards of offshore sand were placed on the shore. Then, in 2012, sand was pumped from 2,000 feet offshore. The most recent effort was in 2021:

> The Waikīkī Beach Special Improvement District Association (WBSIDA), in close partnership with the Department of Land and Natural Resources (DLNR), conducted a beach maintenance project for the Royal Hawaiian to Surfrider Moana beach area. The goal of the Waikiki Beach Maintenance Phase II project was to restore and maintain the public beach between the Kuhio Beach Ewa Groin and the Royal Hawaiian Groin. The project includes hydraulic dredging and pumping up to 20,000 cubic yards of marine sand from offshore Waikīkī as a follow up to the 2012 project which brought in 24,000 cubic yards to Waikīkī Beach. The project started on January 26, and stockpiled 20,000 cubic yards of offshore sand, retrieved from shallow water about 1000-feet offshore. The project was completed in May 2021 (DLNR 2025).



Figure 22. Waikīkī Beach After Beach Replenishment in the 1950s (Bacon 1955).

PREVIOUS ARCHAEOLOGICAL PROJECTS

Many archaeological investigations have been conducted in Waikīkī, and since the early 1900s, numerous traditional Hawaiian burials have been recorded. Undisturbed beach sands (i.e., Jaucas sand), which are associated with traditional Hawaiian burials, have been observed below the historic fill layers throughout Waikīkī. This is also true for cultural deposits and former *lo'i* and *loko i'a*. Previous archaeological projects in coastal Waikīkī are tabulated in Appendix A. Previously identified historic properties are summarized in Table 3[12] and shown in Figure 23.

Offshore of Waikīkī, no archaeological sites or historical shipwrecks have been recorded. However, accumulations of traditional Hawaiian fishing gear within the reef were identified by University of Hawai'i Marine Option Program (UH MOP) divers according to a 2017 report:

> One near-shore fishing site was surveyed by the UH MOP student divers in 1996. Students in the field survey, assisted by UH Anthropology Department graduate Michael Pfeffer, mapped an accumulation of hundreds of fishing lures surrounding specific topographical reef features offshore from Waikiki beach on O'ahu. These bread loaf-shaped basalt sinkers were part of a multicomponent octopus lure, or leho he'e (Maly and Maly 2003). The distribution of lost lures suggests hundreds of years of fishing activity at this specific location and submerged reef feature. Project records for both of these surveys are held by NOAA's Maritime Heritage Program and the University of Hawai'i Marine Option Program [NOAA Maritime Heritage Program 2017:44].

[12] In Table 3, BPBM=Bernice Pauahi Bishop Museum Site Number.

Table 3. Previously Identified Historic Properties in Coastal Waikīkī.

SIHP	Description	Location	Reference
No #	Traditional Hawaiian human burials	James B. Castle property, east end of Waikīkī Beach	See Davis 1984 (recovered in 1901)
No #	Traditional Hawaiian human burials	Outrigger Canoe Club	See Davis 1984 (recovered in 1963)
01974	Traditional Hawaiian human burials and cultural deposit	Moana Surfrider	Simons et al. 1991
02870	Traditional Hawaiian human burials and subsurface features	Hilton Hawaiian Village	Neller 1980; Hurlbett et al. 1992; Tulchin et al. 2011; Yucha and Hammatt 2014; Sroat et al. 2019; Krause et al. 2022
03705	One humerus	Moana Surfrider (former site of Outrigger Canoe Club)	See Davis 1984 (Recovered in 1964, BPBM 50-Oa-A04-024)
03706	Traditional Hawaiian human burial	331 Saratoga Road	See Davis 1984 (Recovered in 1961, BPBM 50-Oa-A04-019)
03707	Traditional Hawaiian human burials	2431 Prince Edward Street	See Davis 1984 (Recovered in 1963, BPBM 50-Oa-A04-023)
04224	Traditional Hawaiian human burials and subsurface features	Pacific Beach Hotel	Beardsley and Kaschko 1998
04570	Traditional Hawaiian human burials and subsurface features	Fort DeRussy	Davis 1989; Streck 1992; Carlson et al. 1994; Denham and Pantaleo 1997a,b; Yucha and Hammatt 2014, Raff-Tierney et al. 2017, Welser and McDermott 2018
04573	Subsurface remnants of Loko Kaipuni	Nimitz Hwy and Ala Moana Blvd	Davis 1989; Pammer et al. 2018
04574	Loko Paweo I	Fort DeRussy	Davis 1989; Simons et al. 1995; Denham and Pantaleo 1997a,b
04575	Loko Ka‘ihikapu	Fort DeRussy	Davis 1989; Denham and Pantaleo 1997b
04576	Loko Paweo II	Fort DeRussy	Davis 1989; Simons et al. 1995; Denham and Pantaleo 1997a
04579	Traditional Hawaiian human burial and subsurface features	Fort DeRussy	Simons et al. 1995; Denham and Pantaleo 1997b
04729	Human remains (scattered)	Waikīkī Aquarium	Cleghorn 1993; Dagher 1993; Dega and Kennedy 1993
04966	Pre-Contact features and human burials	Fort DeRussy	Denham and Pantaleo 1997a
04970	Traditional Hawaiian cultural deposit	Fort DeRussy	Simons et al. 1995; Denham and Pantaleo 1997b; LeSuer et al. 2000
05301	Human burial	Waikīkī Sunset Hotel	Jourdane 1995

SIHP	Description	Location	Reference
05459	ʻAuwai and loʻi remnants	Kalākaua Ave	McDermott et al. 1996
05460	Human burial	Kalākaua Ave	McDermott et al. 1996
05681	Human burial	Ohua St	Cleghorn 2001
05744	Human burials	Ala Wai Blvd	Perzinski et al. 2000
05796	Culturally modified agricultural surface	Waikīkī Shopping Plaza	LeSuer et al. 2000; Yucha et al. 2009; Pammer et al. 2014; Morris and Hammatt 2015; Martel and Hammatt 2017, Beauchan et al. 2016; Farley et al. 2020
05797	Human remains (scattered)	Kalākaua Ave	Winieski and Hammatt 2000
05856	Human burial	Kalākaua Ave	Perzinski et al. 2000; Bush et al. 2002; Winieski et al. 2002
05857	Traditional Hawaiian human burials	Kalākaua Ave	Perzinski et al. 2000; Winieski et al. 2002
05858	Traditional Hawaiian human burials	Kalākaua Ave	Perzinski et al. 2000; Winieski et al. 2001
05859	Traditional Hawaiian human burials	Ulunui Ave and Liliʻuokalani Ave	Mann and Hammatt 2002; Winieski et al. 2002
05860	Two human burials	Kalākaua Ave	Perzinski et al. 2000; Bush et al. 2002; Winieski et al. 2002
05861	Burials (4 individuals); pre-contact cultural deposit, and historic artifacts	Kalākaua Ave	Perzinski et al. 2000; Cleghorn 2001; Winieski et al. 2002; Tome and Spear 2009
05862	Traditional Hawaiian human burials	Kalākaua Ave	Perzinski et al. 2000; Winieski et al. 2001; Winieski et al. 2002
05863	Traditional Hawaiian human burials	Kalākaua Ave	Perzinski et al. 2000
05864	Human burial	Kalākaua Ave	Perzinski et al. 2000; Bush et al. 2002
05883	Discontinuous A horizon	Kalākaua Ave	Winieski and Hammatt 2000
05937	Post-Contact human burials	Royal Hawaiian Hotel	Elmore and Kennedy 2001; Runyon et al. 2015
05940	Subsurface cultural layer	Throughout Waikīkī	Winieski et al. 2001, 2002; Bellville et al. 2014; Davis et al. 2017; Farley et al. 2017, 2018a,b, 2023
05941	Historic Trash pit	Kalākaua Promenade	Winieski et al. 2002
05942	Fragment of light gauge rail	Kalākaua Promenade	Winieski et al. 2002
05943	Low-energy alluvial sediments	Kalākaua Promenade	Winieski et al. 2002
05948	Portion of historic seawall	Kalākaua Ave	Winieski et al. 2001

SIHP	Description	Location	Reference
06369	One in situ burial	Lili‘uokalani Ave and Uluniu Ave	Mann and Hammatt 2002
06372	Historic trash pit	Lili‘uokalani Ave and Uluniu Ave	Mann and Hammatt 2002
06398	Historic trash pit	Lili‘uokalani Ave and Uluniu Ave	Mann and Hammatt 2002
06399	Post-Contact subsurface features	Hilton, Ala Moana Blvd	Putzi and Cleghorn 2002
06636	Buried Kewalo wetland sediment	Ko‘olani	Tulchin and Hammatt 2005; Runyon et al. 2011; Morriss et al. 2013
06641	Layer of burnt trash	Ko‘olani	Tulchin and Hammatt 2005; Runyon et al. 2011
06682	Buried habitation deposit	Ainahau Vista	Chiogioji et al. 2004; Tulchin and Hammatt 2007
06700	Human remains (scattered)	Waikīkī Gateway	Freeman et al. 2005
06701	Coffin burial	Waikīkī Gateway	Freeman et al. 2005
06702	Culturally enriched, buried A-horizon	Waikīkī Gateway	Freeman et al. 2005
06702*	Historic debris/trash deposit	Kapi‘olani Beach Park	Tome and Spear 2005 (*same SIHP, different sites)
06703	Fishpond remnant	Waikīkī Gateway	Freeman et al. 2005
06704	Subsurface cultural layer	Kalākaua Ave	Borthwick et al. 2002
06705	Human skeletal fragments	Ainahau Vista	Chiogioji et al. 2004; Tulchin and Hammatt 2007
06706	Segment of ‘Āpuakehau Stream	Ainahau Vista	Chiogioji et al. 2004; Tulchin and Hammatt 2007
06707	Pre-Contact stone retaining wall	Ainahau Vista	Chiogioji et al. 2004; Tulchin and Hammatt 2007
06819	Human burial	Kalākaua Ave	O’Leary et al. 2005; Hazlet et al. 2008
06848	Cultural layer	Cove Waikiki Condominium	O’Hare et al. 2006; Belluomini et al. 2023
06875	Human burials	Allure Waikīkī	Bell and McDermott 2006
06946	Human burial	Poni Mō‘ī Road	Whitman et al. 2008
07041	Human skeletal remains	Royal Hawaiian and Sheraton	Runyon et al. 2015
07055	Human skeletal remains	Ala Wai	Martel and Hammatt 2017; Belluomini et al. 2016
07065	Human skeletal remains	Princess Ka‘iulani	Runyon et al. 2009; Burke et al. 2014
07066	Cultural layer	Princess Ka‘iulani	Runyon et al. 2009; Burke et al. 2014

SIHP	Description	Location	Reference
07067	Human burial	Princess Kaʻiulani	Runyon et al. 2009; Burke et al. 2014
07068	Cultural layer	Moana Surfrider	Thurman et al. 2009
07069	Historic trash pit	Moana Surfrider	Thurman et al. 2009
07086	Historic trash feature complex	Holomoana St and Kahanamoku St	Mooney et al. 2009
07087	Disturbed human burial	Holomoana St and Kahanamoku St	Mooney et al. 2009
07115	Cultural layer	Koʻolani	Runyon et al. 2011
07116	Buried low-energy alluvial layer	Koʻolani	Runyon et al. 2011
07117	Post-Contact human burials	Koʻolani	Runyon et al. 2011
07118	Cultural layer	Royal Hawaiian and Sheraton	Runyon et al. 2015
07119	Disturbed human burial and cultural layer	Royal Hawaiian	Fong and Hammatt 2010; Lima and Hammatt 2014; Thurman et al. 2011; Bellville-Marrion et al. 2013; Runyon et al. 2015; Moore and Chambers 2022; Kem and Pacheco 2024
07135	Cultural layer and disarticulated human skeletal remains	St. Augustine-by-the-Sea Church	Yucha et al. 2013
07136	Human interment complex	St. Augustine-by-the-Sea Church	Yucha et al. 2013
07208	Subsurface features in dune sand layer; possibly on Makee Island	Honolulu Zoo	Walden et al. 2013; Clark et al. 2014
07307	Subsurface cultural deposit	International Market Place	Hammatt et al. 2012; Enanoria et al. 2024
07308	Subsurface burial/activity area	International Market Place	Hammatt et al. 2012; Enanoria et al. 2024
07309	Moana/Seaside Hotel subsurface infrastructure and deposits	International Market Place	Hammatt et al. 2012; Enanoria et al. 2024
07435	Human skeletal remains	Nimitz Hwy and Ala Moana Blvd	Pammer et al. 2018
07436	Human skeletal remains	Nimitz Hwy and Ala Moana Blvd	Pammer et al. 2018
07514	Human skeletal remains	Cove Waikiki Condominium	Belluomini et al. 2023
07598	Cultural layer	133 Kaʻiulani	Inglis et al. 2014
07599	Human skeletal remains	133 Kaʻiulani	Inglis et al. 2014

SIHP	Description	Location	Reference
07676	Human skeletal remains and disturbed cultural layer	Hilton Hawaiian Village	Yucha and Hammatt 2014
07741	Human skeletal remains	380 Kapahulu Ave	Medina and Hammatt 2016
07813	20th-century infrastructure	Waikīkī Trade Center	Manraith et al. 2015; Farley et al. 2020
07930	Cultural layer and wetland	413 Seaside Avenue	Thurman et al. 2016
07946	Human burial	Princess Kaʻiulani Hotel	Garcia and Shideler 2018
07952	Fishpond sediments (Loko Kaʻohai)	280 Beach Walk	Belluomini et al. 2016
07980	Cultural layer	Waikiki Trade Center	Farley et al. 2020
07981	Historic trash pits	Waikiki Trade Center	Farley et al. 2020
07982	Human skeletal remains	Waikiki Trade Center	Farley et al. 2020
07983	Human skeletal remains	Waikiki Trade Center	Farley et al. 2020
08037	Buried historic surfaces	Nimitz Hwy and Ala Moana Blvd	Pammer et al. 2018
08048	Human skeletal remains	ʻAlohilani Resort	Farley et al. 2023
08168	Buried infrastructure	ʻAlohilani Resort	Farley et al. 2023
08169	Fishpond sediments (Loko Kaipuni)	ʻAlohilani Resort	Farley et al. 2023
08833	Human skeletal remains	Royal Hawaiian	Blahut et al. 2021
08842	Human skeletal remains	Uluniu Ave	Mann and Hammatt 2002
08843	Human burials	Uluniu Ave	Mann and Hammatt 2002
08942	Kuāuna (large berm)	Centennial Park	Farley et al. 2022
08943	Historical infrastructure remnants	Centennial Park	Farley et al. 2022
09240	Human burials	2431 Prince Edward St.	Same as 03707 (BPBM 50-Oa-A04-023)?
09500	Traditional Hawaiian human burials	Hale Koa Hotel	Kimble 1976; Davis 1984 (Recovered 1976, BPBM 50-Oa-A04-025)
09901	Human burials	Moana Surfrider	Griffin 1987
09957	Human burials, post-Contact artifacts	Halekulani Hotel	Neller 1981; Davis 1984 (BPBM 50-Oa-A04-026)
09980	Traditional Hawaiian artifacts	Royal Hawaiian Hotel	See Davis 1984 (recovered in 1925)

1



Figure 23. Previously Identified Traditional Hawaiian Archaeological Sites and Human Burials.

In a report by Van Tilburg, the fishing lure caches identified in 1996 are referred to as submerged traditional fishing sites: "Submerged traditional fishing sites have been located and surveyed in shallow waters near Waikīkī, identified by the accumulation of stone breadfruit-type (octopus) sinkers" (Van Tilburg 2015). A report was identified during background research for this ALR that appears to be a record of UH MOP underwater mapping in 1996; however, it is missing every other page. The report is "a summary of the methodology and findings including a map featuring the density and distribution of Hawaiian stone fishing weights in the near-shore site" (Lovington 1996:1). The report was written by a member of the dive team, Al Lovington. The survey involved plotting the distribution of artifacts; no artifacts were collected. Lovington summarized the project's purpose:

> The site chosen for study is a traditional Hawaiian fishing grounds or *Ko'a. Ko'a* can also mean coral, fishing grounds or the onshore shrines used to mark alignments (transits) so fishermen could find the fishing grounds. The site is located about 500 meters offshore in front of the Waikiki Natatorium, Oahu in about twenty feet of water. . .
>
> The project for MAST '96, the Maritime Archaeology Field School, is to chart the occurrence of Hawaiian lithic fishing artifacts in the offshore site. The 'fishing gear' artifacts are identifiable by their basalt composition and fall into two classes; worked and unworked. The worked class of artifacts includes canoe anchors, plummet weights, handline weights, octopus lure weights, game stones, adzes, and poi pounders, while the unworked stones are various types of sinkers [Lovington 1996:1].

In the methodology section, Lovington writes that the chosen dive was known to contain artifacts:

> MAST '96 selected a primary site to work on under the coordination of Michael Pfieffer, a graduate student in anthropology, who is currently in the process of surveying other selected sites for artifact distribution. The site was specifically chosen for its known abundance of artifacts and easily accessible location. It was hoped that it would provide the ideal training ground for beginning underwater archeaologists [*sic*], but still offer relevant archaeological [*sic*] information.
>
> The site (temporarily designated Natatorium 1) is located in fifteen to twenty feet of water approximately a quarter mile south of the Natatorium. Although it is sufficiently offshore to avoid most surf, heavy surge from the southern swell blanketed the site for several days [Loveington 1996:15].

Due to missing pages in the report, the survey results are unclear. The author suggests returning to the site in order to complete the project:

> The most obvious step remaining is to finish the survey of the site. Completion of the survey grid would allow an analysis of artifact distribution to be conducted. Before we were forced off the site by the large southern swell, we had finished a 24m by 60m survey of the grid. In performing this task a possible improvement to the survey method would be to work along narrower areas to allow the transect lines to be moved more easily; that is, work a 20m swath instead of 24m. Initially, to get an overall feel for the site a controlled sweep of the area using a free swimline would be the fastest survey method to get a quick count and rough layout [Lovington 1996:19].

It seems that, due to poor conditions in the 15.0 to 20.0 ft. depth range, the original project site was abandoned, and the survey shifted to "Free Swimline Surveys" at other locations in the bay. Lovington states, "Swells were reaching eight feet and throwing divers around as well as reducing visibility below the minimum necessary to work. The field school was quick to adopt new strategies to deal with the change in conditions. The swimline survey technique would be practiced over the next three days" (Lovington 1996:19). Unfortunately, the following page is missing.

Only one of the three days of the dive survey is included. During two dives on July 24, 1996, a single canoe anchor was plotted approximately l00.0 m southwest of the Natatorium at a depth of 50.0 ft. Dive #2 was 48.0 ft. deep, approximately l00 m south of Ala Wai Boat Harbor. No artifacts were observed. At the end of the report, the author gives six recommendations for future research:

> [F]irst, test selected lithic artifacts to pinpoint their origin (respective volcanic flow) by either trace element fingerprinting or isotope ratios, secondly, chart sediment transport from littoral drift and offshore drift by running a simulation model with colored basalt stones, thirdly, do a randomized survey of the grids with an air lift to remove sediments, fourthly, study accretion rates of coral on basalt stones, fifthly, study wearing of accretion on the basalt due to transport, and lastly, assess the possibilities [*sic*] of basalt deposition due to human disturbance of the old stream beds, old ponds, landfill of the ponds, and the dredging of the Ala Wai Canal [Lovington 1996:29].

No follow-up work or any other underwater archaeological surveys offshore of Waikīkī were identified during an exhaustive literature search for this ALR. In 1998, an underwater investigation in the North Ship Channel outside Kāneʻohe Bay was conducted to investigate fish populations using a submersible equipped with video cameras. Interestingly, out-of-place water-worn cobbles and boulders were recorded on the seafloor. They were identified as *pōhākialoa* (sinker stones), which were used to sink *palu* (chum bags), and their presence was indicative of a traditional Hawaiian deepwater fishing site:

> The numerous rounded basalt rocks scattered throughout the site are typical of rocks found in streams and on cobble/boulder beaches. The paleo shoreline off Oʻahu has been found to be over 1000 m deep so these rocks could possibly have been rounded in place. However, from well over 1,000 submersible dives conducted by HURL since 1980, it is very uncommon to find rounded basalt cobbles on drown carbonate reef terraces off of this island (J. Smith, pers comm). A more plausible alternative explanation is that these stones were collected onshore and used for deep water bottom-fishing. Pinnacles and other areas of abrupt topography emerging from the seafloor such as this site have been confirmed as fertile bottom fishing grounds (Kelley et al. 2006, Leitner, 2018). The round rocks would have specifically been wrapped inside *palu* bait bags and when the line was jerked, facilitated the unwrapping of the bag and release of the *palu* before dropping free to the seafloor. Further supporting evidence of use in bottom-fishing is their narrow size range which is consistent with their use for fishing. In addition, there was no obvious pattern of deposition or sorting of the rocks as might have occurred if they formed in place. The number of stream/beach rocks found at this known bottom-fishing site along with their localized accumulation on this distinct topography feature, suggests the North Ship Channel Pinnacle was known to, and frequented by, early Hawaiian bottom fishers. Their size, shape, and basalt composition are consistent with historic accounts of stones used to transport *palu* to the bottom [Jokiel et al. 2019:57, 59].

The authors state that the dimensions, shape, and material (basalt) of the artifacts on the ocean floor resembled *pōhākialoa* in the Bernice Pauahi Bishop Museum collections. In the 1960s, a similar *pōhākialoa* measuring 20.3 cm by 10.2 cm was found by a diver in shallow water off Waikīkī (Jokiel et al. 2019:59). The diver took the artifact and sold it at an auction. The authors note that identifying and interpreting artifacts in shallow water can be difficult if they have been weathered by sand, and also because of possible transport between land and sea, driven by erosion, wave action, or human interference. In deeper water, "These obstacles do not occur . . . , providing more valid information and allowing for more positive identification as a fishing site" (Jokiel et al. 2019:60).

SUMMARY AND ASSESSMENT

The proposed REEFrame project is offshore of Waikīkī in Māmala Bay, Island of Oʻahu, State of Hawaiʻi (see Figure 1). Funding for the project is from the National Oceanic and Atmospheric Administration's (NOAA) Office of Habitat Conservation. In addition to NOAA, entities from the public, private, and nonprofit sectors are part of this project, including Conservation International, University of Hawaiʻi at Mānoa, the Hawaiʻi Division of Aquatic Resources, ocean technology firm Natrx, ocean engineering firm Oceanit, and workforce development nonprofit ClimbHI. The project is in ocean waters under the jurisdiction of the State of Hawaiʻi. Because the project involves federal funding and permitting, compliance with the NHPA of 1966 is required. Specifically, NHPA Section 106 requires consultation with interested parties for the proposed undertaking.

The APE for the undertaking measures approximately 11.38 ac. (44.61 ha) and in ocean waters managed by the State of Hawaiʻi. The state's management authority extends seaward up to three nautical miles. TMK plats along the coast near the APE include (1) 2-6-001, 002, and 004. The REEFrame modules

will be installed approximately 0.6 miles (0.92 kilometers) off the coast of Waikīkī Beach, at depths of 40.0–60.0 feet, and serve primarily as coral nurseries, providing attachment sites for "corals and opportunities," and promote natural reef restoration.

Pursuant to the HEPA, Chapter 343 of the HRS, an Environmental Assessment is required for the undertaking. Additionally, because the project involves federal funding and permitting, compliance with the NHPA of 1966 is required. Specifically, NHPA Section 106 requires consultation with interested parties for the proposed undertaking. A historical, cultural, and archaeological background study was conducted to identify any historic properties in the APE and then evaluate any potential impact and recommend mitigation of any adverse effects, if warranted. This archaeological study was conducted in accordance with the Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation, as well as HRS Chapter 6E of the HRS and Title 13 of the HAR, Subtitle 13 (State Historic Preservation Division Rules), Chapter 275 (Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS).

The earliest settlement of the Hawaiian Islands occurred between AD 1000 and 1100, well after the Holocene highstand 3,000 years ago, when sea level had lowered to its present-day level. Consequently, potential cultural resources in Māmala Bay do not include submerged terrestrial sites (e.g, habitation sites). Any offshore traditional Hawaiian sites would be associated with ocean activities, most likely fishing.

RECOMMENDATIONS

As a result of this ALR, it was found that no historic properties are within the proposed project area. The nearest historic properties are along the beach, where no work will be conducted, and there is no potential for submerged former terrestrial archaeological sites in the APE. As for isolated artifacts, such as traditional Hawaiian fishing gear, such finds are unlikely because the APE is in the Halekulani Sand Channel, which experiences dynamic and fluctuating water conditions and was previously mined for sand to replenish Waikīkī beaches.

The recommended finding for the assessment of adverse effects for the proposed undertaking pursuant to 36 CFR 800.5(d)(1) is "No adverse effect." The recommended effect determination for the proposed undertaking pursuant to HRS Chapter 6E and its implementing regulations at HAR §13-275-7(1) is "no historic properties affected."

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GLOSSARY OF HAWAIIAN TERMS

ahu—altar, shrine, cairn; stone enclosure for fish

Heap, pile, collection, mound, mass; altar, shrine, cairn; a traplike stone enclosure made by fishermen for fish to enter; laid, as the earth oven (Pukui and Elbert 1986:8)

ahupua'a—land division and community

Land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (*ahu*) of stones surmounted by an image of pig (*pua'a*) or because a pig or other tribute was laid on the altar as tax to the chief. The landlord or owner of an *ahupua'a* might be a *konohiki* (Pukui and Elbert 1986:9)

'āina—land

Land, earth (Pukui and Elbert 1986:11)

'alamihi—Thukuhar shore-crab

A common black crab (*Metopograpsus thukuhar*) (Pukui and Elbert 1986:18)

ala mihi—path of repentance (Pukui 1983)

alamimo—quick

Quick, fast. *Nā kupua'i alamimo o nā kini maka lehua o nā 'ōpio,* nimble soles [dancing feet] of the many lehua blossoms of youth (Pukui and Elbert 1986:18)

'alaea—reddish brown

Water-soluble colloidal ocherous earth, used for coloring salt, for medicine, for dye, and formally in the purification ceremony called *hi'uwai*; any red coloring matter; according to Dr. Frank Tabrah, brick-red soil containing hematite. See *'i'o'alaea, kuhi 'alaea. Ua 'alaea* (For. 4:399), red rain [red of the rainbow] (Pukui and Elbert 1986:19)

ali'i—chief or chiefess; implies hereditary rank

Chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander (Pukui and Elbert 1986:20)

ali'i'ai-moku—paramount chief

Chief who rules a *moku* (district) (Pukui and Elbert 1986:20)

ali'i nui—high chief or chiefess

High chief (Pukui and Elbert 1986:20)

akua—a god or goddess

God, goddess, spirit, ghost, devil, image, idol, corpse; divine, supernatural; godly (Pukui and Elbert 1986:15)

'anae—mullet

Full-sized *'ama'ama* mullet fish (Pukui and Elbert 1986:24)

'au kī—ti stalk (*Cordyline terminalis)*

Stem of a ti plant (Pukui and Elbert 1986:32)

'aumakua—family god

Family or personal gods, deified ancestors who might assume the shape of sharks (all islands except Kaua'i), owls (as at Mānoa, O'ahu and Ka'u and Puna, Hawai'i), hawks (Hawai'i), *'elepaio*, *'iwi*, mudhens, octopuses, eels, mice, rats, dogs, caterpillars, rocks, cowries, clouds, or plants. A symbiotic relationship existed; mortals did not harm or eat *'aumakua* (they fed sharks), and *'aumakua* warned and reprimanded mortals in dreams, visions, and calls (Pukui and Elbert 1986:32)

'auwai—irrigation canal

Ditch, canal (Pukui and Elbert 1986:33)

ʻawa—kava

The kava (*Piper methysticum*), a shrub 1.2 to 3.5 m tall with green jointed stems and heart-shaped leaves, native to Pacific islands, the root being the source of a narcotic drink of the same name used in ceremonies, prepared formerly by chewing, later by pounding. The comminuted particles were mixed with water and strained. When drunk to excess it caused drowsiness and, rarely, scaliness of the skin and bloodshot eyes. Kava was also used medicinally (Pukui and Elbert 1986:33)

ʻāweoweo—red fish

Various Hawaiian species of Priacanthus, red fishes, sometimes called bigeye (Pukui and Elbert 1986:35)

ʻelepaio—flycatcher (*Chasiempis sandwichensis*)

A species of flycatcher with subspecies on Hawaiʻi (*Chasiempis sandwichensis sandwichensis*), Kauaʻi (*C. sandwichensis sclateri*), and Oʻahu (*C. sandwichensis gayi*) (Pukui and Elbert 1986:35)

haku ʻohana—senior male of an extended family of commoners

The *haku* headed the council of the *ʻohana* (Handy and Pukui 1958:7)

hala—pandanus or screw pine (*Pandanus odoratissimus*)

The pandanus or screw pine (*Pandanus odoratissimus*), native from southern Asia east to Hawaiʻi, growing at low altitudes, both cultivated and wild. It is a tree with many branches, which are tipped with spiral tufts of long narrow, spine-edged leaves; its base is supported by a clump of slanting aerial roots. The pineapple-shaped fruits are borne on female trees whereas the spikes of fragrant, pollen bearing flowers are borne separately on male trees. Many uses: leaves (*lau hala*) for mats, baskets, hats; the yellow to red fruit sections for leis, brushes; male flowers to scent tapa, their leaflike bracts to plait mats (see *hīnano*). (Neal 51.) The aerial root (*uleule*) tip is a good source of vitamin B and cooked in ti leaves was used medicinally, although unpleasant tasting. The tree is called *pū hala*. The *hala lei* is much liked today but formerly was not worn on important ventures because *hala* also means failure. For the same reason some persons will not compose songs about *hala*. Types of *hala* are listed below. Pineapples are hala plus qualifier. See ex., pō 2. *Puna paia ʻala i ka hala*, Puna, its walls fragrant with pandanus [fragrant flowers were placed indoors in house thatching and under mats] (Pukui and Elbert 1986:50) *hala* are listed below. Pineapples are hala plus qualifier. See ex., pō 2. *Puna paia ʻala i ka hala*, Puna, its walls fragrant with pandanus [fragrant flowers were placed indoors in house thatching and under mats] (Pukui and Elbert 1986:50)

Traditional Hawaiian use included thatching, medicine, perfume, plaited items (mats, fans, baskets, sails, bedding), lei, paint brush, food wrapping, sandals (Krauss 1993:7, 17, 31–33, 50, 52, 58–59, 68, 70, 71, 77; Krauss 2001:18)

hano or *hano mālolo*—type of fish net

Fish net, as for *mālolo* fish or ʻ*iao;* bag net (Pukui and Elbert 1986:57)

hāʻueʻue—slate pencil sea urchin (*Heterocentrotus mammillatus*)

Slate pencil sea urchin (Heterocentrotus mammillatus). Also *hāʻueʻue peni, pūnohu* (Pukui and Elbert 1986:60)

heʻe nalu—to surf

To ride a surfboard; surfing; surf rider. *Lit.*, wave sliding (Pukui and Elbert 1986:63)

heiau—ceremonial structure or place

Pre-Christian place of worship, shrine (Pukui and Elbert 1986:64)

heiau poʻokanaka— a class of *heiau* where human sacrifices were made

A *heiau* where human sacrifices were offered (Pukui and Elbert 1986:64)

hinakea—stone to attract fish

Type of stone laid near the coral pile *(umu)* to attract fish; it was flat on one side and rounded on the other, and was believed to attract manini and young of other fish which resembled it in color. *Lit.*, white gray (Pukui and Elbert 1986:71)

hoa‘āina (common people of the land, native tenants

Tenant, caretaker, as on a *kuleana* (Pukui and Elbert 1986:73)

‘ili ‘āina [‘ili]—division of land smaller than an *ahupua‘a*

An *‘ili* land division whose chief pays tribute to the chief of the *ahupua‘a* of which it is a part, rather than directly to the king. Cf. *‘ili kūpono* (Pukui and Elbert 1986:97)

‘ili kū or kūpono—division of land smaller than an ahupua‘a

A nearly independent *‘ili* land division within an *ahupua‘a*, paying tribute to the ruling chief and not to the chief of the *ahupua‘a*. Transfer of the ahupua‘a from one chief to another did not include the *‘ili kūpono* located within its boundaries (Pukui and Elbert 1986:98)

‘ili lele—division of land smaller than an ahupua‘a

Portion of an *‘ili* land division separated from the main part of the *‘ili* but considered a part of it. Also *lele* (Pukui and Elbert 1986:98)

imu—underground earth oven

Underground oven; food cooked in an *imu* (Pukui and Elbert 1986:100)

‘ina—small sea urchin

Small sea urchin (*wana*), as *Echinometra spp.* (Pukui and Elbert 1986:100)

kāhala—greater amberjack (*Seriola dumerili*)

Amberjack or yellowtail (*Seriola dumerilii*) (Pukui and Elbert 1986:110)

kaha nalu—body surfing

Body surfing (Pukui and Elbert 1986:110)

kahawai—stream

Stream, creek, river; valley, ravine, gulch, whether wet or dry (Pukui and Elbert 1986:111)

kahuna—priest

Priest, sorcerer, magician, wizard, minister, expert in any profession (whether male or female); in the 1845 laws doctors, surgeons, and dentists were called kahuna (Pukui and Elbert 1986:114)

kahuna lapa‘au —healer

Medical doctor, medical practitioner, healer. Lit., curing expert (Pukui and Elbert 1986:114)

kahuna nui—high priest

High priest and councilor to a high chief; office of councilor (Pukui and Elbert 1986:114)

kai—sea

Sea, sea water; area near the sea, seaside, lowlands; tide, current in the sea; insipid, brackish, tasteless. *I kai*, towards the sea. *Makai*, on the seaside, toward the sea, in the direction of the sea. *O kai*, of the lowland, of the sea, seaward. *Nā kānaka o kai*, shore dwellers (Pukui and Elbert 1986:114)

kākelekele—hydropathic cure (Beckwith 1970:553)

Redup. of *kākele*: To rub with oil, to mix or stew with sauce or gravy. Cf. *kelekele*, greasy. *Lawe ipu kākele* (For. 5:81), bearer of ointment calabash (Pukui and Elbert 1986:119)

kalo—taro

Taro (*Colocasia esculenta*), a kind of aroid cultivated since ancient times for food, spreading widely from the tropics of the Old World. In Hawai‘i, taro has been the staple from earliest times to the present, and here its culture developed greatly, including more than 300 forms. All parts of the plant are eaten, its starchy root principally as poi, and its leaves as *lū‘au.* It is a perennial herb consisting of a cluster of long-stemmed, heart-shaped leaves rising 30 cm. or more from underground tubers or corms. (Neal [1948]157–60.) Specifically, kalo is the name of the first taro growing from the planted stalk; names of generations as listed for Hawai‘i Island (Kep. 153) are (1) *kalo*: see ex., *palili,* (2) *‘ohā* or *mu‘u,* (3) *‘a‘ae* or *‘ae,* (4) *‘ōnihinihi,* (5) *kokole,* (6) *pahūpahū*.

Kō mākou kalo kanu o ka ʻāina (saying), our planted taro of the land [proud and affectionate reference to a chief]. (PPN *talo*.) (Pukui and Elbert 1986:132)

kānāwai—law

Law, code, rule, statute, act, regulation, ordinance, decree, edict; legal; to obey a law; to be prohibited; to learn from experience (Pukui and Elbert 1986:127)

kapa—tapa

Tapa, as made from *wauke* or *māmaki* bark (Pukui and Elbert 1986:130)

kapu—taboo

Taboo, prohibition; special privilege or exemption from ordinary taboo; sacredness; prohibited, forbidden; sacred, holy, consecrated; no trespassing, keep out. (Pukui and Elbert 1986:132)

kauhale—spatially distinct household

Group of houses comprising a Hawaiian home, formerly consisting of men's eating house, women's eating house, sleeping house, cook-house, canoe house, etc. Term was later used even if the home included but a single house, and is sometimes used for a hamlet or settlement (Pukui and Elbert 1986:135)

kaukauali ʻi—lower chief or chiefess

Class of chiefs of lesser rank than the high chief, the father a high chief and the mother of lower rank but not a commoner (Pukui and Elbert 1986:135)

kī—ti (*Cordyline terminalis*)

Ti, a woody plant (*Cordyline terminalis*) in the lily family, native to tropical Asia and Australia. It consists of a branched or unbranched, slender, ringed stem, ending in a cluster of narrow-oblong, leaves 30 to 60 cm long, from among which at times rises a large panicle of small, light-colored flowers. The leaves were put to many uses by the Hawaiians, as for house thatch, food wrappers, hula skirts, sandals; the thick, sweet roots were baked for food or distilled for brandy. Besides green-leaved tis, which rarely fruit, many ornamental varieties are grown in gardens, having leaves wide to narrow, large to small, the colors purple, crimson, scarlet, rust, pink, or green, striped or plain. Red tis may have red flowers and berries. Green ti leaves are still believed to afford protection from spirits and to purify a menstruating woman (Pukui and Elbert 1986:145)

kia ʻi loko—caretaker, guardian of the pond

Guard of a fish pond (Pukui and Elbert 1986:146)

kilu—a game

The player chanted as he tossed the *kilu* towards an object placed in front of one of the opposite sex; if he hit the goal, he claimed a kiss (Pukui and Elbert 1986).

kinolau—forms taken by a god or demigod

Many forms taken by a supernatural body, as Pele, who could at will become a flame of fire, a young girl, or an old hag (Pukui and Elbert 1986:153)

ko ʻa—fishing altar

Shrine, often consisting of circular piles of coral or stone, built along the shore or by ponds or streams, used in ceremonies as to make fish multiply; also built on bird islands, and used in ceremonies to make birds multiply (Pukui and Elbert 1986:156)

konohiki—land managers

Headman of an ahupuaʻa land division under the chief; land or fishing rights under the control of the *konohiki* (Pukui and Elbert 1986:166)

kou—type of tree

A tree found on shores from East Africa to Polynesia (*Cordia subcordata*), with large, ovate leaves, and orange, tubular flowers 2.5 to 5 cm in diameter, borne in short-stemmed clusters. The beautiful wood, soft but lasting, was valuable to the early Hawaiians and was used for cups, dishes, and calabashes (Pukui and Elbert 1986:167)

kua nalu—back of the wave

Surf just before it breaks, wave crest (Pukui and Elbert 1986:171)

kuhikuhi pu'uone—a site expert

A person skilled in picking good sites (Handy and Pukui 1958:8)

kula—dryland field

Plain, field, open country, pasture. An act of 1884 distinguished dry or *kula* land from wet or taro land (Pukui and Elbert 1986:179)

kūlana nalu—lineup in surfing

Place where the waves swell up and the surf rider starts paddling and racing the wave, usually at the most distant line of breakers. (Pukui and Elbert 1986:179)

kuleana—small piece of land under the responsibility of a tenant

Right, privilege, concern, responsibility, title, business, property, estate, portion, jurisdiction, authority, liability, interest, claim, ownership, tenure, affair, province (Pukui and Elbert 1986:179)

kū'ula—fishing shrine

n. Any stone god used to attract fish, whether tiny or enormous, carved or natural, named for the god of fishermen; heiau near the sea for worship of fish gods; hut where fish gear was kept with *kū'ula* images so that gear might be impregnated with *kū'ula mana*, usually inland and very taboo. Lit., red Kū (Pukui and Elbert 1986:179)

lau—leaf

Leaf, frond, leaflet, greens (Pukui and Elbert 1986:194)

lau 'ōpae—net for catching shrimp

Shrimp net, about a fathom long, placed around a heap of rocks called ahu or imu (fish and shrimp were prodded and frightened from the rock pile into the net); this type of fishing (Pukui and Elbert 1986:197)

lawai'a—to fish

Fisherman; fishing technique; to fish, to catch fish (Pukui and Elbert 1986:197)

leho—cowry shell lure for catching octopus

General name for cowry shell; they were used as octopus lures. *Moe a leho,* lie still as a cowry shell, as to escape detection (PPN fole, PCP lefo.) (Pukui and Elbert 1986:199)

limu kala—seaweed

Common, long, brown seaweeds (*Sargassum echinocarpum*), their stems covered with short branches, bearing rather stiff, twisted, more or less toothed, narrow leaves. Rarely eaten raw because of toughness (though edible); used in ceremonies to drive away sickness and to obtain forgiveness (see kala 1). May be qualified by the terms *lau li'ili'i* or *lau nui.* Also *'ākala* (Pukui and Elbert 1986:207)

limu kalawai —fresh-water algae (*Spirogyra spp.*)

limu pakaeleawa'a or limu huluhuluwaena—seaweed (*Grateloupia filicina)*

līpoa—type of seaweed

Bladelike, branched, brown seaweeds (*Dictyopteris plagiogramma* and *D. australis*) with conspicuous midrib on blade, unique aroma and flavor; highly prized on all islands (Pukui and Elbert 1986:208)

lo'i—wetland taro field

Irrigated terrace, especially for taro, but also for rice (Pukui and Elbert 1986:209)

loko i'a—traditional Hawaiian fishpond

loko i'a kalo—fishpond with *kalo* (taro)

Combination fishpond and taro patch (Pukui and Elbert 1986:210)

loko kuapā— a type of Hawaiian walled fishpond on the shoreline

Fishpond made by building a wall on a reef (Pukui and Elbert 1986:171)

loko pu'uone (or pu'uone)— dune bank fishpond; a type of Hawaiian fishpond near the ocean

Pond near the shore, as connected to the sea by a stream or ditch (Pukui and Elbert 1986:359)

loko 'ume'iki—shore pond

Shore fishpond with lanes leading in and/or out of the pond, used for trapping fish and probably only on Moloka'i, (Summers, 1964:12–19, 24.) *Lit.,* small pond drawing in (Pukui and Elbert 1986:210)

loko wai—fresh-water pond

Fresh-water pond or lake (Pukui and Elbert 1986:210)

lo'ulu—fern

An endemic fern (*Coniogramme pilosa*) with leaves somewhat like those of the breadfruit tree (*'ulu*) but the divisions narrower and deeper (Pukui and Elbert 1986:210)

lū'au— young taro tops

Young taro tops, especially as baked with coconut cream and chicken or octopus (Pukui and Elbert 1986:214)

maka'āinana —commoner

Commoner, populace, people in general (Pukui and Elbert 1986:224)

malihini—stranger

Stranger, foreigner, newcomer, tourist, guest, company; one unfamiliar with a place or custom; new, unfamiliar, unusual, rare, introduced, of foreign origin; for the first time (Pukui and Elbert 1986:231)

mālolo—flying fish; *Parexocoetus brachypterus* and others

General term for Hawaiian flying fishes (*Parexocoetus brachypterus* and others) (Pukui and Elbert 1986:233)

manini—surgeonfish (*Acanthurus triostegus*)

Very common reef surgeonfish (*Acanthurus triostegus*), also called convict tang, in the adult stage (Pukui and Elbert 1986:239)

māno–dam

Dam, stream, or water source, headwaters, place where water is obstructed for distribution in channels, channels (Pukui and Elbert 1986:239)

manō kumupa'a—ancestral shark

mele—song

Song, anthem, or chant of any kind; poem, poetry; to sing, chant (Pukui and Elbert 1986:245)

moano—goatfish

Goatfish (*Parupeneus multifasciatus*) (Pukui and Elbert 1986:249)

mō'ī —king

King, sovereign, monarch, majesty, ruler, queen (Pukui and Elbert 1986:251)

moku—district

District, island, islet, section, forest, grove, clump, severed portion, fragment, cut, laceration, scene in a play (Pukui and Elbert 1986:252)

mo'o—supernatural lizard

Lizard, reptile of any kind, dragon, serpent; water spirit (Pukui and Elbert 1986:253)

mo'ōlelo–legend

Story, tale, myth, history tradition, legend, journal, log, yarn, fable, essay, chronicle, record, article (Pukui and Elbert 1986:254)

mua—type of *heiau* also called a men's house

Men's eating house (Pukui and Elbert 1986:255)

muliwai—estuary

River, river mouth; pool near mouth of a stream, as behind a sand bar, enlarged by ocean water left there by high tide; estuary (Pukui and Elbert 1986:256)

nalo—wave

Wave, surf; full of waves; to form waves; wavy, as wood grain (Pukui and Elbert 1986:260)

ʻohana—family

Family, relative, kin group; related. *ʻOhana holoʻokoʻa, ʻohana nui*, extended family, clan (Pukui and Elbert 1986:276)

ʻōkuʻu—dysenteric disease, possible cholera

Disease at the time of Ka-mehameha I, perhaps cholera, and perhaps so called because it was dysenteric, and people were squatting (*ʻōkuʻu*) much at stool (Pukui and Elbert 1986:282)

ʻopihi—limpet

Limpets, Hawaiians recognize three kinds: *kōʻele* (*Cellana talcosa*, the largest), *ʻālinalina* (*C. sandwicensis*), *makaiauli (C. exarata).* Scientists also recognize *C. melanostoma* (Pukui and Elbert 1986:292)

ʻoʻopu—goby

General name for fishes included in the families Eleotridae, Gobiidae, and Blennidae. Some are in salt water near the shore, others in fresh water, and some said to be in either fresh or salt water. Varieties include bluespotted goby (*Quisquilius eugenius*) and indigo hover goby (*Ptereleotris heteropterus*). *ʻOʻopu ʻai lehua*, poetic description of *ʻoʻopu* found in upland streams where lehua flowers drop into the water; lit., lehua-eating *ʻoʻopu*. *Kau ke alapiʻi a ka ʻoʻopu*, the *ʻoʻopu f*ish form a stairway [*ʻoʻopu* are said to jump over rocks from pool to pool]. See also *alamoʻo*, naniha, *ʻōkuhe, ʻoau 1*. (PCP *kokopu.*) (Pukui and Elbert 1986:290)

paʻakai—salt

Salt (Pukui and Elbert 1986:297)

pāhale—house lot

House lot, yard, fence (Pukui and Elbert 1986:299)

pākākā nalu—canoe surfing

pali—cliff

Cliff, precipice, steep hill or slope suitable for *olonā* and *wauke*; full of cliffs; to be a cliff (Pukui and Elbert 1986:321)

palu—fish bait

A relish made of head or stomach of fish, with kukui relish, garlic, chili peppers; fish bait made of fish head or stomach, also used for chumming (Pukui and Elbert 1986:331)

pipipi—nerite (*Nerita picea*)

General name for small mollusks, including *Theodoxus neglectus* (Pukui and Elbert 1986:331)

pōhaku—stone

Rock, stone, mineral, tablet (Pukui and Elbert 1986:334).

pōhākialoa—stone used as landmark

Stone used as a landmark, as of a land boundary, or for locating a fishing ground; stone with a knob at the top, used as a weight for deep-sea fishing; fishing grounds about 260 m deep (Pukui and Elbert 1986:334)

pueo—owl

Hawaiian short-eared owl (*Asio flammeus sandwichensis*), regarded often as a benevolent ʻ*aumakua* (Pukui and Elbert 1986:348)

puhi—eel

Eel (see below). A hitherto undescribed eel was identified in 1978 as *Gymnothorax ruepelliae*. Some persons considered *puhi* as *ʻaumākua* (Pukui and Elbert 1986:349)

puhikiʻi—any species of young flying fish

According to some, young of all flying fish; according to others, same as *mālolo* (Pukui and Elbert 1986:350)

pūloʻuloʻu—kapu sticks

A tapa-covered ball on a stick (*pahu*) carried before a chief as insignia of taboo (Pukui and Elbert 1986:354)

pūpū ālealea— Hawaiian top shell *(Turbo sandwicensis)*

uhu—parrotfish (*Scarus* spp.)

The parrot fishes, of which *Scarus perspicillatus* is among the most abundant and largest; *uhu* are plant eaters, the teeth are strong and beaklike, well fitted for clipping off food from coral (Pukui and Elbert 1986:364)

unu—same as *umu*

Small stone, pebble, stone chip; wedge, prop. Cf. *unu pehi ʻiole*. *Kohala i ka unu paʻa*, Kohala with the solid stone [firmness]. *hoʻo.unu* To place stones; to pave, macadamize (Pukui and Elbert 1986:372)

ʻūʻū —squirrelfish (*Myripristis* spp.)

All soldierfishes of the genus *Myripristis*; some were considered *ʻaumākua* (Pukui and Elbert 1986:374)

wahi pana—legendary place

Legendary place (Pukui and Elbert 1986:377)

APPENDIX D

CULTURAL IMPACT ASSESSMENT IN SUPPORT OF REEFRAME: RESTORATION OF SEVERELY DEGRADED CORAL REEFS IN HAWAIʻI VIA PERMANENT CORAL NURSERIES ON 3D PRINTED CONCRETE REEF FRAMEWORKS, WAIKIKI AHUPUAʻA, KONA MOKU ISLAND OF OʻAHU, STATE OF HAWAIʻI

DATED MARCH 2026

Draft Cultural Impact Assessment in Support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawaii via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupua‘a, Kona Moku Island of O‘ahu, State of Hawai‘i

TMK: (1) 2-6 (Offshore)

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March 2026

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DRAFT REPORT

Cultural Impact Assessment in Support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawaii via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupuaʻa, Kona Moku Island of Oʻahu, State of Hawaiʻi

(1) 2-6 (Offshore)

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MANAGEMENT SUMMARY

Project Information Type	Information
Document Title:	Cultural Impact Assessment in Support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawaii via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupuaʻa, Kona Moku Island of Oʻahu, State of Hawaiʻi
Date/Revised Date:	Draft: February 2026
SHPD HICRIS Project No.:	2025PR01358
SHPD Reference Document:	-
Federal Award ID No.:	NA23NMF4630084
Archaeological Permit #:	SHPD Permit No. 26-37
Project Location:	Māmala Bay, Honolulu, HI 96815
Project TMK:	(1) 2-6 (Offshore)
Ocean Authority:	State of Hawaiʻi
Project Proponents:	Conservation International Foundation
Project Tasks:	Cultural Impact Assessment and Ka Pa'akai Assessment
Parcel Acreage:	N/A
Project Area	Approx. 11.4 ac. (44.6 ha)
Principal Investigator:	Nicole Vernon, M.A.
Regulatory Oversight:	Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended. Hawaii Environmental Policy Act (HEPA), Chapter 343 of the Hawaii Revised Statutes (HRS) HRS Chapter 6E-8 and Title 13 of the Hawaiʻi Administrative Rules (HAR), Subtitle 13 (State Historic Preservation Division Rules), and Chapter 275 (Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E8, HRS).
Project Background:	REEFrame is a four-year, collaborative coral reef restoration project in Hawaii that seeks to foster coral growth and improve habitat by building permanent coral nurseries. Innovative DryForming™ technology will be used to create naturally shaped concrete modules that will provide an ideal habitat for both recruiting and growing coral, fish, and other reef life. These REEFrame modules will be installed approximately one mile off the coast of Waikīkī Beach, in approximately 40.0–60.0 feet of water, and serve primarily as coral nurseries, providing attachment sites for corals that will support reef restoration projects. Simultaneously, these permanent structures will also provide shelters for a variety of species, as they are naturally colonized by corals, fish, and other sea life. Eventually, they will become de facto natural reefs.
SIHP #:	None
Findings:	The Project Area is located roughly 0.6 miles (0.92 km) offshore from Waikīkī Beach. Native Hawaiian cultural practices associated with the area include surfing, canoeing, swimming, gathering and fishing.
Human Skeletal Remains:	None
Cultural Impact Determination:	The assessment has identified no adverse effects on cultural resources, practices, or beliefs. Short-term access restrictions in off-shore locations used for canoeing and fishing will occur during placement of the REEFrame Modules.

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PCSI Editorial Policy

PCSI follows the latest edition of the Society for American Archaeology (SAA) Style Guide regarding textual elements (e.g., numbers, dates, statistical copy, italicization, capitalization, hyphenation, and accents and diacritical marks) and citations. The authority for English spelling is the most recent edition of Merriam-Webster's Collegiate Dictionary. Unless noted, the authorities for Hawaiian spelling and geographic place names are the Hawaiian Dictionary (Pukui and Elbert 1986), the most recent listing of the Hawai'i Board on Geographic Names (HBGN), and Place Names of Hawaii (Pukui et al. 1974). PCSI uses the official spelling of Hawaii (without an 'okina) to refer to the State and State agencies (unless an alternative spelling has been officially adopted); spellings presented in quotations and references retain their original punctuation.

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INTRODUCTION

Under contract to Conservation International, Pacific Consulting Services, Inc. (PCSI) has prepared this Cultural Impact Assessment (CIA) report in support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawaii via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupua‘a, Kona Moku, Island of O‘ahu, State of Hawai‘i. Funding for the Proposed Action is being provided by the National Oceanic and Atmospheric Administration's (NOAA) Office of Habitat Conservation. In addition to NOAA, entities from the public, private, and nonprofit sectors are involved in this project, including Conservation International, the University of Hawai‘i at Mānoa, the Hawai‘i Division of Aquatic Resources, ocean technology firm Natrx, ocean engineering firm Oceanit, and workforce development nonprofit ClimbHI. The project is in ocean waters under the jurisdiction of the State of Hawai‘i.

REGULATORY CONTEXT

Pursuant to Hawaii Environmental Policy Act (HEPA), Chapter 343 of the Hawaii Revised Statutes (HRS), an Environmental Assessment (EA) is required for the Proposed Action. This CIA was prepared in accordance with the *Guidelines for Assessing Cultural Impacts* adopted by the Environmental Council, State of Hawai‘i (November 19, 1997) in support of the EA The Guidelines provide methodological and content protocol for projects/actions that may have the potential to affect cultural resources, stipulating specific matters that should be addressed in all CIAs..

In accordance with the provisions of HRS Chapter 343 and its implementing regulations contained in Hawaii Administrative Rules (HAR), Title 11, Chapter 200.1, the CIA provides a detailed analysis of how the Proposed Action could impact cultural practices, resources, and beliefs. The disclosure of this information is intended to promote transparent and responsible decision-making in accordance with Articles IX and XII of the *Constitution of the State of Hawaii*, other state laws, and the courts of the state, which all mandate government agencies to endeavor to promote and preserve the cultural practices and resources of Native Hawaiians and other ethnicities.

An alternative analytical framework, commonly termed a Ka Pa‘akai assessment, can be used for addressing the preservation and protection of cultural practices specific to Native Hawaiian communities. This approach resulted from a 2000 Hawaii Supreme Court ruling (*Ka Pa‘akai O Ka ‘Aina versus Land Use Commission).* In its decision, the court established the following three-part analytical approach:

- Part 1, identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary Native Hawaiian rights are exercised;
- Part 2, identify the extent to which those resources and rights will be affected or impaired; and
- Part 3, specify any measures to be taken to reasonably protect Native Hawaiian rights if they are found to exist.

A Ka Pa‘akai assessment was also prepared for the Proposed Action following the above analytical approach and is provided in Appendix B.

ASSESSMENT METHODOLOGY

This assessment was prepared based on historical records and past ethnographic research identified and reviewed by PCSI. PCSI also attempted to recruit informants to participate in the assessment process through a notice posted in the Office of Hawaiian Affairs (OHA) newsletter, Ka Wai Ola, a dedicated web page, and directed outreach. A total of 56 individuals and organizations with a knowledge of cultural practices and features in the Waikīkī area were contacted and invited to consult in the preparation of this assessment. These included 21 cultural descendants identified from past CIA reports and burial treatment planning efforts, the Office of Hawaiian Affairs, several Native Hawaiian Organizations (NHOs), community groups, civic organizations, and businesses. None of the parties contacted provided any

information to guide this assessment. Appendix A of this CIA describes the efforts used to identify, contact, and solicit information from knowledgeable individuals and organizations.

PROJECT AREA

The REEFrame Project Area is at the mouth of the ʻĀpuakēhau Channel along the coast of Waikīkī in Honolulu, Hawaiʻi and is depicted in Figure 1. The Project Area is approximately 0.75 to 1 mile off Waikīkī Beach in water depths between 40 to 60 feet. The state's management authority extends seaward up to three nautical miles. Tax Map Key (TMK) plats along the coast near the project area include (1) 2-6-001, 002, and 004 (Figures 2 through 4). No work will be conducted on land (i.e., the beach or shoreline).

PROPOSED ACTION

The Proposed Action is the REEFrame project. It is a four-year, collaborative coral reef restoration project in Hawaiʻi that seeks to foster coral growth and improve habitat by building permanent coral nurseries. Innovative DryForming™ technology will be used to create naturally shaped concrete modules that will provide an ideal habitat for both recruiting and growing coral, fish, and other reef life.

REEFrame modules are digitally designed 3D printed concrete reef systems. A module comprises five total units, including four units which form the base and the fifth unit on top. Up to 150 REEFrame modules are planned to be installed approximately 0.6 miles (1.0 kilometer) off the coast of Waikīkī Beach, at depths of approximately 40.0–60.0 feet (approximately 12.0–18.0 meters), and serve primarily as coral nurseries, providing attachment sites for corals that will support reef restoration projects. Simultaneously, these permanent structures will also provide shelters for a variety of species, as they are naturally colonized by corals, fish, and other sea life. Eventually, they will become de facto natural reefs.

The modules comprise concrete material with steel hardware covered in concrete coatings and contain holes, crevasses, ledges and other intentional design elements to help mimic a natural reef structure. These features vary between modules, and aim to provide habitat for coral, fish and other sea life. Each module measures six feet wide and six feet tall. The design weight is an average of five tons and structurally designed to be stable in a 50-year southern swell storm event where wave heights may reach or exceed 18 feet with a sustained 18 second period.

The REEFrame modules will be fabricated at the Natrx facility in Amelia, Louisiana, and transported to Hawaiʻi. Placement of REEFrame modules will require construction barges with heavy equipment to carefully place the units on the sandy sea floor. To help control the risks of inadvertently placing a structure on the natural reef, construction will proceed only during fair weather conditions at the site (calm waves, currents and winds). GPS will be used to confirm the placement locations of each module. Additionally, observation divers will assist with the operation, ensuring the accuracy of each placement and avoiding damage to sensitive species and habitats. On-site deployment of the REEFrame modules is anticipated to last two to four weeks. Vessel traffic in the project area will be temporarily restricted during deployment.

ENVIRONMENTAL SETTING

Waikīkī Ahupuaʻa is located on the leeward side of Oʻahu and extends from the Koʻolau mountain range through the coastal plain to the shoreline. Traditionally, the ocean rights of a *konohiki* (land manager) extended from the *ahupuaʻa* shoreline to the outer edge of the reef or one mile offshore. The project area is situated in the reef zone roughly 0.6 miles offshore from Waikīkī Beach.

GEOLOGY AND HYDROLOGY

The project area is located within the larger area known as Māmala Bay, which spans from Barbers Point to Diamond Head. Underlying Waikīkī Beach and coastal waters is a fossil reef. Sand was naturally

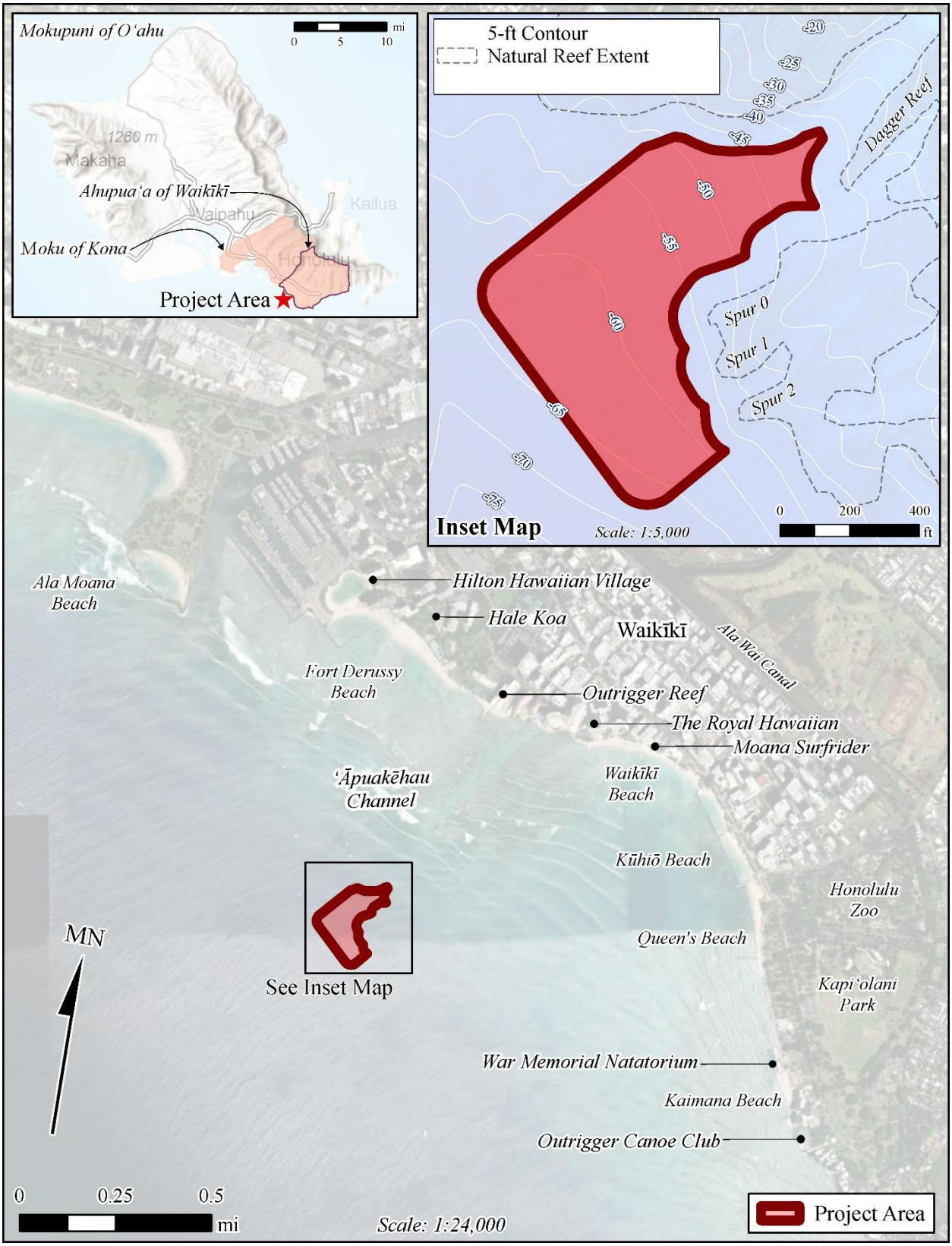


Figure 1. Aerial Imagery Showing Project Area in Relation to Coastal Waikīkī (ArcGIS Map Service 2025).

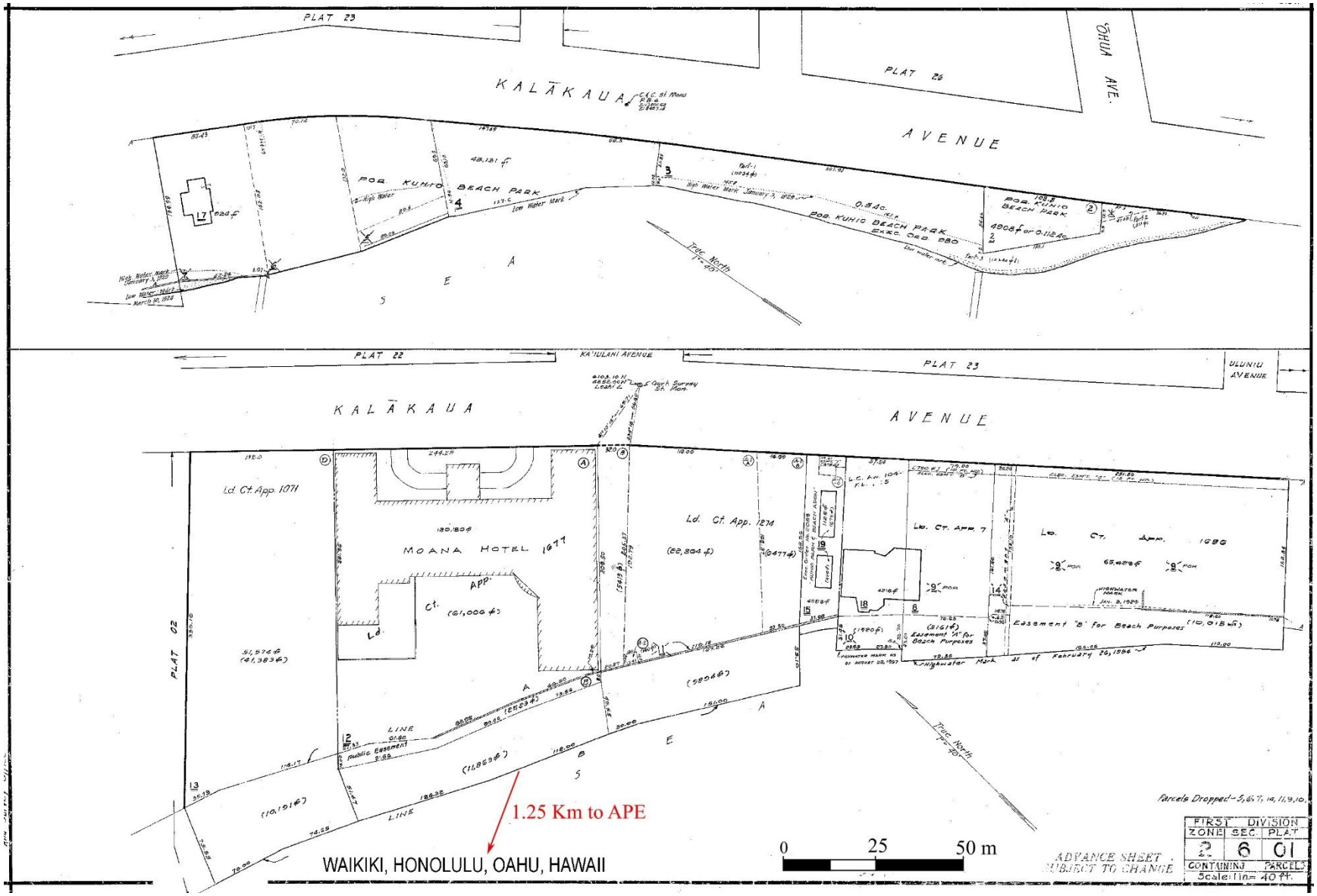


Figure 2. Tax Map Key (TMK) Plat Map (1) 2-6-001 (TH 1932a).

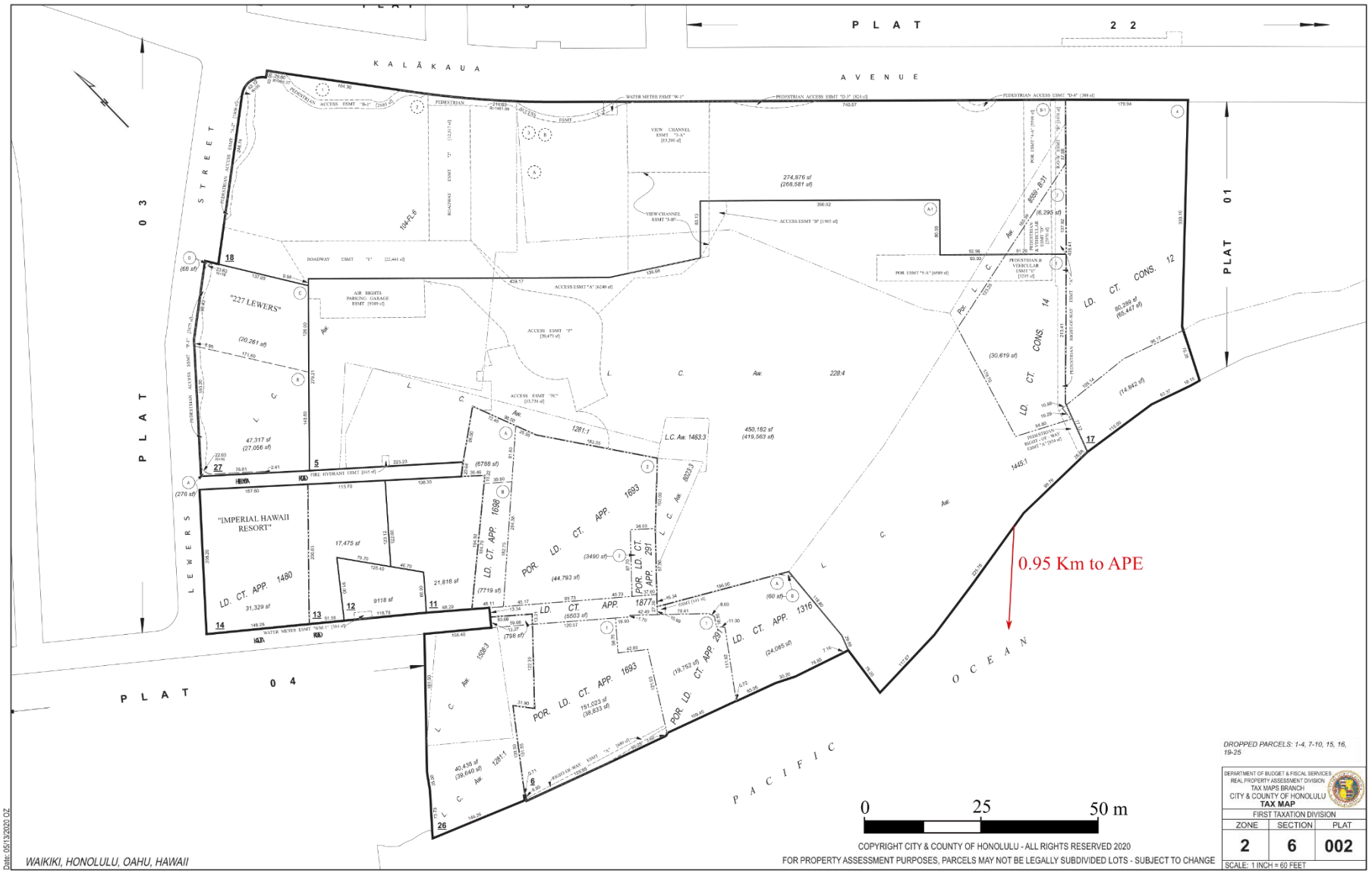


Figure 3. Tax Map Key (TMK) Plat Map (1) 2-6-002 (CCH 2020).

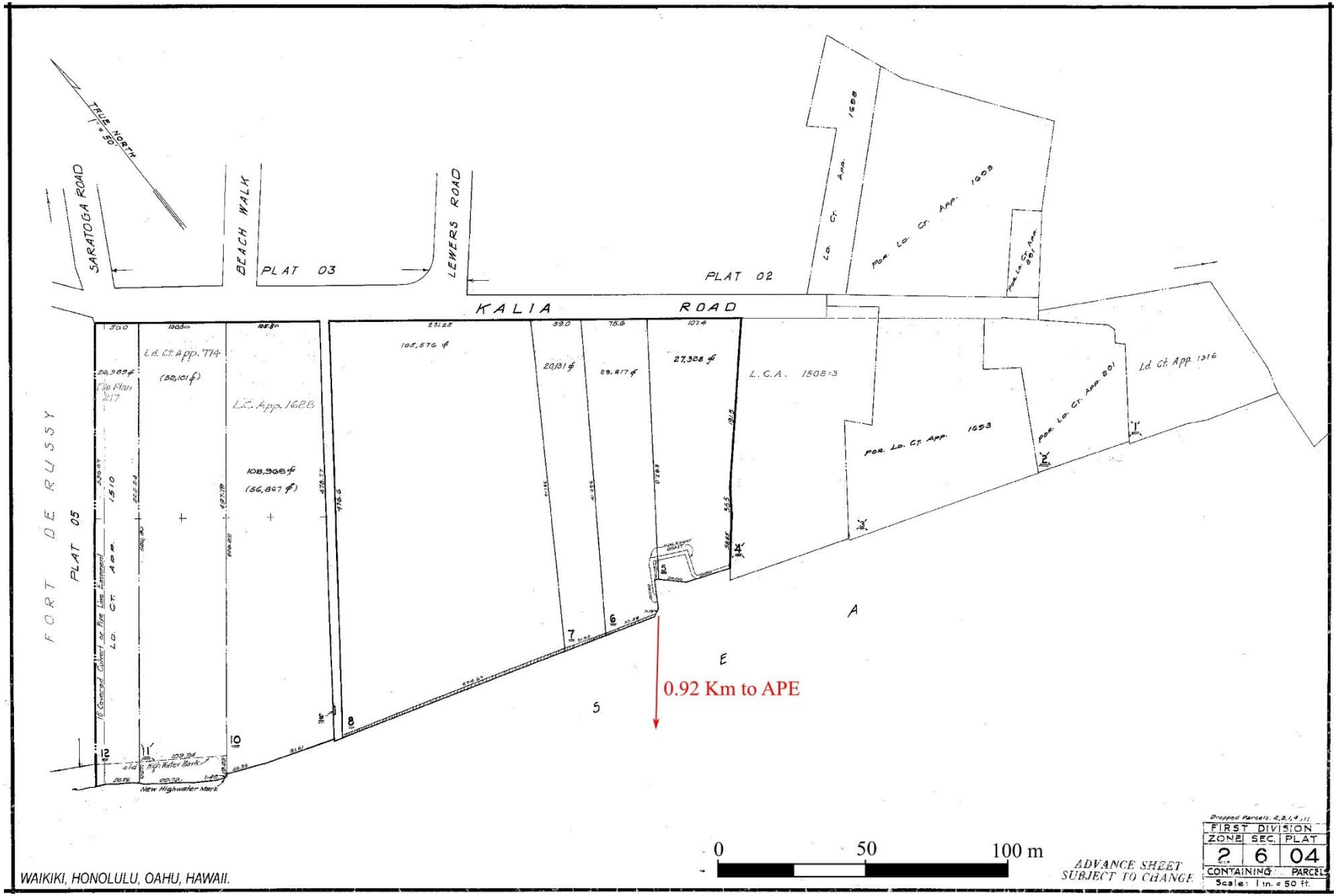


Figure 4. Tax Map Key (TMK) Plat Map (1) 2-6-004 (TH 1932b).

derived from the reef and, to a minor extent, from volcanics. The peak of sand deposition occurred during the Kapapa Stand (+2.0 m) at 1,500–4,000 bp.

The shoreline of Waikīkī is a narrow beach that has undergone extensive modifications since the early twentieth century. Previously, the coastal plain consisted of wetlands, mudflats, duck ponds, and fishponds, all fed by streams that emptied into the ocean. From the narrow carbonate sand beach, the fringing reef gently sloped seaward with few thin patches of sand (Wiegel 2008:3). In the 1880s and 1890s, residences, hotels, bathhouses, and piers were built on the limited shoreline. More drastic changes came in the 1900s, when sand was removed from a portion of the coast, and the reef was dredged for sand, coral rubble, and rock to fill the wetlands. In the 1920s, the Ala Wai Canal and Ala Wai Yacht Harbor were also constructed. Urban projects affecting the beach and reef at Waikīkī have continued into the twenty-first century:

> Channels, basins, and ponds have been dredged in the reef for several purposes; they front about one-half of the shore. These have caused changes in wave and current action, and in the transport and deposition of sand and silt. Much of the sand now on the beach segments between Diamond Head and Ala Moana Beach Park has been brought from other locations in Hawaii for beach fill, or for constructing a beach by placing sand on top of a base made of crushed coral rock dredged from the nearshore. Also, sand was dredged in 2000 and in 2006 from small deposits on the reef, pumped to shore at Kuhio Beach, and distributed along the section of beach which is protected by a shore-parallel breakwater (crib wall), elevation about MLLW, and groins connected to shore. Since Duke Kahanamoku's comments in the 1930s, guidelines governing beach nourishment have been to preserve the breakers for surfboarding, provide a sand blanket to cover the inshore coral, and stabilize a dry beach for sunbathing [Wiegel 2008:3].

Although most of the springs were filled during reclamation projects, spring water still surfaces in the ocean off Waikīkī in the shallow reefs along the beach, especially in winter and spring, and during periods of heavy rains in the inland valleys (Tilburg et al. 2017:101).

CLIMATE, WAVES, AND CURRENTS

Mean annual rainfall on the coast of Waikīkī is 25.5 inches, with most precipitation occurring between October and March (Giambelluca et al. 2013). Average temperatures range from 76° to 89° in August and 67° to 80° in February (NOAA 2025). Annual average ocean surface temperature in Māmala Bay ranges from 71° to 82° (PacIOOS 2025).

Seasonal wave variation includes waves affected by northeast Tradewinds, Kona (southwesterly) winds, and wind from the southern hemisphere (Sea Engineering 2010:38–39). Trade winds blow from the northeast and are more frequent in the dry season. Waikīkī is sheltered from a direct trade wind wave approach, but they can be refracted by Diamond Head and approach from the south. South swell waves are produced by winds from the Southern Hemisphere (Antarctic storms) and are more common during the dry seasons. Breaking south swell waves can reach one to two meters high. Local fronts and tropical storms produce Kona storm waves, which are year-round but infrequent, and can cause damaging wave action (Sea Engineering 2010:43).

Currents in Waikīkī are primarily tidal, but winds can also generate nearshore currents (Miller 2002:22). Currents in the nearshore and surf zones are driven by breaking waves.

ARCHAEOLOGICAL PERSPECTIVES AND HAWAIIAN CULTURAL HISTORY

Over the last century, archaeologists have proposed various Hawaiian cultural sequences subdivided into stages developed through archaeological research, paleoenvironmental, and chronometric data. More recently, these stages have proved problematic due to the validity of radiocarbon dates for certain samples, the variations in development over time throughout the archipelago, and the accepted nomenclature. Without adhering to specific temporal stages, the following section summarizes the cultural changes over time, beginning with the arrival of Polynesians to the islands.

EARLY PRE-CONTACT PERIOD

The coastal portions of wet, fertile windward valleys of the Hawaiian Islands are assumed by archaeologists to have been the first areas colonized by Polynesians, though the timing varied between islands (Athens and Ward 1993; Dye 1994; Emory 1968; Emory and Sinoto 1965; Hunt and Holsen 1991; Kirch and McCoy 2023; Sinoto 1970; Spriggs and Anderson 1993). Over the last two decades, analysis and reanalysis of paleoenvironmental and archaeological chronometric data have shown that the earliest settlement of the Hawaiian Islands occurred between AD 1000 and 1100 (Dye 2011; Kirch 2011; Kirch and McCoy 2007, 2023:81; Rieth et al. 2011; Wilmshurst et al. 2011).

There is only sparse evidence of the earliest human occupation in the Hawaiian Islands, and, in most cases, the radiocarbon data and the contexts from which they were derived have been debated (see Dye and Pantaleo [2010] and Rieth et al. [2011] for a summary). By the thirteenth century, the unique aspects of Hawaiian culture had developed, indicating a rapid adaptation to a new environment (Dye 1994; Dye and Komori 1992). Such adaptations included the expansion of the population inland and the exploitation of leeward resources such as salt, wood, grasses, lithic raw materials, birds, and marine life by windward inhabitants (Kirch 1984; Kirch and McCoy 2023). Oral histories indicate that Oʻahu was under the control of the Maweke-Kumuhonua lineage around AD 1300 (Cordy 1996), and Koʻoloaupoko Moku was under the control of Kalehenui. Along with the rising population, there was increasing political and social complexity. By the 1400s, Oʻahu was unified by Kumuhonua, an ʻEwa *aliʻi nui* (high chief).

LATE PRE-CONTACT PERIOD

The population continued to grow and expand into the interior of all islands after AD 1600, with the appearance of interisland polities and internecine warfare by Captain Cook's arrival in AD 1778. At the time of European contact, and for some time before, Hawaiian society consisted of four or five hierarchically organized polities on the islands of Kauaʻi, Oʻahu, Mauʻi, and Hawaiʻi (Cordy 2000; Earle 1991; Hommon 1976, 1989; Kirch and McCoy 2023; Malo 1951). Within each polity were two or three broad levels of social ranking legitimized by a system of stringent religious and ideological sanctions (Hommon 1976; Kirch 1984; Kolb 1994). The *aliʻi* constituted a group of chiefly levels that, among other things, held use rights over the land (Cordy 2004; Kirch 1984). The vast majority of Hawaiians belonged to local descent groups of commoners called *makaʻāinana*, who held usufruct land rights and lived and farmed within *ʻili ʻāina* (land division of an *ahupuaʻa* paying tribute to the *ahupuaʻa* chief).

Land and architectural hierarchies mirrored social hierarchies in late pre-Contact Hawaiʻi (Kolb 1994). At the base were local residence groups composed of household clusters within *ʻili ʻāina* (Cordy 1981:55; Cordy and Kashko 1980; Kirch and Kelly 1975:178; Kolb et al. 1997; Weisler and Kirch 1985). Residence groups in traditional Hawaiian society were composed of one or more spatially distinct households called *kauhale*. The ideal *kauhale* was a spatially segregated compound composed of several structures with different functions, including men's sleeping houses, women's sleeping houses, cooking houses, women's menstruating houses, and other special-use structures or activity areas (e.g., lithic workshops, garden plots, etc.). In addition, several *kauhale* may have shared a *mua* (men's house) where community-integrating activities occurred.

Socially, residence groups were bilaterally organized; however, descent was reckoned (cognatically) through land tenure (Davenport 1959; Kirch 1971, 1984; Tainter and Cordy 1977:100). Residential groups were arranged into communities called *ahupuaʻa*, and were controlled by *kaukauliʻi* (lower chiefs) or *konohiki* (land managers). Within the *ʻiliʻāina*, and perhaps the *ahupuaʻa*, the *makaʻāinana* (commoner) likely continued to adhere to some ancestral principles of Polynesian social organization (Kirch 1984:31–34; Kirch and Green 2001).

CULTURAL BACKGROUND

Archival background research and literature review examined maps, ethnographic, historical, and archival documents, and previous archaeological studies from the coast to the outer reef of Waikīkī. Relevant historical maps were georeferenced to identify traditional Hawaiian or historic features in the area,

and these were supplemented with nineteenth-century land and sea boundary descriptions. The information obtained from these sources was synthesized to present data findings and to evaluate cultural resources and practices associated with the project area.

MOʻOLELO AND WAHI PANA

The Hawaiian cultural landscape can be described through *moʻolelo* and *wahi pana* (significant Hawaiian place names). *Moʻolelo* may be myths, legends, proverbs, and events surrounding well-known individuals in Hawaiian history (Pukui and Elbert 1986:254). The project area is offshore from the coastal *ʻili*
(from west to east) of Kālia, Keōmuku, Helumoa, Ulukou, Kapuni, Uluniu, Auʻaukai, Hamohamo, Kekio, Kāneloa, and Kapua in Waikīkī Ahupuaʻa. Waikīkī, which can be translated as "spouting water" (Pukui et al. 1974:223), is named for its former wetlands fed by numerous streams from the valleys of Makiki, Mānoa, and Pālolo. The *ʻili* are shown on the historical map in Figure 5**.** and listed in Table 1 along with other traditional places. Hawaiian historian John Papa ʻĪʻī mentions some of the places in a description of a traditional trail that crossed lower Waikīkī:

> A trail led out of the town at the south side of the coconut grove of Honuakaha and went on to Kalia. From Kalia it ran eastward along the borders of the fish ponds and met the trail from lower Waikiki. … The trail from Kawaiahao [the location of today's Kawaiahaʻo church] which led to lower Waikiki went along Kaananiau [today's King Street], into the coconut grove at Pawaa [Makiki area], the coconut grove of Kuakuaka, then down to Piinaio; along the upper side of Kahanaumaikai's coconut grove, along the border of Kaihikapu pond (today's Fort Derussy), into Kawehewehe; then through the center of Helumoa of Puaaliilii, down to the mouth of the Apuakehau Stream [ʻĪʻī 1959:92].

Traditional history tells of *aliʻi nui* Kalamakua-a-Kaipuholua **(**Kalamakua) of Halawa on Oʻahu and Keleanohoanaʻapiʻapi (Kelea) of Maui. Their daughter Lāʻielohelohe was born at Helumoa and raised at Kaluakau, in Waikīkī. She was betrothed to Maui *aliʻi nui* Piʻilani, and after marrying, she lived at Halehuki on Maui. During one of her pregnancies, she returned to Oʻahu, and Kihaʻapiʻilani, future Maui *aliʻi nui*, was born at ʻĀpuakēhau (*Ke Au ʻOkoʻa,* Dec. 15, 1870). According to Native Hawaiian historian Samuel Kamakau, a rock was placed at ʻĀpuakēhau to mark where he was born (Kamakau 1991:94).

There are many Hawaiian sayings associated with places and events in Waikīkī, several of which include Kālia ʻIli, which spanned the western half of coastal Waikīkī. For example, *Kāhunahuna paʻakai o Kālia*, or "Fine-grained salt of Kālia" (Pukui 1983:144). According to Pukui, Kālia was a place for gathering salt, and the name was used as "a derogatory term for the dried, viscid matter in the corners of the eyes of an unwashed face" (Pukui 1983:144).

Kālia was also a place to gather ʻ*alamihi* crabs. The crabs were abundant at Kālia, and there is the saying: *Hoʻi i Kālia i ka ʻai ʻalamihi*, or "Gone to Kālia to eat *ʻalamihi* crabs" (Pukui 1983: 110). Pukui (1983:110) explains that this saying means a person is in a repentant mood, as it plays on the word ʻ*alamini,* which may also be *ala mihi* (path of repentance).

Waikīkī was known for *limu līpoa* (*Dictyopterisplagiogramma* and *Dictyopterisaustralis*), a brown seaweed with a strong aroma and spicy flavor, traditionally preserved by salting (Aiona 2003). There is the Hawaiian saying: *Nā līpoa ʻala o Kawehewehe* (The fragrant *līpoa* of Kawehewehe), referring to the *līpoa* at Kawehewehe, which was fragrant from the shore. It was often mentioned in songs about Waikīkī (Pukui 1983:146).

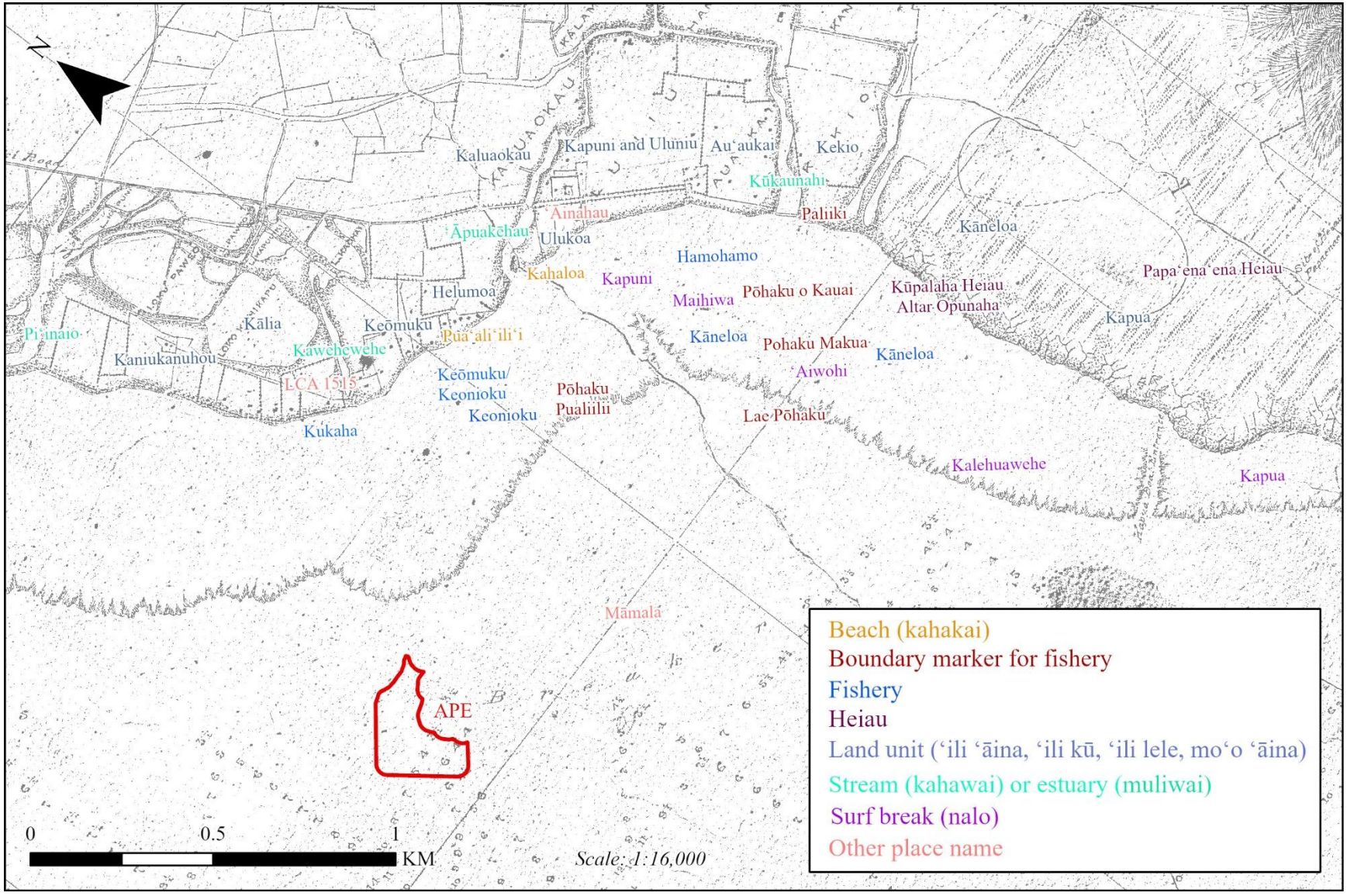


Figure 5. Traditional Place Names in Coastal Waikīkī Overlain on Portion of Map by Covington (1881). Places Names Added Based on Data from Mahele Testimony, LCA Descriptions, and Additional Historical Maps (Lyons ca 1876a,b).

Table 1. Coastal Waikīkī Traditional Place Names.

PLACE	MEANING	DESCRIPTION
ʻĀinahau *Royal Residence*	"*Lit.,* Hau tree land" (Pukui et al. 1974:7).	"Home and land of Princess Kaʻiulani at the site of the present Princess Kaʻiulani Hotel" (Pukui et al. 1974:7). "On the day of the baptism of Princess Ruth Keelikolani deeded to the Princess Kaiuani part of the homestead now known as Ainahau, on which the cocoanut grove was planted" (PCA 1899:1).
ʻAiwohi *nalo*	"*Lit.,* royal ruler" (Pukui et al. 1974:8).	"Ancient surfing area at Wai-kīkī, Oʻahu" (Pukui et al. 1974:8; see also (Kamakau 1991:44). "Today it is known as Publics" (Clark 2011:128).
ʻĀpuakēhau *muliwai, kahawai*	"*Lit.,* basket [of] dew" (Pukui et al. 1974:13)	"Old stream that debouched, near the present Moana Hotel, Wai-kīkī, probably named for a rain" (Pukui et al. 1974:13).
Auʻaukai *ʻili kū*	"*Lit.,* bathe [in the] sea" (Pukui and Elbert 1986:31)	"Kamaukoli, sworn. I came with Kaahumanu to Hamohamo. Kekupuohi, the other of Kaahumanu, gave Auaukai to Kaahumanu, Auaukai is an old name for that piece of land. I always understood that Kalia was a separate land" (Maly et al. 2013:254).
Hamohamo *ʻili kū*	"*Lit.,* rub gently (as the sea on the beach)" (Pukui et al. 1974:40).	"Area near ʻOhua Avenue, Wai-kīkī, Oʻahu, once belonging to Queen Liliʻu-o-ka-lani. . . *A ia akula paha i Wai-kīkī, i Hamohamo i ka ʻimi ʻahuʻawa,* maybe just at Wai-kīkī, at Hamohamo looking for *ʻahuʻawa* sedge (disappointment, failure; all one does is 'rub' and this is 'bitter' [*ʻawa*])" (Pukui et al. 1974:40).
Helumoa *ʻili ʻaina*	"*Lit.,* chicken scratch" (Pukui et al. 1974:44).	"Old land division near the Royal Hawaiian Hotel at Helu-moa Street, Wai-kīkī, and site of a *heiau* where Kahahana was sacrificed… (Chickens scratched to find maggots in the victim's body. The supernatural chicken, Kaʻau-hele-moa, flew here from Kaʻau Crater in Pālolo.)" (Pukui et al. 1974:44). Princess Pauahi inherited Helumoa from her cousin, Princess Ruth Keʻelikōlani, where she and her husband Charles Reed Bishop spent much time enjoying the sheltered *ulu niu* (coconut grove) (PCA 1899:1)."The sand of Helumoa was known as *Ke oneʻai aliʻi o Kakuhihewa* (The Chief Devouring Sand of Kakuhihewa) because of the curse placed by the prophet Kaʻopulupulu. When Kaʻopulupulu was brought with his son, Kahulupuʻe, to be executed at Waikīkī, he cursed the place where his *hinu* (body-grease) should drip upon the sand. This curse was upon the chiefs and the people" (Hibbard and Franzen 1986:5).
Kahaloa *kahakai*	"*Lit.,* long place" (Pukui et al. 1974:62).	"Beach area between the Royal Hawaiian and Hale-kū-lani hotels, Wai-kīkī, noted for its fragrant *līpoa* seaweed " (Pukui et al. 1974:62). Named for one of four stones believed to have been medical *kahuna* from Tahiti (Boyd 1906:140).
Kalehuawehe *nalo*	"*Lit.,* the removed lehua lei" (Pukui et al. 1974:76).	"Named for an ancient surfing area at Wai-kīkī . . , now called Castle's. Sick persons were brought here for cleansing baths. . . (Pīkoi, the rat killer, went to Waikīkī wearing a *lehua lei*. He asked a surfing chiefess for her board. She refused because the board was taboo. They surfed and he gave her his lei)" (Pukui et al. 1974:76).

PLACE	MEANING	DESCRIPTION
Kālia *ʻili kū*	"*Lit.,* waited for" (Pukui et al. 1974:77).	"Returned by Kamamalu at the Māhele, retained by the Gov. as Fort Land. Kāliaresembles an *ahupuaʻa* extending across Waikīkī from Makiki in the west to Kapahulu in the east, fragmented by many intervening *ʻili* and *kuleana*" (Ulukau 2025).
Kālia *kahawai*		Kālia Stream rises in Mānoa Valley, joins Pāhoa Stream near Pahupahuapuaʻa, and continues to the sea through Muliwai o Kūkaunahi, between Hamohamo and Kekio. Both streams have been realigned to form the Mānoa-Pālolo Drainage Canal, which flows to the Ala Wai Canal (Ulukau 2025).
Kāneloa *ʻili kū*	"*Lit.* tall Kāne" (Pukui et al. 1974:84).	"March 8, 1876: In lease from the Commissioners of Crown Lands to Mrs. Lilia K. Dominis showing that 20.85 acres of the above land [Kāneloa] had been granted to same [Mrs. Lilia K. Dominis], including the fishing rights" (HSA 2025). Kāneloa encompasses the Honolulu Zoo and much of Kapiʻolani Park. "There were sun worshippers among the original arrivals in Hawaii, and there were two temples dedicated to the sun on Oahu - - one at Kaneloa (a part of the present Kapiolani Park), and one at Kuaokala, Waianae..." (Sterling and Summers 1978:98; Ulukau 2025).
Kaniukanuhou *moʻo ʻaina*	[not translated]	"LCAw 2511 to Alapai: Kaniukanuhou ma Kālia" (Ulukau 2025).
Kapua *awa*	"Probably, *lit.*, the flower" (Pukui et al. 1974:89).	"Kapua Boat Entrance" appears on RM 1382; "Kapua Channel" outside the Outriggers Canoe Club.
Kapua *ʻili lele*		Includes the eastern part of Kapiolani Park, touching Papaenaena Heiau. Named for the adjoining *lele* of Kekio called Kapua (Ulukau 2025).
Kapua *nalo*		Ancient surfing area, Wai-kīkī, Oahu . . .; it is now filled in and a part of Ka-pio-lani Park" (Pukui et al. 1974:89).
Kapua *heiau*		Near Kapiolani Park, opposite Camp McKinley. *Heiau poʻokanaka*. Fragments of its walls, torn down in 1860, show it to have been about 240 square feet; said to be the place of sacrifice of Kaolohaka, a chief from Hawaiʻi, on suspicion of being a spy. Probably in the *lele* of Kapua (Ulukau 2025).
Kapuni *ʻili lele*	"*Lit.,* the surrounding (perhaps named for the spreading banyan tree on the ʻĀina-hau estate of A. S. Cleghorn)" (Pukui et al. 1974:89).	"Former land area" (Pukui et al. 1974:89).
Kapuni *nalo*		"Ancient surfing area" (Pukui et al. 1974:89). "Named for one of four stones, now at the Waikīkī Beach Center, which had been placed there to commemorate the four medical *kahuna* from Tahiti. See Paemahu for story. Today it is known as Canoes" (Clark 2011:128).

PLACE	MEANING	DESCRIPTION
Kawehewehe *awa*	"*Lit.,* the removal" (Pukui et al. 1974:99).	"Reef entrance and channel off Grey's Beach, just east of the Hale-kū-lani Hotel, Wai-kīkī, Honolulu. The sick were bathed here as treatment. The patient might wear a seaweed (*limu-kala*) lei and leave it in the water as a request that his sins be forgiven, the lei being a symbol" (Pukui et al. 1974:99).
Kawehewehe *muliwai, kahawai*		Muliwai o Kawehewehe drained several ponds in Kālia, below Kalākaua Avenue, following the present Saratoga Street (Ulukau 2025).
Kawehewehe *moʻo ʻaina*		Claim no. 1377 by Malo for his "pahale aia i Kawehewehe iloko o Kalia ma Waikīkī" was not awarded (Ulukau 2025).
Kekio *ʻili ʻaina*	[not translated]	A *lele* of *ʻili kūpono* Kekio in Palolo Valley (Ulukau 2025).
Keōmuku *ʻili ʻaina*	"*Lit.,* the shortened sand" (Pukui et al. 1974:99).	The *ō* is short for "one" (Ulukau 2025). Kahaleuliuli claimed land and fishery (Ulukau 2025).
Kūkaunahi *muliwai, kahawai*	[not translated]	Appears on RM 1952 (Bishop 1881); Kālia and Pāhoa fed into the Muliwai o Kūkaunahi between Hamohamo and Kekio and drained into the sea. Other maps label it as Hamohamo Stream.
Kuekaunahi *kahawai*	"Perhaps, *lit.*, to remove scales from fish" (Clark 2002:199)	"Small stream that paralleled Kapahulu Avenue and crossed Waikīkī Beach at the intersection of Kalākaua and Kapahulu Avenue. It was eventually enclosed in a culvert and at the shore its waters were channeled into the ocean through the Kapahulu Groin" (Clark 2002: 199).
Maihiwa *nalo*	[not translated]	Ancient surfing area, Waikīkī, Oʻahu (Kamakau 1991:44). Today it is known as Cunha's (Clark 2011:128).
Papanui *nalo*	"*Lit.,* big board" (Pukui et al. 1974:180).	"Deep-water summer surfing area about a mile seaward of Kū-hiō Beach, Wai-kīkī, Honolulu, named in 1930 by Duke Ka-hana-moku to honor the big boards that were ridden there" (Pukui et al. 1974:180).
Piʻinaio *muliwai, kahawai*	[not translated]	Muliwai was fed by ʻAuwai Alanaio and exited into the ocean near the ʻIlikai Hotel. The stream Piʻinaio fed the Loko Kaipuni. Has been filled in, and all flow has been channeled into the Ala Wai.
Puaʻaliʻiliʻi *kahakai*	"*Lit.,* little pig" (Pukui et al. 1974:190).	"Beach area at Wai-kīkī, Honolulu, approximately between ʻĀpuakēhau (site of the Moana Hotel) and Helu-moa (site of the Royal Hawaiian Hotel). Ka-mehameha I's houses were here" (Pukui et al. 1974:190).
Ulukou *ʻili ʻaina*	"*Lit.*, kou tree grove" (Pukui et al. 1974:215).	"Area in Wai-kīkī, Honolulu [near the Moana Hotel]" (Pukui et al. 1974:215).
Uluniu *ʻili ʻaina*	"*Lit.,* coconut grove" (Pukui et al. 1974:215).	LCAw 104FL to Kekuanaoa: "Aina ma Kalia, Waikiki, Kona, Oahu. Apana 5. Kahuahale ma Kapuni me Uluniu... 31 eka" (Ulukau 2025).

Kai

Kamakau described the many Hawaiian terms for specific places in the *kai* (sea), defined by the break of the waves and the activities or practices associated with the area. Based on his description, the project area perhaps falls within the *kua nalu* (back of the wave) or *kai kea* (white sea). Also in the depths of the project area are the *kai lu'u* (sea for diving) and *kai paeaea* (sea for pole fishing). Next beyond these zones are *kai 'o leho*[1] and *kai 'okilo*[2] *he'e* (sea for octopus fishing), the *kai kaka uhu* (sea for netting *uhu*), the *kai ka'ili* (sea for fishing with hook and line), and the *kai lawai'a* (sea for deep sea fishing) (Kamakau 1976:26–27).

> *Ka po'e kahiko* distinguished by name the waters along the coast, out to sea, and to the deep ocean. The place on land where waves break and spread is the *lihi kai* or *'ae kai*, edge of the sea. Where they wash over the land is called *pahola, hohola,* or *palaha* ("spread"), and the place where they break and spread toward land is called *pu'eone* or *po'ina nalu* or *po'ina a kai*.
>
> The overall term for a place where shallow seas come in without rising [into breakers] is *kai kohola* or just *kohola* (the shallow sea within the reef). The water on the *mauka*, or land, side of the *kohola* is called the *kai 'elemihi* [for the *'elemihi* crabs that are to be found there]; the *makai*, or seaward, side of the *kohola* is called the *kai haha papa'i* (the sea in which to feel for *papa'i* crabs). The mauka part is also called *kai kahekaheka* [because of the many small salt-collecting sea pools], or *kai ki'oki'o* [because water remains in the rocky basins after the tide goes down], or hapuna [for the puddles of standing water]. Seaward of this area are the *kai hele ku*, the sea for wading; the *papa he'e,* the octopus grounds; the *kai 'ohua*, feeding grounds of young fishes; and the *kai 'au kohana*, the sea for bathing naked.
>
> Then comes the *kai he'e nalu*, surf-riding sea, or *kua'au*, and the *po'ina nalu*, or *po'ina*, where the waves break. Just beyond this surf line is the area called *kua nalu*, back of the wave, or *kulana*, pitch and toss, and then the *kai kea*, white sea; or *kai lu'u,* sea for diving; or *kai paeaea*, sea for pole fishing. Outside of there are the areas of the *kai 'o leho* and *kai 'okilo he'e*, sea for octopus fishing; the *kai kaka uhu*, sea for netting *uhu*; the *kai ka'ili*, sea for fishing with hook and line; and the *kai lawai'a,* sea for [deep sea] fishing
>
> Just before the sea becomes very dark is the *kai lu he'e*, the sea in which to catch octopuses with lures, and where the sea is very dark blue is the *kai malolo* and *kai hi aku*, the sea in which to fish for *malolo* and *aku*. Outside of there are the *ko'a hi kahala* and *ko'a hi 'ahi*, the fishing grounds, *ko'a*, for *kahala* and *'ahi*. Beyond is the ocean, *moana*, called *lepo* or *lewa* or *lipo*—the dark blue-purple sea of Kane, *kai popolohua mea a Kane*—that extends to the clouds on the horizon [Kamakau 1976:26–27].

Native Hawaiian historian David Malo defined numerous Hawaiian terms for the physical characteristics of the *kai*. In the list below, Malo notes that *kai kohala* describes the area of reef at Waikīkī:

> 1. The ancients applied the name kai to the ocean and all its parts. That strip of the beach over which the waves ran after they had broken was called *a'e-kai*.
> 2. A little further out where the waves break was called *poi'na-kai* [*po'ina kai*]. The name *pue-one* was likewise applied to this place. But the same expressions were not used of places where shoal water extended to a great distance, and which were called *kai-kohala* (such as largely prevail for instance at Waikiki).
> 3. Outside of the *poi-na-kai* lay a belt called the *kai-hele-ku*, or *kai-papau*, that is, water in which one could stand, shoal water. Another name given it was *kai-ohua*.
> 4. Beyond this lies a belt called *kua-au* where the shoal water ended; and outside of the *kua-au* was a belt called *kai-au*, *ho-au*, *kai-o-kilo-hee*, that is, swimming deep or sea for spearing squid,

[1] *Leho* is a cowry shell lure for catching octopus.
[2] *Okilo* means to search for or look for, such as looking into the water for squid, octopus, or fish.

or *kai-hee-nalu*. That is, a surf-swimming region. Another name still for this belt was *kai kohola*.

5. Outside of this was a belt called *kai-uli*, blue sea, squid-fishing sea *kai-lu-hee*, or sea-of-the flying-fish, *kai-malol*o, or sea-of-the *opelu*, *kai-opelu*.
6. Beyond this lies a belt called *kai-hi-aku*, sea for trolling the *aku*, and outside of this lay a belt called *kai-kohola*, where swim the whales, monsters of the sea; beyond this lay the deep ocean, *moana*, which was variously termed *waho-lilo*, far out to sea, or *lepo,* under ground, or *lewa* floating, or *lipo*, blue-black, which reaches *Kahiki-moe*, the utmost bounds of the ocean.
7. When the sea is tossed into billows they are termed *ale*. The breakers which roll in are termed *nalu*. The currents that move through the ocean are called *au* or *wili-au*.
8. Portions of the sea that enter into recesses of the land are *kai-hee-nalu*, that is a surf-swimming region. Another name still *kai-o-kilo-hee*, that is swimming deep, or sea for spearing squid, or called *kai-kuono*; that belt of shoal where the breakers curl is called *pu-ao*; another name for it is *ko-aka.*
9. A blow-hole where the ocean spouts up through a hole in the rocks is called a *puhi* (to blow). A place where the ocean is sucked with force down through a cavity in the rocks is called a *mimili,* whirlpool; it is also called a *mimiki* or an *aaka.*
10. The rising of the ocean-tide is called by such names as *ka-pii*, rising sea, *kai-nui,* big sea, *kai-piha*, full sea, and *kai-apo*, surrounding sea.
11. When the tide remains stationary, neither rising nor falling, it is called *kai-ku*, standing sea; when it ebbs it is called *kai-moku,* the parted sea, or *kai-emi*, ebbing sea, or *kai-hoi,* retiring sea, or *kai-make*, defeated sea.
12. A violent, raging surf is called *kai-koo*. When the surf beats violently against a sharp point of land, that is a cape, *lae*, it is termed *kai-ina-ka-ka-lae*.
13. A calm in the ocean is termed a *lai* or *a malino* or a *pa-e-a-e-a* or *a pohu* [Malo 1903:25–26]

Ka Lawai‘a

Ka lawai‘a (fishing) is the dominant theme in *mo‘olelo* related to Waikīkī. In a line from the *Chant for Kūali‘i* it is said (Fornander 1917:394–400): *He kai hului ko Kālia*, which translates as “A sea for fishing with a drawnet is the sea of Kālia” (Pukui 1983:74). Also speaking of fishing nets is the proverb*: Ka i‘a pīkoi kānaka o Kālia; he kānaka ka pīkoi, he kānaka ka pōhaku*. This translates as: “The fish caught by the men of Kālia; men are the floaters, men are the sinkers” (Pukui 1983:150). According to Pukui (1983:150), this saying describes how *‘anae* (mullet) were caught at Kālia:

> In ancient days when a school of mullet appeared at Kalia a bag net was set and the men swam around it in a row and surrounded the fish. Then the men would slap the water together and kick their feet, driving the frightened fish into the opening of their bag net. Thus the fishermen of Kālia became known as human fishnets [Pukui 1983:150].

Kālia is mentioned in *Ka makini kā‘ili aloha o Kīpahulu*, or “The love snatching wind of Kīpahulu.” The following excerpt from the story tells of how a woman fishing in Kālia finds an enchanted container in the sea:

> A woman of Kīpuhulu, Maui, listened to the entreaties of a man from O‘ahu and left her husband and children to go with him to his home island. Her husband missed her very much and grieved. He mentioned his grief to a *kahuna* skilled in *hana aloha* sorcery, who told the man to find a container with a lid. The man was told to talk into it, telling of his love for his wife. Then the *kahuna* uttered the incantation into the container, closed it, and hurled it into the sea. The wife was fishing one morning at Kālia, O‘ahu, when she saw the container floating in on a wave. She picked it up and opened it, whereupon a great longing possessed her to go home. She walked until she found a canoe to take her to Maui [Pukui 1983:158].

In 1902, an article on fishing by Judge Daniel Kahāʻulelio of the Lāhainā area was published in *Nupepa Kuakoa*. He described a fishing method previously practiced by his *ʻohana* (family) in which a large quantity *iheihe* (half-beak; *Euleptorhamphus longirostris* and others), *puhikiʻi* (any species of young flying fish), and *mālolo* (flying fish; *Parexocoetus brachypterus* and others) were caught and sold at an excellent price. *Puhikiʻi* was a favorite fish for eating raw and with *līpoa*. So was *mālolo*, although it was sometimes cooked in *kī* (ti, *Cordyline terminalis*) leaves (Titcomb 1972:104). *Iheihe* was often broiled in *kī* leaves (Titcomb 1972:83). When Kahāʻulelio first visited Honolulu in 1848, he observed the same method of fishing at Waikīkī every year he traveled there for work. The technique required many hands to work up to fifty *hano* or *hano mālolo* (a type of net) from several canoes:

> When the canoes returned, they formed into a semicircle and the two end canoes directed the formation. Those on the inside canoes were ever watchful. The men on the outer canoes stood up and so did the head fisherman as he shouted the commands continuously. Thus did he shout, "Swing wide with your net, you in the center. You in that end lift it up." That was how the malolo were drawn in. When the semi-circle of canoes narrowed in close to the bag net, some of the canoes have moved on the left away from the rest. Then the swiftest of the canoes hurried to the edge of the net. That was the time when the puhikii and iheihe were drawn in by the side nets. When the edge of the bagnet was quietly lifted to see inside, it was thick with iheihe and puhikii. This was called a makahei. The fisherman kept a close watch lest the fish notice them and then there would be none to catch but the lifting of the net was an exciting occasion. If there was luck, one, two or three hauls filled a canoe. The fish was divided at sea; all one did was to take his catch ashore [Kahāʻulelio 1902:37].

Emma Kaʻilikapuolono Metcalf Beckley Nakuina, a Hawaiian judge, cultural historian, and writer, also described this method of fishing:

> The "hano" is a large bag net of very fine mesh, with a flaring mouth, used to capture flyingfish. There are two varieties of flying-fish here, entirely distinct from each other. The same net and method of capture is also employed for the "iheihe," a long thin fish, usually 1 ½ feet in length, with a very sharp-pointed snout, that generally arrives here at about the same time as the large flying-fish. . .
>
> For catching the large flying-fish the "hano" is piled on a double canoe or large single one, and a start is made early in the morning with an attending fleet of from twenty to forty canoes. Women very often go in this kind of fishing to help paddle the canoes, as no particular skill is called for on the part of the general hands, the success of the fishing depending altogether on the good judgment and sight of the lookout. This person is generally on a light canoe manned by only two or three hands, and he is standing up always on the cross-ties of the canoe looking for the fish. Whenever he discerns a strong ripple, he points it out to the rest of the canoes, who then surround the spot indicated while he confers with the head fishermen about the best place to drop the net, *kuʻuna* which depends upon which way the current sets. When the net is all ready the canoe paddles very quickly in towards it, splashing the water and driving the fish before them into the open net. [Beckley 1883:254].

Umu

Although the current project area is much farther offshore, it shares similarities with the traditional Hawaiian *umu*, also known as *imu* or *unu. Umu* were artificial fish shelters or reefs that functioned as fish aggregating devices. Dr. Kekuewa Kikiloi provides a description:

> [They were] common features along shorelines that helped provide protection and regulated the growth and reproduction of inshore fish species … These fish shelters were artificial reefs made of rock or coral piles with enough space between the rubble to allow for algal growth on the surfaces (Kikuchi 1973:78). These stones functioned in the same way that naturally occurring rock outcroppings and coral reef habitats do, by providing a hard substrate necessary for the basic formation of reef bottom communities. Besides providing stability and some protection from predators, these shelters also helped to regulate fish growth and potentially increase fish stocks by serving as artificial homes for fish to congregate and reproduce [Kikiloi 2003:5–6].

Fish most often attracted to *umu* were *u'u* (*Myripristis* spp.; squirrelfish), *kala* (*Naso unicornis;* unicornfish), *manini* (*Acanthurus triostegus;* surgeonfish), *moano* (*Parupeneus multifasciatus;* goatfish), *kahala* (*Seriola dumerili;* greater amberjack), *uhu* (*Scarus* spp.; parrotfish), and *puhi* (*Muraenidae*; eels) Kikiloi 2003:6]. Margaret Titcomb, a librarian at the Bishop Museum in the mid-1900s, described underwater chambers constructed to attract and trap *uhu*. They were 8.0 square feet and built in water 1.5 to 5.0 feet deep along narrow reef channels. They were maintained, or "weeded," to only contain seaweeds edible to the *uhu.* One entrance was on the side where *uhu* could file through. Titcomb described how the method worked: "When the season came—May, June and July—the outer gate was opened, allowing the leader to come in with his followers. The gate was then shut and the other gate opened as soon as enough uhu had been taken for use. Many schools of uhu come during a season, so this trap could be used many times" (Titcomb 1972:149).

Kamakau used the term *unu* as one of three types of fishing shrines:

> In his fifth year Liholiho was declared Kamehameha's successor and was taught to observe the tabu of the *heiau* and the *waihau*[3], instructed in erecting the *unu, ku'ula,* and *ko'a* shrines, in observing the tabu of the *loulu* ceremony in the heiau, the offering of the ivory tooth, and the different types of prayers and offerings" [Kamakau 1992:221].

The three different terms for these artificial fish shelters may have been due to regional differences in terminology or whether they were placed in freshwater or saltwater. Titcomb's information came from William Watson of Kāne'ohe and named the chambers "ahu," the gates "ohi'a," and the channels "ku'una*"* (Titcomb 1972:149). Other terms used when discussing *umu* are listed in Table 2.

Table 2. Hawaiian Terms Related to *Umu*.

TERM	DEFINITION	SOURCE
ahu	A traplike stone enclosure made by fishermen for fish to enter.	Pukui and Elbert 1986
'eho	Stone pile . . . especially as used to mark land boundaries; stone image; heap of stones under water (at times fishermen block one end with a net and drive the fish in from the other end), also *umu*, *imu*	Elbert 1959; Pukui and Elbert 1986
Imu	Rock and coral fish trap; the fisherman might insert a branch into an opening at one side to frighten the fish into a surrounding net. Also *ahu*, *umu*.	Pukui and Elbert 1986
hinakea	Type of stone laid near the coral pile (*umu*) to attract fish; it was flat on one side and rounded on the other, and was believed to attract manini and young of other fish which resembled it in color. Lit., white gray.	Pukui and Elbert 1986
lau 'ōpae	Shrimp net, about a fathom long, placed around a heap of rocks called *ahu* or *imu* (fish and shrimp were prodded and frightened from the rock pile into the net); this type of fishing.	Pukui and Elbert 1986
umu	A heap of rocks placed in the sea for small fish such as the manini to hide in: this was surrounded by a net and the fish were caught. More commonly called *imu*. *ho'o.umu* To make an *umu*; to pile in a heap.	Pukui and Elbert 1986
unu	Small stone, pebble, stone chip… *ho'o.unu* To place stones; to pave, macadamize.	Pukui and Elbert 1986

[3] A *heiau* where hogs, bananas, and coconuts were sacrificed, but not human beings; a *heiau* for *mo'o* spirits (Pukui and Elbert 1986).

These terms are also found in Mahele land claim descriptions from the mid-1800s. In defining the boundary between Mapulehu and Kaluaʻaha on Molokaʻi, an *imu* in the sea is mentioned in three Native Testimonies. Quotations below highlight the reference to *imu* in bold, followed by the original Hawaiian text in brackets:

> Aikake Lui (Isaac Lewis) Claim 3218, Mapulehu, Molokai
>
> Timoteo Keaweiui sworn: Work on Niaupala loko was done by the government at the time Liholiho went to Britain, and it has been secured to this day, and it is in the hands of the government. I have seen the opening of Huaea, and I have heard about it as follows. It is the boundary of Kaluaaha and Mapulehu. It runs from Hueea to the uplands to Kihele which is small point, then lying to the **imu of Kanealai. This is a large and long imu from one water hole to the other** [*ka imu ia o Kanealai, he imu nui keia loihi, mai keia kahawai a kela kahawai*] and just mauka of this area *is* the maika grounds.
>
> Pulehu sworn: Huaea is the boundary makai separating Mapulehu and Kaluaaha, from there to the house of Puhikea, then it comes back to Kahaluukou and Kuunalei and to this lower end. The sea is for Kaluaaha, the land for Mapulehu to the **imu of Kanealii** [*imu o Kanealii*], from there to below toward this way and running directly to the adobe which Timoteo has just mentioned. I have not known that this loko is for any other land.
>
> Ku sworn: I have seen the boundary of Mapulehu and Pukoo 3. Kepemanu is a rocky hill mauka of the government road, the boundary runs to the sea east of the **coral imu** [*imu puna*] to the beach, that is Pukoo. Mauka is the sea of Mapulehu [Avakonohiki 2025a,b].Claims also mentioned *umu ʻōhua* (stone mound fry fishery):
>
> 7702 Kooka at Kealia, Kona, Hawaii. An **umu ohua**
>
> 8758 Kaiolani at Ninole, Kau, Hawaii. An **umu ohua**
>
> 10510 Nawali at Ninole, Kau, Hawaii. An **umu ohua** [Maly and Maly 2003b].

Claims using the term *unu* were associated with *ʻoʻopu* (freshwater goby) fisheries:

> 11108 Kulu at Waipio, Hawaii. An **unu** (stone mound) for a fresh water oopu fishery.
>
> 11105 Naailuhi at Waipio, Hawaii. An **unu** (stone mound) for a fresh water oopu fishery
>
> 4696 Laauohala at Puueo, Hilo, Hawaii. "…an **unu oopu** (stone mound fishery) made by my own hands" [Maly and Maly 2003b].

In 1902, Hawaiian fishing expert Kahāʻulelio described using *lau ʻōhua liko*, a seine made of *kī lau* (ti leaves), to catch *ʻōhua liko* (manini fry) at *umu.* Around Lāhainā, where he was from, the term *ahu* was employed, while in Hāna they used the term *umu*:

> Lau Ohualiko—It is the same as the Lau-opae and is about a fathom in length. It was used for fishing around the ahu or imu as the people of Hana call it. We use the term ahu. In it are found the opae or shrimps and other small fish that could be quickly caught and eaten for breakfast. On a morning when the tide is low then the net that is fine meshed is used or mosquito netting can be used instead. The net is put around (the ahu) as far as the kuku or bracing sticks of the net, then the stones of the ahu are removed until there is none left. You will see the bag in the net well filled. With three stone ahus, one could fill a pail such as are bought in stores. Even small lobsters, that are very good eating are caught in this way [Maly and Maly 2003b:115].

Due to the scarcity of primary-source information on *umu*, similar practices in Oceania may offer more insight into the use of *imu*. This was noted by Kikiloi in his 2003 article on aquaculture in pre-Contact Oceania. He cited the *ulung* (piled-rock traps) used in Yap, which were described in a 1981 article by Dr. Roslind Hunter Anderson. Dr. Hunter-Anderson was not able to document an *ulung* firsthand but gathered information from a local informant. In her article, the description and *ulung* illustration, shown below in Figure 6, are similar to Hawaiian *umu*. The following is Dr. Hunter-Anderson's discussion of *ulung* in Yap:

Mueller described the piled-rock trap *(ulung)* as an adjunct to a combination fishing method using an anchored net covering the pile of rocks and attached to a basket with net tubing . . . I was not able to observe directly the use of *ulung,* but informants described the operation somewhat differently than Mueller. This may reflect differing practices due to varying local conditions within Yap's lagoon; Mueller observed *ulung* use in Gachpar, Gagil, while my information comes from northeastern Map.

Contemporary use of *ulung* is rare. One built in Map a few years ago involved the skillful piling of coral and stone to create openings in which reef fish could take refuge during low tides but which still allowed the fisherman to spear them readily. Ideally, the piled rock traps were located in coral-free areas in mid-lagoon, where there were no other places for fish to retreat to. Spearing rather than using nets and baskets was indicated by Map residents.

Prehistoric use of piled-rock traps in Map's northeastern lagoon was reportedly extensive. Although no clear forms can be discerned today, some rubble is present in this area and may represent former *ulung.* This area now has large patches of living coral which have completely overgrown and obscured several stone traps within the last 30 years or so. It is said that when *ulung* were built, the lagoon was clear of live coral, already taken for building house foundations and other construction.

The lagoon where *ulung* were built was partitioned into family plots, each with three or four of these traps. A family would own or gain permission to build them on a plot, harvesting the traps at will. Access to these traps was controlled, and infringements by nonowners could result in the loss of the trespasser's land or similar severe sanction. No data exist on *ulung* yields fished with spears, but they were likely to have been relatively small. In Map, taking of fish from one of these traps seems to have been limited to one fisherman at a time for the use of his family. This use contrasts with the anchored net and basket technique described by Mueller. In that case, several men were involved, and the catch was brought to the village (Gachpar) for division [Hunter-Anderson 1981:86–87].

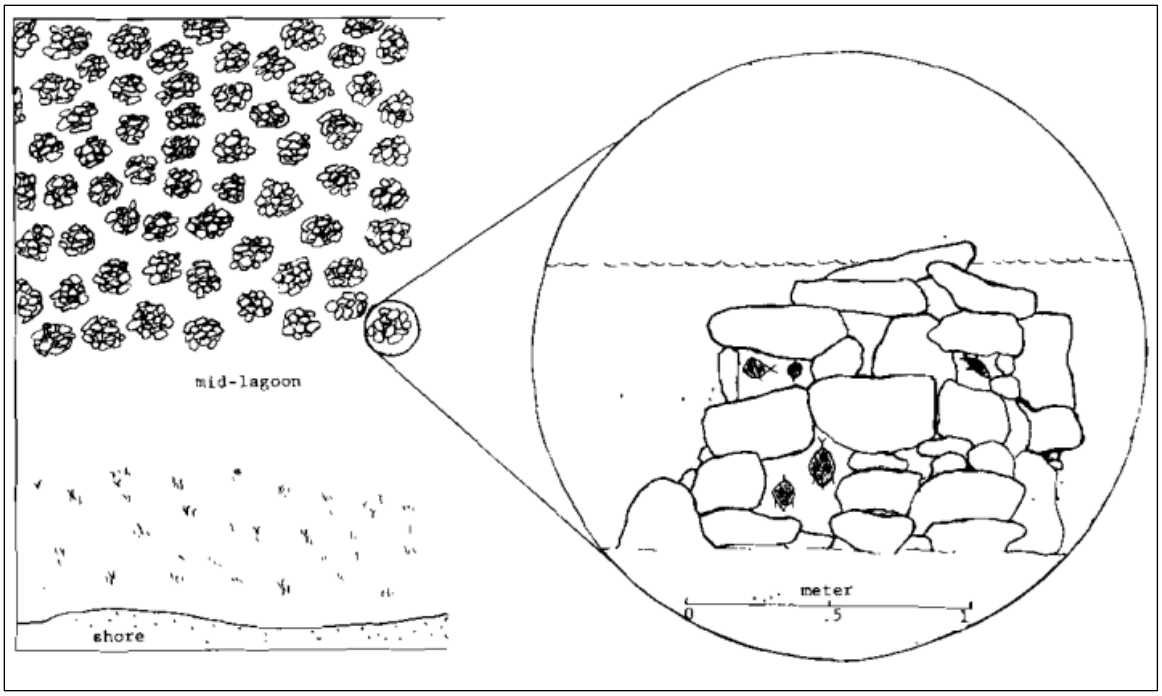


Figure 6. Illustration of Ulung from Yap, Similar to Umu used in Hawai‘i (Hunter-Andersen 1981: Figure 4).

The term *imu* also appears in *Kaao Hooniua Puuwai no Ka-Miki* (*The Heart-Stirring Legend For Kamiki*), which was published in *Ka Hoku o Hawaii* between 1914 and 1917. In the *moʻolelo*, Kamiki (The quick, or adept, one) and his brother Makaʻiole (Rat [squinting] eyes) journey all around the island of Hawaiʻi. While traveling south on the leeward side of the island, they are warned of a family of fierce *ʻōhole*[4] who waylaid travelers as they passed through their residential compound, which spanned both sides of the trail. They kept an *imu* hot and ready to bake any traveler who lost a competition to them. The victims' bones were fashioned into fishhooks (Maly and Maly 2003:15). To each warning, the brothers replied that they were well trained in *ʻōhole* practices and their purpose was to track down such people (Maly and Maly 2003:15).

> Ka-Miki and Makaʻiole arrived at the compound of Omokaʻa and Okoe *mā*, and indeed the famed *imu* in which they baked their victims glowed red hot with its fire. Omokaʻa sat on the *mauka* side and Okoe on the *makai* side of the *imu*, and upon seeing Ka-Miki *mā* they both reached for their tripping clubs. The four competitors exchanged taunts and riddles. And Ka-Miki warned the couple that they would be the ones baked in their own *imu*. Seeing that Ka-Miki *mā* were versed in riddling, Omokaʻa and Okoe started their efforts at defeating Ka-Miki *mā*, in hopes of baking them in the *imu* [Maly and Maly 2003:16].

Okoe challenged Kamiki to solve several riddles, one of which includes the multiple interpretations of *imu*:

> *Aia la! Aia hoʻi! Kuʻu imu aʻohe ahi, kuʻu imu uwahi ʻole, kuʻu imu hoʻokāhi no pōhaku, kuʻu imu ʻelua no peʻa kauwawe, kuʻu imu e ...*
>
> *Behold, behold indeed!* ***My imu has no fire****, no smoke, my imu has one stone, and two ti leaf bundle covers, yet it is my imu...*[Maly and Maly 2003:17].

Kamiki responded to Okoe correctly, winning the contest:

> ***He imu manini ko kai, aʻohe ahi pau no naʻe ka manini i ka ʻai ʻia.*** *He imu maiʻa ko uka ua* moʻa *pala kupule iloko o ka lua, aʻohe ahi pau no naʻe i ka ʻai ʻia…*
>
> **The rock mound an imu for the manini in the sea, has no fire, yet it is consumed.** The smokeless imu is in the uplands, is an over ripened banana, and it too is consumed... [Maly and Maly 2003:17].

Similar to an *umu* is a pebble ridge described in the *moʻolelo* of ʻAiʻai, as told by Moke Manu and translated by S. N. Emerson. In the following excerpt, ʻAiʻai builds a resting place for *aweoweo* with pebbles:

> Aiai's good work did not stop at this point, but proceeding to Honomaele he picked up three pebbles at the shore and going into the sea, out beyond the breaking surf, he placed them there. In due time these three pebbles gathered others together and made a regular ridge, and when this was accomplished the aweoweo gathered from the far ocean to this ridge of pebbles for rest, whereupon all the people came with nets, hook, and line and caught them as they desired. The writer witnessed this in 1845 with his own eyes. This koʻa for aweoweo is still there but difficult to locate from the fact that all the old residents are gone; either dead or moved away [Manu 1901:116].

Limu

Traditionally, numerous types of *limu* were gathered at Waikīkī for food, medicine, and spiritual practices. In the shallow waters off the coast, a map dated 1825 is labeled, "Reef dry at low water, and is then covered with the Natives in search of shellfish etc." (Malden 1825). This would have included multiple types of *limu*. Reed described the ubiquity of *limu* in 1907:

[4] Experts skilled in fighting or in other competitions, such as running, fishing, debating, or solving riddles, that were practiced by the ancient Hawaiians (Maly and Maly 2003:15).

> Nearly all the limu is sold in the market by native women, who have other Hawaiian delicacies, as sea urchins, roasted kukui nuts, crabs, cocoanut pudding, small cubes of raw beef liver, ready to serve with limu, etc. The amount of limu sold in Honolulu does not, of course, include nearly all that is actually consumed either on these islands, on Oahu, or even in Honolulu, as every native family living on or near the beach gets its own supply of algae fresh from the sea whenever it is desired [Reed 1907:74–75].

Queen Liliʻuokalani owned the Hamohamo fishery located on the front of her property at this time. In 1906, a notice ran in Hawaiian newspapers prohibiting anyone from taking *limu pakaeleawaʻa*[5] or *limu huluhuluwaena*[6] (*Grateloupia filicina)*, *ʻopihi (Cellana sp.), pūpū ālealea (Turbo sandwicensis), ʻina (Echinometra sp.), hāʻueʻue* (slate pencil sea urchin, *Heterocentrotus mammillatus),* and *pipipi (Nerita picea)* from the shores of Hamohamo, which belonged to Queen Liliʻuokalani. She propagated limu by transplanting samples collected from locations across all the main islands.

> HOOLAHA HOOKAPU. Ke hoike ia aku nei ka lohe i na mea apau, e hele nei ka auau kai, a lawaia paha ma ke kai o Hamohamo, ma Waikiki-kai, Honolulu, Oahu, ke hookapu nei ka Moiwahine Liliuokalani aole e kii i ka Limu Pakaeleawaa, me ka Limu Huluhuluwaena, Opihi, Pupualealea, I-na, Haueue, ame Pipipi, ma ke alo ponoi iho o ka Pa Alii. Na kona mau lima alii ponoi no i kanu a hookawowo i kela mau mea apau i hoike ia ae la maluna, a o ka mea e kii ana i keia mau mea e hookapu ia nei, e hopu ia no oia, a hoopai ia e ke kanawai. O keia mau mea apau i kanu ia e ka Moiwahine mai Hilo i lawe ia mai ai kekahi no Lahaina kekahi, no Molokai kekahi, no Kauai kekahi, no Waialua, Oahu nei, kekahi [Carter 1906].
>
> NOTICE OF PROHIBITION Public notice is given to all who swim or fish in the ocean at Hamohamo, Waikīkīkai, Honolulu, Oʻahu. Her Royal Highness Liliʻuokalani has prohibited the gathering of Limu Pakaeleawaa, as well as Limu Huluhuluwaena, ʻOpihi, Pūpū Ālealea, ʻIna, Hāʻueʻue, and Pipipi in the area immediately in front of the Royal Grounds. Her own royal hands planted and cultivated all of these creatures identified above, and anyone who gathers these things currently placed under prohibition will be arrested and charged according to the law. All of these creatures were established here by Her Majesty. Some were from Hilo, others were brought here from Lāhaina, others from Molokaʻi, some from Kauaʻi, others were from Waialua, here on Oʻahu as well [Gomes 2024:48].

Minnie Reed, a teacher at Kamehameha Schools, published her study of limu in 1907. She noted that transplanting *limu* was an ancient practice:

> There are. . . several places where a certain favorite limu has been transplanted from other islands and guarded carefully until it could get established. Limu pakaeleawaa was transplanted from Hawaii to Molokai by an old chief, who planted it on the inner edge of his fish pond, where it is now growing luxuriantly. This same limu has also been transplanted to the beach in front of the residence of ex-Queen Liliʻuokalani, near Diamond Head, and also in front of her Waikiki place. It is thriving in both places, so the writer has been told.
>
> . . . There may have been more attempts at cultivating or transplanting seaweeds by the natives of the past, for no doubt when a chief moved from one island to another, he brought with him his best taro and yam plants for his lands; why not his favorite limus to his fish ponds or beach? [Reed 1907:73].

Manō

In ancient times, the *manō kumupaʻa* (ancestral sharks) Kanehunamoku and Kamohoaliʻi, declared a *kānāwai* (law) on Oʻahu that made it *kapu* (taboo) for any shark there to bite people (Kamakau 1964:73).

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[5] "*Limu huluhuluwaena* is the native name for *Grateloupia filicina*, generally used on the island of Hawaii and in frequent use on Kauai and Oahu, while *limu pakaeleawaa* is the name always used on Kauai and in common use on Molokai, Maui, and Oahu" (Reed 1907:64, footnote b).

[6] Bushy, pyramidal plants with flattened stems and fine branches in one plane. Grows as small groups on rocks covered with fine sand. After washing, plants are usually finely chopped and lightly salted. Eaten with raw liver, raw fish; added to cooked beef at serving time; or eaten with dried or broiled *heʻe* (octopus) (Reed 1907:65).

According to Kamakau, this held true until more recent times, except for ʻUnihokahi (One-toothed), an *akua manō* (shark god) who had only one tooth. One of the Oʻahu places he swam was in the waters off Kahaloa [beach at today's Royal Hawaiian Hotel] in Waikīkī:

> *Malihini* [foreigners] may be skeptical that he had only one tooth, but this was known to everybody. We all know that sharks have rows and rows of teeth, but this shark, called ʻUnihokahi (One-toothed), had but one tooth. He was known to Peleioholani, Kahekili, and Kamehameha I. When the chiefs went surfing at Kapua in Waikiki, if a man was bitten by this particular shark that left a single toothmark, it was a warning that an enemy of the sea was approaching. Chiefs and people went hurriedly to shore; it would not do to hesitate, for soon the dorsal fin and side fins of an approaching shark would be visible [Kamakau 1964:73].

At Waikīkī, *akua mano* protected the ocean from the *malihini* (foreign) sharks looking to eat humans. Kamakau tells of a *malihini* shark that was caught at Kapua (the vicinity of today's Outrigger Canoe Club) in 1834:

> In 1834, during the time of Kaomi, a *malihini* shark came to Waikiki in search of food. When he reached Kaʻalawai and Kaluaahole, he was refused by the guardian sharks of that place (*ka poʻe kamaʻaina kiaʻi o ia wahi*) and then he came to Kapua, where the guardians of Waikiki were, and argued with them. They decided to kill him and to leave visible proof of it, so they forced his head into a cleft in the rocks at Kukaʻiunahi, *makai* of Kupalaha. It could not get free, and there it was with its tail—two or more *anana* in length—flapping in the air, and a little companion shark swimming around it. If this had been done by men it would have been impossible to hold it fast without tying it with ropes, but as it was done by those whom men had made into supernatural beings, the shark was made fast without ropes. When this wondrous sight was seen, men ran with ropes and tied them to the tail and dragged the shark ashore, still alive, with its eyes blinking and its body turning from side to side. It died from being dragged here and there, and by the time they reached Honolulu it was all flabby [Kamakau 1964:74].

Heʻe Nalu, Pākākā Nalu, and Kaha Nalu

Waikīkī has always been known for surfing. This includes *heʻe nalu* (board surfing), *pākākā nalu* (outrigger canoe surfing), and *kaha nalu* (body surfing). The *kai heʻe nalu* (surf-riding sea) at Waikīkī was one reason *aliʻi* found it an attractive place to live (Handy and Handy 1991:268). This is stated by Kamakau, along with the names of the surf spots at Waikīkī:

> Waikīkī sits proudly in the calm of the Kaʻao breeze… Waikīkī was a land beloved of the chiefs and there many of them lived from remote times to the time of board surfing could be indulged in there, and for this reason the chiefs liked the place very much. At Waikīkī are the surfs of Ka-lehua-wehe, ʻAiwohi, Maihiwa, and Kapuna [Kamakau 1991:44].

ʻĪʻī wrote of *pākākā nalu* and mentions Kamerhameha I at Kapuni in Waikīkī:

> About canoe surfing. There are many ways to show skill in canoe surfing. The king [Kamehameha I] was especially noted for it, and so was his pupil, Gideon Laanui. They were often seen together gliding on the surf outside of Haleumiumiiole at Kawaihae and at Kapuni, outside of Kiikiiakoi. They would allow waves to go by until they saw the one they wished to glide on, then ride it to the spot where they chose to land. There are ways of selecting waves which will go all the way to shore, and the king and his pupil were unusually skillful at this. Such things were actually taught [ʻĪʻī 1959:135].

Kaha nalu was briefly mentioned as a footnote by Thrum in his translation of Fornander (1916):

> Surf riding has a wider range of sport than shown above for canoe surfing is also very generally practiced, and occasionally body surfing. This requires strong, expert swimmers to attain sufficient momentum to ride in on the surf without a board or other support. This, termed *kaha nalu*, is still practiced [Thrum 1916, Footnote 26 in Fornander 1916:206].

Kamakau (1991) wrote that the wives of ʻUmi enjoyed *kahu nalu*, and mentions "ʻUmi's skill in surf-riding," which implies this was the type of surfing ʻUmi competed in against Paiʻea, chief of

Laupāhoehoe. Malo (1951) also cited the race as *kaha nalu*. In contrast, Fornander used the term "*heenalu"* ("board-surfing") as the type of race they engaged in, but quotes ʻUmi as challenging Paiʻea to a race in "*kaha nalu"* ("surf riding"). The following account is from Kamakau's *Story of ʻUmi*:

> ʻUmi and his wives went sea bathing, surfing (*heʻe nalu*), riding on the surf (*kaha nalu*), and a certain chief of Laupahoehoe noticed ʻUmi's skill in surf-riding. His name was Paiʻea, and he knew all the surfs and the best one to ride. It was the one directly in front of Laupahoehoe, facing Hilo. It was a huge one which none dared to ride except Paiʻea, who was noted for his skill. Gambling on surfing was practiced in that locality. All of the inhabitants from Waipunalei to Kaʻula placed their wages on ʻUmi, and those of Laupahoehoe on Paiʻea. The two rode the surf, and while surfing Paiʻea noticed that ʻUmi was winning. As they drew near a rock, Paiʻea crowded him against it, skinning his side. ʻUmi was strong and pressed his foot against Paiʻea's chest and then landed ashore. ʻUmi won against Paiʻea, and because he crowded ʻUmi against the rock with the intention of killing him, Paiʻea was roasted in an imu (in later years) [Kamakau 1992:10–11].

There is a Hawaiian saying that refers to the most famous break at Waikīkī, Kalehuawehe (Take-off-the-kehua): *Ka nalu haʻi o Kalehuawehe* (The rolling surf of Kalehuawehe). The name is from *He Kaao no Pikoiakaalala: Ke Keiki Akamai i ka Pana,* published in a series from 1865 to 1866 in *Ka Nupepa Kuakoa*, as told by S.M. Kaui. Pīkoiakaʻalalā (Pikoi-son-of-the-crow) was a renowned rat shooter and the son of ʻAlalā and Koukou. The family were *kūpua* (beings with supernatural powers and multiple body-forms). In part three of the story, published in December 1865, Pīkoiakaʻalalā plans to travel from his home at Kahaloa in Mānoa, along with people from Kaapakahua, Kawailele, Puahia, Kānewai, Kamōʻiliʻili, and Kāmoku, to spend the day at Waikīkī (Kaui 1865).

Before leaving, he has his sister, Kauʻiomānoa, gather lehua flowers for lei. Kauʻiomānoa was the wife of Pāwaʻa, a Mānoa chief. She knew there were lehua at Kahoʻiwai, further inland. She gathers enough to make four lei: two for Pīkoiakaʻalalā's neck and two for his head.

At the beach, he sees Kahamaluʻihi and her *kuhu* out in the *kulana-nalu* (lineup). When she comes ashore, Pīkoiakaʻalalā asks to use her board, but that is *kapu*, and she offers the board belonging to her *kuhu*. Out in the ocean, he is warned that one side of *nalo o Kapuni* is reserved for the chieftess. But on the side that is not *kapu*, no waves were passing, so he paddled further out. Kahamaluʻihi followed him, and they both arrived at a place offshore from Kapua. Pīkoiakaʻalalā asked her why she was next to him when she had her own *kapu* wave. She replies that perhaps there were no waves on her side of *nalu o Kapuni*. They ended up in an unnamed spot that no one ever surfed. The chieftess admired Pīkoiakaʻalalā and asked to have one. He gave her one of his lehua lei, and that spot is now known as *nalo o Kalehuawehe*.

Pīkoiakaʻalalā said to the chieftess that she could have the first wave, and he would take the second. When the first wave came, she did not move. When the second wave came, he caught it, as did the chieftess, and they rode the same wave to shore. Chief Kakuhihewa saw the two together and ordered his men to kill the surfer riding with his wife as soon as he came to shore. On the beach, Pīkoiakaʻalalā resisted the arrest and asked to speak to Kakuhihewa before they killed him. He was taken to Helumoa where Kakuhihewa and Kahamaluʻihi lived. As Pīkoiakaʻalalā was speaking to the chief, Kahamaluʻihi's *kuhu* entered and recognized him as the famous rat-shooter boy who beat the high chief Mainele on Kulaokahua plain. To prove his identity, he again competed with Mainele, this time in the house at Helumoa. Pīkoiakaʻalalā won with his archery skills and solidified his reputation as a famous rat shooter.

Malo described *heʻe nalu* as the national sport of Hawaiians and mentioned betting on competitions, as Kamakau did in the *Story of ʻUmi* (see Kamakau 1992). The following is from Malo (1903):

> 1. Surf-riding was a national sport of the Hawaiians, on which they were very fond of betting, each man staking his property on the one he thought to be the most skillful.
> 2. When the bets were all put up, the surf-riders, taking their boards with them, swam out through the surf, till they had reached the waters outside of the surf. These surf-boards were made broad and flat, generally hewn out of koa; a narrower board, however, was made from the wood of the wiliwili.

3. One board would be a fathom in length, another two fathoms, and another four fathoms, or even longer.

4. The surf-riders, having reached the belt of water outside of the surf, the region where the rollers began to make head, awaited the incoming of a wave, in preparation for which they got their boards under way by paddling with their hands until such time as the swelling wave began to lift and urge them forward. Then they speeded for the shore until they came opposite to where was moored a buoy, which was called a *pua*.

5. If the combatants passed the line of this buoy together it was a dead heat; but if one went by it in advance of the other he was the victor.

6. *A i ka an hou ana, o ka mea i komo i ka pua hoomawaena wai oia, aole e hiki i ke kulana, o ka eo no ia nana; pela ka he'e nalu* [untranslated; perhaps, " In the next heat (to break a tie), the one who places second loses; that is surfing" [Malo 1903:293–294].

There is a *mo'olelo* that tells of the skilled surfer Keleanuinohoana'api'api (Kelea), the Great-Kelea-Who-Flutters, and how Waikīkī became her home. Kelea was the sister of the *mō'ī* of Maui, Kawaokaohele (Kamakau 1991:88). In addition to being extremely beautiful, she was an excellent surfer and often rode with the chiefs. Lō Lale, chief of Līhu'e, was in need of a wife and had sent men to find someone suitable. By canoe, they searched other islands and, at Hāna on Maui, learned of Kelea. Hearing of her beauty and how she surfed every morning, the men set off for Hāmākuapoko, Kelea's home. They spotted her surfing and approached her in their canoe. They convinced her to ride with them to shore, not knowing it was a "wife-snatching" canoe, *he wa'a kā'ili wahine* (Kamakau 1991:88). They rode the waves to shore twice and then vanished out to sea heading for Wai'alua on O'ahu.

After ten years of marriage and living in the uplands of Līhu'e, Kelea asked Lō Lale if she could visit the coast, and he granted permission. So, she traveled south with her companion toward the seashore. After the channels of Pu'uloa were in view, they went to Hālawa, and Kelea asked what else was before them to the east. One replied, "It is dense with *kou*[7] and coconut trees, and it is also a place where one may watch the chiefs enjoying surfing," which excited Kelea, and on they went to Waikīkī:

> They went along until they entered the coconut grove of Kawehewehe in Waikīkī. The kama'āina of the place saw this beautiful woman and welcomed her and shook down coconuts for the three to eat. They asked, "Where are you from? And where are you going?" "We have come from 'Ewa from the upland of Līhu'e because we wanted to go sightseeing. This is the most pleasant place we have seen." The *kama'āina* said, "This is a place for enjoyment. Over there is the *kou* grove of Kahaloa where one may view the surfing of the chiefs and of the *ali'i nui* Kalamakua."
>
> Joyful at the thought of surfing, Kelea said to her companions, "Let us go on." They entered the *kou* grove of Kahaloa and watched the chiefs surfing in. Kelea inquired of the *kama'āina,* "Is it possible to obtain a surfboard for the asking?" "Ka! Are you skilled at surfing?" "Who would not be if one had a board?" retorted Kelea. When the *kama'āina* heard these words, they were astonished; those of Līhu'e were accustomed to slicing *mo'okīlau*[8] ferns and *pōpolo*[9] stalks, but of surf riding these people knew nothing. The *kama'āina* thought that Kelea had been born at Līhu'e; they did not know she came from Maui.
>
> The *kama'āina* said that a surfboard could readily be obtained. So she asked them for a board, and perhaps because she was so beautiful a woman, someone gave her one. When she received it, she went to the edge of the sea and rubbed off the red dirt of 'Ewa from her feet so as to look fresh. When she had finished, she dipped into the sea, then jumped upon her board and paddled off like an expert. Those who were watching saw that she managed her board like one trained, moving along easily and noiselessly without the least heeling over.
>
> When Kelea reached the place where the surf broke, she left that place to the *kama'āina* and paddled on out to wait for a wave to rise. As she floated there, the first wave rose up but she did not take it,

[7] A tree, *Cordia subcordata*, much used by the early Hawaiians for cups, dishes, and calabashes (Kamakau 1991: 261).
[8] General name for ferns on a single stem (Kamakau 1991:262).
[9] The black nightshade, *Solanum nigrum*. In Hawai'i, young shoots and leaves may be eaten as greens (Kamakau 1991:264).

> nor did she take the second or third wave, but when the fourth wave swelled up, she caught it and rode it to shore. As she caught the wave, she showed herself unsurpassed in skill and grace. The chiefs and people who were watching burst out in cheering—the cheering rising and falling, rising and falling.
>
> While Kelea was surfing, the chief Kalamakua was working in his fields. When he heard those loud shouts he was startled and asked his men, "What is that shouting reverberating from the seashore?" "It is probably because of a skilled woman surfer," they answered. The chief remembered the chiefess of Maui, Kelea. He left off his work and went to stand on the shore to watch. As Kelea rode in on a wave, the *mōʻī* ran to the edge of the sea and stood there. When the chiefess reached the sand, he took hold of her board and asked, "Are you Kelea?" "Yes," she answered. She stood up, naked. The *mōʻī* removed his *kihei* shoulder covering and wrapped it around her as a *pāʻū* and took her to a *kapu* place. That was the beginning of her life as the *aliʻi wahine mōʻī* and she married (*hoʻāo mare*) the *mōʻī* Kalamakua [Kamakau 1991:90–91].

At the east end of Waikīkī is a surf break traditionally called Kapua (today known as Tongg's). In 1809, Kaʻahumanu surfed at Kapua to temper her anger after the execution of her lover, Kanihonui, a nephew of Kamehameha (ʻĪʻī 1959:51). She was planning to make war with Kamehameha and place young Liholiho on the throne. Liholiho, along with other chiefs and chiefesses, accompanied Kaʻahumanu on the holiday she proclaimed, when conditions for surfing were good at Kapua:

> It was where one could look up directly to the heiau on Leahi, where the remains of Kanihonui were, all prepared in the customary manner of that time. It was said that only Kaleiheana, who was a Luluka, watched over the corpse from the time of death until it was decomposed. The chiefess had heard something about her lover's remains being there, and perhaps that was why the proclamation was made.
>
> On the appointed day, chiefs, chiefesses, prominent people, and the young chief Liholiho went to Kapua. When all had assembled there, the king gathered his men together in readiness for trouble. He sent a messenger, Kinopu, after Kaahumanu's followers to find out what they were planning. It is said that three things were done at Kapua: surfing, lamenting, and more surfing; and it is said that they had intoxicants with them. Thus they whiled away the time until evening.
>
> Before the company returned to Honolulu, Kaahumanu, surrounded by the chiefs, kept crying and looking up at Leahi [ʻĪʻī 1959:51].

Traditional history suggests multiple *kapu* concerning surfing. These include *makaʻāinana* and *aliʻi* sharing waves and specific boards exclusive to *aliʻi*. The waves at Waikīkī can be very long, and are called *nalu ʻopuʻu,* which is described below:

> *Ka nalu ʻōpuʻu* is a long-period wave, one of great magnitude but not necessarily large by definition—this is groundswell, and the term *haʻi* references the shoaling process, when a wave gathers and breaks, thus turning over on itself. An *ʻōpuʻu* wave is best termed an open ocean wave that rolls in towards and spills over like a long-period wave at Waikīkī, a wave that breaks and spreads. That is not to say that this wave does not have the potential to be large, as these waves were also known to break at Waimea on the north shore of Oʻahu. With *kakala* and ʻōpuʻu, the key is the recognition of wavelength as affecting the characteristics of the wave, which we categorize today as short-period and long-period waves, respectively [Finney and Houston 1996:]

Another surf spot in Waikīkī was Kawehewehe, which was where Lunalilo surfed in 1886, according to a *Ka Nupepa Kuokoa*: "News from the Royal Court. The Prince W. C. Lunalilo is still enjoying himself in Waikīkī, spending a lot of time relaxing and surfing in the waves of Kawehewehe [*i ka heenalu mau i na nalu o ka wehewehe*], riding in a slide and returning to the curl" (Clark 2011:13). Photographs of surfing and canoeing at Waikīkī around 1900 are shown in Figure 7 and Figure 8.

Later in the year an article titled "A Kind Request" appeared, inviting military leaders to Lunalilo's home at ʻĀpuakēhau to watch surfing at Kāhala: "Last Saturday, His Highness ... W.C. Lunalilo, made a request to his military leaders to visit his home thatched with coconut fronds at Apuakehau to pass the time and to relax watching the surfers on the slippery waves at Kahala"(Clark 2011:126).

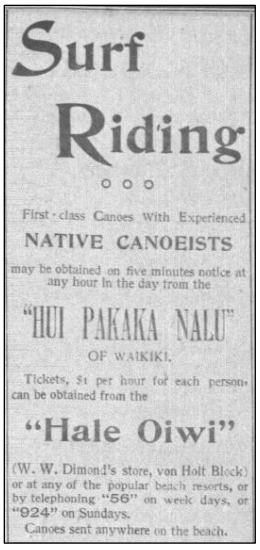
> Additional Waikīkī surfing references appear in newspaper articles in 1886 and 1887. In 1886, George Macfarlane hosted guests from San Francisco at his seaside home, which is depicted on the map in Figure 9: The Misses Hooker, Miss Nina Adams. Miss Grace Eldridge, Mr. Hooker, Mr. Knowles and Mr. Watson were entertained at Col. G.W. Macfarland's seaside residence on Wednesday afternoon at sea bathing and canoe riding on the surf. The novelty of the entertainment was most enjoyed by the distinguished strangers [PCA 1886:2].

In 1887, Lunalilo hosted Freemasons from Sacramento. Events included watching surf riding:

> On Saturday afternoon His Majesty the king gave a luau at his summer residence, Waikiki, in honor of Grand Master E.C. Atkinson and his visiting Masons. A large lanai had been erected on the grounds, the interior of which was tastily decorated. The Royal Hawaiian Band was present and discoursed sweet music throughout the afternoon. Soon after the guests arrived they went down to the beach and witnessed some surf-riding. This was followed by a luau [PCA 1887:2].

By the late 1800s, elite residences lined Waikīkī Beach, which included high-ranking Hawaiians and affluent white residents, as shown on the annotated map (see Figure 9). In 1897, a group of Hawaiians formed Hui Pākākā Nalu, a canoe surfing club in Waikīkī, and catered to tourists wishing to try the sport (Clark 2011:69). The manager of the club was W.W. Dimond, whose residence is shown on the map in Figure 9. The following is an article announcing the new beach concession and the accompanying advertisement:

> Hui Pakaka Nalu
>
> A number of Hawaiians living near the beach at Waikiki, and owning canoes, have formed a hui for the purpose of giving tourists and others a chance to enjoy it a surf ride. The men, who will paddle the canoes, are expert surf riders and anyone who can swim and is not afraid of a dipping in the briny deep can safely risk the experience of the peculiar sensation which a surf ride causes.
>
> Mr. W Dimond, who is one of our most celebrated canoe steerers, has kindly agreed to act as manager of the Hui Pakaka Nalu. Canoes can be obtained at all the bathing resorts at Waikiki, managed by "professionals." All the timid little girls and the bold mashers want to do is to dig $1.00 an hour for the pleasure of riding on the surf, and it is safe to predict that even the elderly "new woman" in the scientific "profession," will take a chance at riding on the foam-crested waves of the Pacific Ocean, under the guidance of the expert boat steers.
>
> And what tales will be unfolded when our tourists after their experience on the surf meet at the fireside in New England. We wish the Hui Pakaka Nulu all possible success and many bright dollars [PCA 1897:2].



Missionaries had scorned Hawaiian *he'e nalu* since their arrival before the Mahele, but the sport persisted in Hawaiian culture through the end of the century despite oppression (Finney and Houston 1966). Those who frequented Waikīkī waves in the 1890s included Princess Victoria Ka'iulani, niece of Queen Lili'uokalani, and her cousin, Prince Jonah Kūhiō Kalaniana'ole (Blake 1983:60; Walker 2008:94). After annexation, there was an increased interest by Hawaiian and new foreign residents in Waikīkī.

At this time, renowned surfer and swimmer Duke Kahanamoku, his siblings, and other Native Hawaiians frequented the waves at Waikīkī. In 1908, newcomer Alexander Hume Ford founded the exclusive Outrigger Canoe Club at the east end of the beach, and by 1915, had 1,200 members and a whites-only policy. In response to the blatant racism of the Outrigger cohort, the Hui Nalu surf club was formally organized in 1911[10] by William "Knute" Cottrell, Duke Kahanamoku, Kenneth Winter, Edward Kaleleihealani "Dudie" Miller, and other Hawaiians (Walker 2008:96). As Hui Nalu grew, elite Hawaiians joined, including Prince Jonah Kūhiō Kalaniana'ole.

[10] The group was informally organized in 1905 (Walker 2008:96).



Figure 7. West End of Waikīkī Beach in 1904 (HAS 2025).

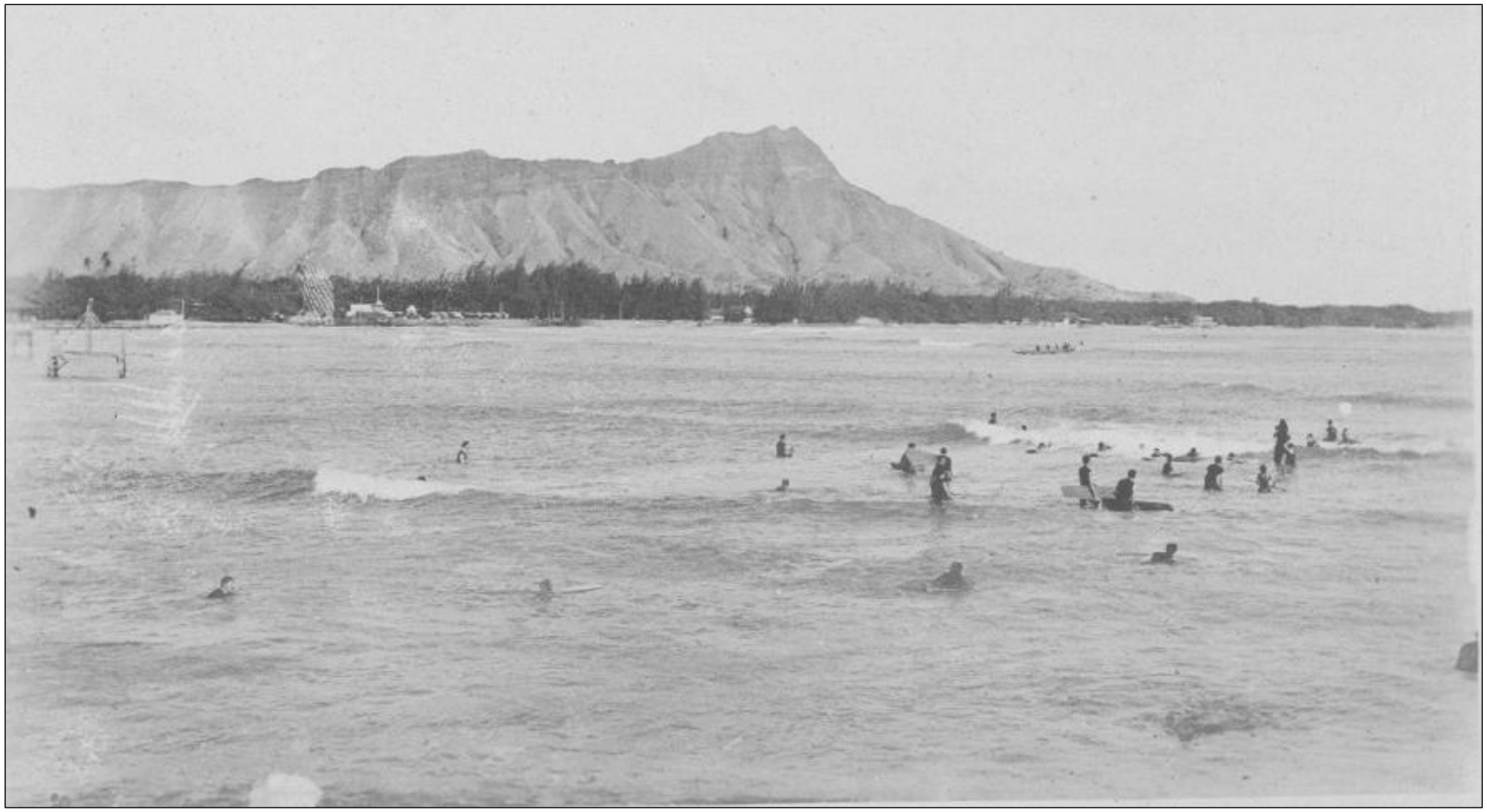


Figure 8. Surfers at Waikīkī in ca 1900 (UHM 2025d).

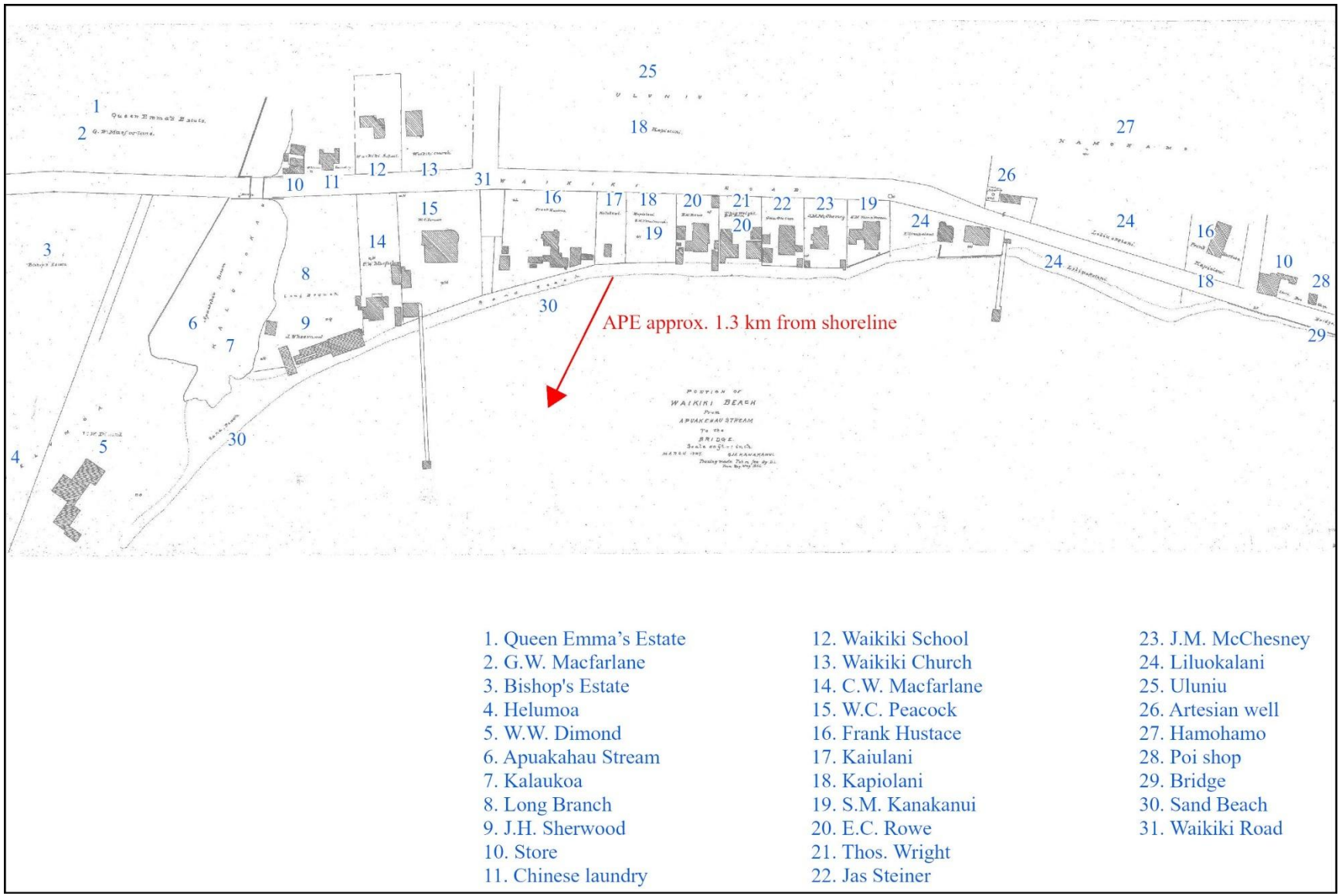


Figure 9. Residences, Businesses, and Place Names Circa 1897 (Kanakanui 1897). Blue and Red Text Added.

In 1915, Hui Nalu surfers opened their first concession stands and took jobs as lifeguards, bodyguards, instructors, entertainers, and tour guides for tourists in Waikīkī. They became known as Waikīkī beachboys and their work was profitable (Walker 2008:98). As poignantly stated by Isaiah Helekunihi Walker, surfer and Professor of History and Academic Vice-President at Brigham Young University-Hawai'i: "Rather than exploited laborers who commodified their own surfing culture, these Hawaiian surfers operated their own businesses in the 1920s and 1930s as historical agents who made a decent living in Waikīkī, often at the expense of haole" (Walker 2008:2005).

Wa'a

The first inhabitants of Hawaii migrated in *wa'a* (canoes), relying on navigation skills developed over centuries of wayfaring in their home islands of Oceania. These original *wa'a* were large, high-walled, double-hull (*wa'a kaulua*) canoes that could carry significant amounts of provisions, livestock, and personal belongings, as well as the new settlers. After arriving in Hawaii, *wa'a* designs were modified to optimize their use for fishing, shorter-range transportation, and recreation. The design and size of a canoe depended upon its intended use. Smaller *wa'a kaukahi* (single hull canoes) were used for fishing and for traveling around the island. Larger canoes were used for distant trips to other islands. Certain canoes were used in times of war. Others were used for sports and recreation.

Kahalaopuna

Kahalaopuna was the daughter of the twins Kahaukani (a name for Mānoa wind) and Kauakuahine (the name of a famous Mānoa rain), who were the children of Akaaka and Nalehuaakaaka in Mānoa Valley. When Kahalaopuna grew up, she lived in the valley with her attendants in a house at Kahaiamano on the road to Waiakekua. Her house was surrounded by a fence of *'au kī* (stalks of ti [*Cordyline terminalis*]), and there were *pūlo'ulo'u* (*kapu* sticks) on each side of the gate, which warned people that it was forbidden ground. She was extremely beautiful and "of a semi-supernatural descent" (Nakuina 1907:119). From a young age, she had been betrothed to Kauhi, a young chief of Kailua, whose family regularly sent her poi from their land and fish from Kawainui. People passing near her home would try to catch a glimpse of her. The wedding was drawing near, and not yet having seen Kahalaopuna in person, Kauhi went to Waikīkī on a day when the surf was good at Kalehuawehe. People had come from all parts of the island to surf. Kauhi overheard two men bragging about their affairs with Kahalaopuna. The men were "Kumauna and Keawaa, both of whom were disfigured by a contraction of the lower eyelids, and were known as *makahelei* (drawn eyes)" (Nakuina 1907:120). They falsely bragged of their "conquest of the famous beauty, representing the leis with which they were decked as love-gifts from Kahalaopuna" (Nakuina 1907:120). As the men continued talking about Kahalaopuna, Kauhi began to believe them and became enraged at her purported betrayal of him just prior to their marriage.

Determined to kill Kahalaopuna, Kauhi left Waikīkī and set out for his betrothed's house in Mānoa:

> He started for Manoa at dawn, and proceeded as far as Mahinauli, in mid-valley, where he rested under a hala (*Pandanus odoratissimus*) tree that grew in the grove of wiliwili (*Erythrina monosperma*). He sat there some time, brooding over the fancied injury to himself, and nursing his wrath. Upon resuming his walk he broke off and carried along with him a bunch of hala nuts. It was quite noon when he reached Kahaiamano and presented himself before the house of Kahalaopuna. The latter had just awakened from a sleep, and was lying on a pile of mats facing the door, thinking of going to the spring, her usual bathing-place, when she perceived a stranger at the door [Nakuina 1907:125].

Kahalaopuna recognized Kauhi from the descriptions people had told her. Trusting her betrothed, she agreed to follow him into the forest. After confronting her, he struck her with a heavy bunch of *hala* nuts (screw pine; *Pandanus odoratissimus*), which killed her. He buried her body nearby, and then he headed down the valley to Waikīkī.

A great *pueo* (owl), an *'aumākua* (ancestor spirit) of Kahalapuna's family, witnessed the murder and flew to the grave and unburied her. The *pueo* then breathed life back into her and healed her wounds.

Kauhi had not yet traveled far and realized Kahalaopuna was resurrected when he heard her singing a song of lament for his actions and saw the *pueo* overhead. Kauhi went back and, a second time, ordered her to follow him. When they reached the summit of the ridge separating Mānoa and Nu‘uanu, Kauhi again murdered her with a blow from a heavy bunch of *hala* nuts and buried her body. Again, the *pueo* resurrected her, and Kauhi heard her song. Once more, he ordered her to follow him and then led her into Nu‘uanu valley at Kaniakapupu, and then over to Waolani ridge, where he killed and buried her. She was resurrected again, and then a fourth time murdered and buried, this time in Kalihi.

On Kauhi’s fifth and last attempt to murder Kahalaopuna, he decided to thwart the *pueo* from resurrecting her:

> He this time took her across gulches, ravines, and plains, until they arrived at Pohakea, on the Ewa slope of the Kaala Mountains, where he killed her and buried her under a large *koa* (*Acacia koa*). The faithful owl tried to scrape the dirt away, so as to get at the body of the girl, but his claws became entangled in the numerous roots and rootlets which Kauhi had been careful not to cut away. The more the owl scratched, the more deeply tangled he got, and, finally, with bruised claws and ruffled feathers, he had to give up the idea of rescuing the girl; and perhaps he thought it useless, as she would be sure to make her resurrection known to Kauhi. So the owl left, and followed Kauhi on his return to Waikiki [Nakuina 1907:125].

However, an *‘elepaio* (a monarch flycatcher; *Chasiempis sandwichensis*), who was a cousin of Kahalaopuna, saw what happened and flew to tell her family. At the same time, her spirit caught the attention of a group of people passing by on the road. The following excerpt tells of how she was rescued by a young man. He took her to Mō‘ili‘ili and, with his family’s help, she was resurrected and healed through *kakelekele* (hydropathic cure) at Puna o Mau‘oki:

> In the meantime, the spirit of the murdered girl discovered itself to a party who were passing by; and one of them, a young man, moved with compassion, went to the tree indicated by the spirit, and, removing the dirt and roots, found the body, still warm. He wrapped it in his *kihei* (shoulder scarf), and then covered it entirely with *maile*, ferns, and ginger, and, making a *haawe*, or back-load, of it, carried it to his home at Kamoiliili. There, he submitted the body to his elder brother, who called upon two spirit sisters of theirs, with whose aid they finally succeeded in restoring it to life. In the course of the treatment she was frequently taken to an underground water-cave, called Mauoki, for the *kakelekele* (hydropathic cure). The water-cave has ever since been known as the “Water of Kahalaopuna” [Nakuina 1907:126].

The man who found Kahalaopuna was intent on marrying her, but she refused because she and Kauhi were still betrothed. A plot was hatched to keep her last resurrection a secret and then fool Kauhi into his own death. The man learned all the songs that Kahalapuna sang to the murderous Kauhi. He then attended the *kilu*[11] house, where Kauhi was enjoying games. Over three nights, the man attended the games and sang Kahalaopuna’s *mele* (song):

> On the third night, the third song having been sung, the dispute between the young men became so violent that Kauhi told the young man that the Kahalaopuna he knew must be an impostor, as the real person of that name was dead, to his certain knowledge. He dared him to produce the young woman whom he had been representing as Kahalaopuna; and should she not prove to be the genuine one then his life should be the forfeit, and on the other hand, if it should be the real one, then he, Kauhi, should be declared the liar and pay for his insults to the other with his life.
>
> This was just what the young man had been scheming to compass, and he quickly assented to the challenge, calling on the King and chiefs to take notice of the terms of agreement, and to see that they were enforced.
>
> On the appointed day Kahalaopuna went to Waikiki, attended by her parents, relatives, servants, and the two spirit sisters, who had assumed human form for that day so as to accompany their friend

[11] “Kilu game: the player chanted as he tossed the kilu towards an object placed in front of one of the opposite sex; if he hit the goal, he claimed a kiss” (Pukui and Elbert 1986).

> and advise her in case of necessity. Akaaka, the grandfather, who had been residing in Waikiki some little time previous to the dispute between the young men, was appointed one of the judges at the approaching trial.
>
> Kauhi had consulted the priests and sorcerers of his family as to the possibility of the murdered girl having assumed human shape for the purpose of working him some injury. Kaea, a famous priest and seer of his family, told him to have the large leaves of the a-pe (*Calladium costatum*) spread where Kahalaopuna and party were to be seated. If she was a spirit, she would not be able to tear the a-pe leaf on which she would be seated, but if human, the leaf or leaves would be torn. With the permission of the King, this was done. The latter, surrounded by the highest chiefs and a vast assemblage from all parts of the island, was there to witness the test.
>
> When Kahalaopuna and party were on the road to the scene of the test, her spirit friends informed her of the a-pe leaves, and advised her to trample on them so as to tear them as much as possible, as they, being spirits, would be unable to tear the leaves on which they should be seated, and if any one's attention were drawn to them, they would be found out and killed by the poe po-i uhane (spirit catchers). The young girl faithfully performed what was required of her. Kaea, on seeing the torn leaves, remarked that she was evidently human, but that he felt the presence of spirits, and would watch for them, feeling sure they were in some way connected with the girl. Akaaka then told him to look in a calabash of water, when he would in all probability see the spirits. The seer, in his eagerness to unravel the mystery, forgot his usual caution and ordered a vessel of water to be brought, and, looking in, he saw only his own reflection. Akaaka at that moment caught the reflection of the seer (which was his spirit), and crushed it between his palms, and at that moment the seer dropped down dead. Akaaka now turned around and opened his arms and embraced Kahalaopuna, thus acknowledging her as his own beloved granddaughter.
>
> The King now demanded of the girl and of Kauhi an account of all that had happened between them, and of the reported death of the maiden. They both told their stories, Kauhi ascribing his anger to hearing the assertions of the two disfigured men, Kumauna and Keawaa. These two, on being confronted with the girl, acknowledged never having seen her before, and that all their words had been idle boastings. The King then said: "As your fun has cost this innocent girl so much suffering, it is my will that you two and Kauhi suffer death at once, as a matter of justice; and if your gods are powerful enough to restore you, so much the better for you."
>
> Two large imus (ground ovens) had been heated by the followers of the young men, in anticipation of the possible fate of either, and Kauhi, with the two mischief-makers and such of their respective followers and retainers as preferred to die with their chiefs, were baked therein [Nakuina 1907:127–128].

Kauhi and his companions were baked in two *imu* on the side of ʻĀpuakēhau stream in Ulukou. After, Kauhi's people were so enraged by his actions that they gave their allegiance to Kahalaopuna. The *mōʻī* (king) granted the man who saved her and avenged her murder permission to marry her. The next night, a *manō kumupaʻa* of Kauhi's family sent a great tidal wave over Waikīkī to wash out his bones from the *imu* into the sea and transform Kauhi and his men into sharks. Knowing this, Kahuapuna's grandfather forbade her from ever going into the sea. She obeyed her grandfather for two years.

One day, when all the men went to Mānoa to cultivate *kalo* (taro), Kahalaopuna was left alone with her servants in Waikīkī. That day, the surfing was quite good:

> The surf on that day was in fine sporting condition, and a number of young women were surfriding, and Kahalaopuna longed to be with them. Forgetting the warning, as soon as her mother fell asleep she slipped out with one of her maids and swam out on a surf-board. This was Kauhi's opportunity, and as soon as she was fairly outside the reef he bit her in two and held the upper half of the body up out of the water, so that all the surf-bathers would see and know that he had at last obtained his revenge.
>
> Immediately on her death the spirit of the young woman went back and told her sleeping mother of what had befallen her. The latter woke up, and, missing her, gave the alarm. This was soon confirmed by the terrified surf-bathers, who had all fled ashore at seeing the terrible fate of

> Kahalaopuna. Canoes were launched and manned, and chase given to the shark and his prey, which could be easily tracked by the blood.
>
> He swam just far enough below the surface of the water to be visible, and yet too far to be reached with effect by the fishing-spears of the pursuers. He led them a long chase to Waianae; then, in a sandy opening in the bottom of the sea, where everything was visible to the pursuers, he ate up the young woman, so that she could never again be restored to this life.
>
> Her parents, on hearing of her end, retired to Manoa Valley, and gave up their human life, resolving themselves into their supernatural elements. Kahaukani, the father, is known as the Manoa wind, but his usual and visible form is the grove of ha-u (hibiscus) trees, below Kahaiamano. Kauakuahine, the mother, assumed her rain form, and is very often to be met with about the former home of her beloved child.
>
> The grandparents also gave up their human forms, and returned, the one to his mountain form, and the other into the lehua bushes still to be met with on the very brow of the hill, where they keep watch over the old home of their petted and adored grandchild [Nakuina 1907:131–132].

Heiau and Koʻa

Several *heiau* (traditional Hawaiian temples) and *koʻa* (fishing shrines) were once located in Waikīkī Ahupuaʻa. Malo wrote, "The heiaus or altars, at which fishermen performed their religious ceremonies, were of a class different from all others" (Malo 1903:274). He described *koʻa* as a term for the altar at a *kuʻula*:

> Kuula: this was generally a mere rude pile of stones, often placed on a promontory or elevation overlooking the sea. Coral or some sort of limestone was preferred to any other variety of stone. The altar itself was commonly called a koʻa, Kuula being the name of the chief patron deity of fishermen. The number of gods and godlings worshipped by fishermen is too numerous for mention [Malo 1903:278–279].

Kamakau described the types of *koʻa*: "*koʻa* shrines set up for the increase of deep sea fishes (*koʻa kuʻula hoʻoulu iʻa*) and the *koʻa* to the god Kanekoʻa set up along the banks of rivers, streams, and shore and inland ponds (*kuapa me na loko*) for the increase of *ʻoʻopu* fishes (*koʻa hoʻoulu ʻoʻopu*)" (Kamakau 1961:33). Prior to a fishing, *poʻe lawaiʻa* (skilled fishermen) would gather for a ceremony:

> Before starting out to fish for the *opelu* the fishermen would assemble at the kuula heiau in the evening, bringing with them their nets, of the sort called *aei*, pigs, bananas, coconuts, poi, and their sleeping apparel, that they might spend the night and worship the god of fishing.
>
> While engaged in this ceremony, all the people sat in a circle, and the kahuna, bringing a dish of water that had in it a coarse sea-moss, limu kala, and turmeric, stood in their midst and uttered a prayer for purification (*pule huikala*) [Malo 1903:274].

Fishermen worshipped "a number of other fishing-gods," and "Hina-hele was a female deity worshipped both by women and fishermen" (Malo 1903:113). Depending on the god of a fishman, there would be certain *kapu*. For example, the color *ʻeleʻele* (black, from *paʻu*, soot), *ʻōlena* (yellow, from turmeric), or ʻ*alaea* (reddish brown, from *ʻalaea lepo*, clay containing iron) are cited by Malo (1903). The *kapu* would apply to the clothing of the fisherman and his wife, items in his home, his fishing gear, and anyone entering their home who had with them what was *kapu* (Malo 1903:274).

In Thrum's Hawaiian Annual for 1907, *heiau* in Waikīkī included Papaʻenaʻena Heiau, Kapua Heiau, Kūpalaha Heiau, Helumoa or Āpuakēhau Heiau, Makahuna Heiau, Kamauakapu Heiau, Kulanihakoi Heiau, and Pahu-a-Maui Heiau (Thrum 1906a:44–45; Thrum 1906b: 49–69). Not noted by Thrum is Hale Kumukaʻaha Heiau, which was mentioned by Hawaiian historian Samuel Kamakau in the Hawaiian newspaper *Kuakoa* (McAllister 1933:78).

The best-known *heiau* among those mentioned above is Papaʻenaʻena Heiau. Numerous accounts of this *heiau* from early voyagers were compiled by McAllister (1933:71–74). The *heiau* was located on the west side of Lēʻahi (Diamond Head) and visible from Waikīkī (McAllister 1933:71). Thrum further

offered that it was "at the foot of Diamond Head slope, rear of Douglas' premises [Between Paki Avenue and La Pietra]" (Thrum 1906a:44). It was a *heiau poʻokanaka* (*heiau* where human sacrifices were made) and known for the number of sacrifices carried out by Kamehameha I. A description of Papaʻenaʻena Heiau during this early period is from the journal of Tyerman and Bennet (1832:48–49):

> In the year 1804, when the late king, Tamehameha, was on his way from Hawaii, to invade Tauai, he halted with an army of eight thousand men at Oahu. The yellow fever broke out among the troops, and in the course of a few days swept away more than two-thirds of them. During the plague, the king repaired to the great marae at Wytiti, to conciliate the god, whom he supposed to be angry. The priests recommended a ten day' tabu, the sacrifice of three human victims, four hundred hogs, as many cocoanuts, and an equal number of branches of plantains. Three men, who had been guilty of the enormous turpitude of eating cocoa-nuts with the old queen (the present king's mother), were accordingly seized and led to the marae. But there being yet three days before the offerings could be duly presented, the eyes of the victims were scooped out, the bones of their arms and legs were broken, and they were then deposited in a house, to await the coup de grace on the day of sacrifice. While these maimed and miserable creatures were in the height of their suffering, some persons, moved by curiosity, visited them in prison, and found them neither raving nor desponding. But sullenly singing the national *huru*---dull as the drone of a bagpipe, and hardly more variable-as though they were insensible of the past, and indifferent to the future. When the slaughtering time arrived, one of them was placed under the legs of the idol, and the other two were laid, with the hogs and fruit, upon the altar-frame. They were then beaten with clubs upon the shoulders till they died of the blows. This was told us by an eye-witness of the murderous spectacle [Tyerman and Bennet 1832:48–49].

A chief named Kaolohaka is also said to have been sacrificed at this *heiau*: "Fragments of its walls, torn down in 1860, show it to have been about 240 feet square; said to be the place of sacrifice of Kaolohaka, a chief of Hawaii, on suspicion of being a spy" (Thrum 1906a:44).

Based on various accounts, McAllister determined that the *heiau* was "a quadrangular paved terrace, with walls on three sides, but open on the west side, which faced the village of Waikīkī and the sea" (McAllister 1933:74). Multiple step-like terraces led to the open side of the *heiau*. Averaging measurements from first-hand accounts, McAllister estimated that the *heiau* was approximately 128.0 ft. by 68.0 ft., with walls 6.2 ft. high and 3.0 ft wide. According to Thrum (1906a:44), the *heiau* was destroyed by Kanaʻina in 1856, and the stones were used to enclose Queen Emma's premises and for road work.

Kapua Heiau was located somewhere in or near Kapiʻolani Park and is mentioned in the *Legend of Pumaia* (Fornander 1917:470–476). Pumaia was a pig farmer who lived in Pukaola in the Kona District of Oʻahu. The *mōʻī* of Oʻahu, Kūaliʻi, was building Kapua Heiau, "east of Leahi Hill overlooking Māmala Bay" (Fornander 1917:470). When the *heiau* was complete, Kūaliʻi repeatedly ordered pigs from Pumaia until one day, Pumaia refused to oblige him. The *mōʻī* sent soldiers to fight Pumaia over one of the pigs, and Pumaia killed all the men but one. Kūaliʻi then declared war on Pumaia. Pumaia won multiple battles against the soldiers until finally Kūaliʻi prayed to his god to capture Pumaia. Only then was he caught and bound: "Kualii was so incensed at Pumaia that he was immediately killed and was dragged to Kapua, where his dead body was thrown into the pit with the men he had killed. During the ill treatment given to his body, the jaws were crushed and cut up into fragments" (Fornander 1917:474).

Makahuna Heiau was once located on the south side of Diamond Head, overlooking "Aqua Marine" and near the former residence of Honorable Sanford B. Dole (McAllister 1933:196). According to a historical map by Wall (1893), the *heiau* was west of Diamond Head Lighthouse. McAllister offers the following account:

> Thrum writes: "A large heiau enclosure dedicated to Kane and Kanaloa, of Kuula character, so said." Tucker reports: "Opposite the residence of the Honorable Sanford B. Dole. The ruins of a heiau of the Pookanaka class. Was located at this place in order to propitiate, by human sacrifice, the departure of the Aliis to foreign shores, and Black Point, between that and Kahala, was called Keala o Kahiki. These ruins are mostly all overgrown and have been used probably to make fences or for road purposes. A dense growth of lantana and kiawe, scrub kiawe, covers the ruins" [McAllister 1933:196].

Kūpalaha Heiau was located near Emmanuel S. Cunha's estate, near the intersection of Kapahulu and Kalākaua Avenues (Pukui et al. 1974; Thrum 1906a). The location of this estate is shown in Figure 9**.**, at the shoreline boundary of Hamohamo and Kāneloa fisheries. In his description, Thrum wrote: "Entirely obliterated. Class unknown, but said to have had connection in its workings with Papaenaena" (Thrum 1906a:44). In an archaeological monitoring report for utilities work on Kalākaua Avenue, Hammatt and Chiogioji (2002:9) located Kūpalaha Heiau "on or adjacent to Kalākakua Ave., just southeast of the intersection with Monsarrat Ave."

The *kuahu* (altar) at Kūpalaha Heiau was called Opunaha, as shown on a historical map by C.J. Lyons labeled "Altar of Opunaha." In modern times, Opunaha is associated with a seasonal ceremony practiced where Kūpalaha Heiau once stood:

> Each year we gather at the site, just ʻEwa of the Waikiki Aquarium before sunset, on May 2. Therefore, we invite any of you who are interested to join us, as we celebrate those dates that are truly of our place, in the places at which they were marked in ancient times. It is for us kānaka who live in these times, to continue the ancient observances, lest they disappear into obscurity.
>
> We gather at the water's edge at the site of Kūpalaha, the luakini heiau of the Oʻahu Aliʻi, the sibling heiau of Papaʻenaʻena (portions of which still grace the base of Lēʻahi) where, from its kuahu (altar), named Opunaha, the setting sun would be observed by the kahuna kilolani, and on a specific day, the sun would set into the bowl of Puʻu o Kapolei in the Waiʻanae Range, when seen from Opunaha, marking the end of the Hoʻoilo (Hawaiian Winter) and the start of the Kauwela (Hawaiian Summer) for Oʻahu, and the reactivation of the luakini of Kū.
>
> We chant the exit of Lono and the entrance of the time of Kū, the prowess of warriors and mahiʻai (farmers) who prayed to Kūnuiākea (the god of chiefly governance) and Kūikeolowalu (Kū of combined effort). We tell the story of a famous battle between pueo (owls) and kānaka (people) that took place exactly where we gather. And as the sun sets, we share a chant to the setting sun:
>
> Ke aui nei ka lā -- Welo! Welo!
> Ke mōlehulehu mai nei -- Nakolo! Nakolo!
> ʻO ka napoʻo ana i lalo -- I ka mole o Lehua!
> Ma ʻalihilani -- E moe! E moe!
> Aloha e, kukulu o ka lani
> Aloha e kukulu o ka honua
> ʻAuē! Anuanu oʻu mau iwi hilo nei --
>
> The sun is lowering -- Setting! Setting!
> Dusk approaches -- Crawling! Crawling!
> Sinking below -- at the base of Lehua!
> On the horizon -- To sleep! To sleep!
> Aloha to the foundations of the heavens
> Aloha to the foundations of the world
> Aue! I am chilled to the core --
>
> [Gon 2025].

Kūpalaha Heiau was associated with a legend involving Kākuhihewa, *mōʻi* (king) of Oʻahu circa 1540–1634, and Pueo Aliʻi (king of the owls). In the legend, a man named Kapoi went to gather pili grass at a marsh near the beach. He found seven owl eggs, which he collected, intending to eat them later (Thrum 1907:200–202). After returning home, an owl arrived at his fence and cried out, "O Kapoi, give me my eggs!" Hearing the repeated pleas, Kapoi returned the eggs. The owl became his *ʻaumakua* (family god) and instructed him to build Manua Heiau (situated on the southwest side of Pūowaina [Punchbowl Crater]). After building the *heiau,* he offered bananas and set the *kapu* days for its dedication. At the same time, Kākuhihewa was building a *heiau* in Waikīkī, and he made a law that if any person built a *heiau* and set the *kapu* before him, that person would be put to death. Kapoi was arrested and taken to the Kūpalaha Heiau in Waikīkī. Kapoi's *ʻaumakua pueo* tried to help him by calling on all of the *pueo* in the islands to gather and fly to Kūpalaha Heiau to battle the soldiers. The soldiers surrendered then surrendered to the *pueo*.

Since that day, the *pueo* is considered a powerful *akua* (god), and the location of the battle was known as Kukaeunahio-ka-pueo, which means "the confused noise of owls rising in masses" (Thrum 1907:200–202).

A Hawaiian saying associated with Kākuhihewa and Kūpalaha Heiau, which is explained by Pukui below:

> *Ke one ʻai aliʻi o Kakuhihewa.*
>
> The chief-destroying sands of Kakuhihewa.
>
> The island of Oʻahu. When the priest Kaʻopulupulu was put to death by the chief Kahāhana for warning him against cruelty to his subjects, he uttered a prophecy. He predicted that where his own corpse would lie in a heiau at Waikīkī, there would lie the chief's corpse as well. Furthermore, he said, the land would someday go to the sea — that is, to a people from across the sea. This was felt to be a curse. When Kamehameha III was persuaded by a missionary friend to move the capital from Lahaina to Oʻahu, a kahuna, remembering the curse, warned him not to, lest the monarchy perish. The warning was ignored, and before the century had passed, the Kingdom of Hawaiʻi was no more [Pukui 1983:190].

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Nā Pōhaku Ola o Kapaemahu

Four sacred stones near Kūhiō Beach in Waikīkī were dedicated as Nā Pōhaku Ola o Kapaemahu in 1997. For over 100 years, the story of the stones has unfolded, including their history of relocation (Fernandez-Akamine 2023). Briefly, they are a remembrance left by four *kāhuna* from Tahiti who lived in Waikīkī sometime between 1200 and 1500 AD. Regarding their arrival in the islands: "From the land of Moaulanuiakea (Tahiti) there came to Hawaii long before the reign of King Kakuihewa, four soothsayers from the Court of the Tahitian King. Their names were: Kapaemahu, Kahaloa, Kapuni and Kinohi" (Boyd 1906:140). The four were much loved by the people of all the Hawaiian Islands for their grace, healing powers, and wisdom:

> They were received as became their station, and their tall stature, courteous ways and kindly manners, made them soon loved by the Hawaiian people. The attractiveness of their fine physique and kindly demeanor was overshadowed by their low, soft speech which endeared them to all with whom they came in contact. They were unsexed by nature, and their habits coincided with their feminine appearance, although manly in stature and general bearing. After a long tour of the islands this quartette of favorites of the gods settled at Ulukou, or Kou, Waikiki, near where the old time Maikai house stood, which location is within a few lots of the Moana Hotel.
>
> The wizards or soothsayers proved to be adepts in the science of healing and many wonderful cures by the laying on of hands are reported to have been effected by them so that their fame spread all over this island (Oahu), as the ancients say, "from headland to headland." Their wisdom was shown by many acts which gave them fame among the people [Boyd 1906:140].

Years later, before leaving the island, they selected four stones to be brought from Kaīmuki to Waikīkī. Two were placed at their home, and two were placed in the sea where they bathed. The leader of the four, Kapaemahu, transferred his power into the stones during a one-month ceremony. Afterward, the four *kāhuna* disappeared.

The sacred stones were uncovered at ʻĀinahau, once the property of Princess Victoria Kaiʻulani, daughter of Princess Miriam Likelike and Governor Archibald Scott Cleghorn. Cleghorn noticed one of the *pōhaku* partially protruding from the sand for some time before having it excavated. Another *pōhaku* was uncovered on the property to the east. Two more stones were then located and excavated. According to Cleghorn, the four *pōhaku* were found in a straight alignment (PCA 1905). However, the legend states, "Four large selected rocks, weighing several tons each, were taken to the beach lot at Ulukou, Waikīkī, two of which were placed in the position occupied by their hut and the other two were placed in their bathing place in the sea" (Boyd 1906:141). During the Mahele, testimony concerning fisheries' boundaries described several *pōhaku*, either on the shoreline, the inner reef boundary, or the outer reef. These *pōhaku* are shown in Figure 5: Paliikii, Pōhaku o Kauai, Pōhaku Makua, Lae Pōhaku, and Pōhaku Pualiilii (possibly Puʻliʻiliʻi). One could speculate that some of these *pōhaku* are related to *Nā Pōhaku Ola o Kapaemahu*.

Cleghorn had the *pōhaku* displayed at ʻĀinahau, and in his will, he requested that they be protected after his death, which occurred in 1910. Somehow, they were later misplaced. In 1963, they were again uncovered after the demolition of commercial structures built on and adjacent to the former Cleghorn property. They were displayed at the beach with a plaque that referred to the *pōhaku* as "Wizard Stones." In 1994, the *pōhaku* were moved and rearranged for new construction. In 1997, they were moved to their current location, enclosed with a fence for protection, and a new plaque was installed, partially telling the significance of Nā Pōhaku Ola (Fernandez-Akamine 2023).

TRADITIONAL HISTORY AND LOKO IʻA

Waikīkī became the seat of royal power in the 1400s when Māʻilikūkahi, *aliʻi nui* (high chief) of Oʻahu, moved his court to the south side of the island. Māʻilikūkahi was born at Kūkaniloko and was chosen to be *mōʻī* at age 29 (Kamakau 1991:53). According to Kamakau, "Soon after he became *mōʻī* the chiefs took Māʻili-kūkahi to Waikīkī to live; he was perhaps the first of the ruling chiefs to live there. Until then, the chiefs had lived in Waiʻalua and ʻEwa" (Kamakau 1991:53). Handy and Handy noted that Waikīkī, with its sheltered bay and nearby valleys of Pālolo, Mānoa, and Nuʻuanu, was an ideal settlement location (Handy and Handy 1991:268).

Māʻilikūkahi is attributed with creating the land division system, enacting just laws, and bringing peace and prosperity to the island (Kamakau 1991:54–56). According to Kamakau (1991):

> When the kingdom passed to Māʻili-kūkahi, the land divisions were in a state of confusion; the *ahupuaʻa*, the *kū* [ʻili kūpono], the *ʻili ʻāina*, the *moʻo ʻāina*, the *paukū ʻāina*, and the *kīhāpai* were not clearly defined. Therefore Māʻili-kūkahi ordered the chiefs, *aliʻi*, the lesser chiefs, *kaukau aliʻi*, the warrior chiefs, *pūʻali aliʻi*, and the overseers, *luna* to divide all of Oʻahu into *moku* and *ahupuaʻa*, *ʻili kūpono*, *ʻili ʻāina*, and *moʻo ʻāina*. There were six districts, *moku*, and six district chiefs, *aliʻi nui ʻai moku*. Chiefs were assigned to the *ahupuaʻa*—if it was a large *ahupuaʻa*, a high chief, an *aliʻi nui*, was assigned to it. Lesser chiefs, *kaukau aliʻi*, were placed over the *kūpono* lands, and warrior chiefs over *ʻili ʻāina*. Lands were given to the *makaʻāinana* all over Oʻahu [Kamakau 1991:54–55].

Another Oʻahu chief known for ruling during a time of prosperity on Oʻahu was Chief Kalamakua-a-Kaipūhōlua. He ruled around the sixteenth century (based on Stokes' [1933] 20 year-count; Kelly 1989) and was the first to build an extensive irrigation system of *loko ʻai* (fishpond) and *loʻi* (irrigated taro field) in Waikīkī. Kamakau wrote:

> Kalamakua-a-Kaipūhōlua was a good chief. He was noted for cultivating, and it was he who constructed the large pond fields Keʻokea, Kūalulua, Kalāmanamana, and other *loʻi* in Waikiki. He traveled about his chiefdom with his chiefs and household companions to cultivate the land and gave the produce to the commoners, the *makaʻāinana* [Kamakau 1991:45].

The plains and coast of Waikīkī contained *loko iʻa kalo* (fishpond with *kalo*), connected to *loko puʻuone* (dune bank fishpond) and *loko kuapā* (walled fishpond on the shoreline). The network was integrated with the natural landscape. Kapaʻakea was favorable for *loko wai* and *loko iʻa kalo* because of the numerous freshwater springs and streams. Streams that followed from the mountains transported

nutrients to the *loko and lo'i*, which were connected by *'auwai* (channels one to two meters wide). *Loko i'a kalo* could be near the shore or further inland, and like *lo'i*, watered via irrigation ditches. Salinity would vary by location due to tidal action. Typically, *loko i'a kalo* contained *āholehole (Kuhlia sandvichensis*) and *'o'opu (Eieotridae* and *Gobiidae* families), and of course *kalo* (taro).

Kamakau (1992) described the initial creation of various pond types:

> Fishponds, *loko i'a*, were things that beautified the land, and a land with many fishponds was called a "fat" land (*'aina momona*). They date from very ancient times. Some freshwater ponds, *loko wai*, were made when the earth was made, but most of the *loko i'a* and the shore ponds, *loko kuapa*, were made by *ka po'e kahiko* [Kamakau 1992:66].

In *Native Planters in Old Hawaii* (Handy and Handy 1991), the various applications of the term *wai* are discussed:

> *Wai* is fresh water. *Puna* is a spring, or *puna wai*, fresh-water spring. *Wai puna* is spring water. *Kaha wai* is a stream or river (*kaha* meaning place), and the same applies to the ravine, gulch, or valley cut by the stream, or which contains the stream. The artificial diversion of "a flow" of fresh water by means of a ditch or channel, for purposes of domestic use and irrigation, is *'auwai* (*au* meaning a flow or current). A fresh-water pond or lake, whether filled by surface drainage, a spring or springs, stream or ditch water, is *loko wai*, or commonly just *loko* (meaning inside, within) [Handy and Handy 1972:101–102].

Inland fishponds were fed by springs, streams and/or ditches which could be route for the *'o'opu nakea* (Hawaiian goby; *Chonophorus stamineus*), and various shrimp (*'ōpae*), which were then another food source to harvest (Kelly 1989:83). For example, at the large *loko wai* Kawainui in Kailua, three endemic *'o'opu* (*Eleotris sandwicensis, Awaous stamineus, and Stenogobius hawaiiensi*) and the two endemic crustaceans *ōpae kala'ole* (*Atyoida* bisculata) and *'ōpae 'oeha'a* (literally, crooked-walking shrimp; clawed shrimp; *Marcrobrachium grandimanus*), have been documented in the modern era (HHF Planners 2019:3-123; Kelly 1979:17; Pukui and Elbert 1986:291).

What we know of the *loko i'a* from late-1800s maps and descriptions is not indicative of their condition in the previous century or earlier. By the 1830s, the Hawaiian population had drastically decreased due to the spread of Western diseases, and traditional Hawaiian culture was upended by Western influence. Not only did large *loko i'a* lack the workforce needed for operation and maintenance, but the social structure they were built around was altered (Drigot 1982:23). Kikuchi argues that "it seems very likely that selected fishponds played an important symbiotic role in the nature and development of the chiefdom, in particular, of the royal court (Kikuchi 1976:198).

Apple and Kikuchi (1975) classified several types *loko i'a* as royal fishponds, which were "owned exclusively by ruling chiefs" and managed by the *konohiki,* who was a resident and acted as a representative of the *ali'i nui*; *haku 'ohana* (senior male of an extended family of commoners), who reported to the *konohiki*; and a *kia'i loko* (caretaker, guardian of the pond), who may have communicated with the *ali'i nui* directly or through the *konohiki* (Apple and Kikuchi 1975:8, 43–44). Traditionally, prior to the 1800s, all the resources of the land were owned by the *ali'i'ai-moku* (paramount chief). This extended to important *loko i'a* that were connected deep in the past or those that were highly productive, which Kikuchi argues were "manifestations of his supreme rights, including his right of ownership and his right to rule" (Kikuchi 1976:197).

In addition to the *loko i'a* on the landscape, there were *heiau* of *ali'i'ai-moku*, many of which were destroyed in the 1800s. Mau'oki Heiau, was adjacent to the large *loko wai* in upper Kapa'kea. Both *heiau* and *loko i'a* were constructed under the supervision of a *kuhikuhi pu'uone* (site expert [*kahuna*]). The *kuhikuhi pu'uone* decided the location and dimensions and was knowledgeable in the "geography of the land, the nature of the resident spirits of the site, and the total lore of the native religion" (Kikuchi 1976:199). In the construction of *loko i'a*, the *kuhikuhi pu'uone* ensured balance with the gods and guardian spirits, which was needed for successful productivity.

The operation of *loko iʻa* was led by the *konohiki* and the *kiaʻi loko,* who were tasked with "instructing the tenants of the land when and where to construct, repair, and clean the different aquacultural structures" (Kikuchi 1976:199). Like a *kiaʻi loko*, the *konohiki* also guarded against poaching. The following is a description of caring for the 450-acre Kawainui from Kekoowai (1922) in Summers 1964:

> This being communal work, the *konohiki* (land agent) commanded the men, women, and children of Maunawili, Kailua, and Waimanalo to come to Kawainui. The people went into the pond, and with their hands, broke the limu (algae) loose, piling it up and twisting it under as it was gathered. After a quantity of limu had been piled and twisted under, the workers formed it into a ring. "Then the limu that was broken off was pressed (*pili*) down like a dish, and all the fish that were caught in this limu dish were for the limu breakers." The workers put these fish into *lauhala* bags which were tied behind them, for the fish in the "limu dish" were no longer the property of the *konohiki*. Breaking of the limu was continued until the pond was clean and "the food of the fish clean," which for Kawainui Pond, required three days [Summers 1964:22].

The *loko iʻa* were also protected by *moʻo*, who kept the water clean from pollution by humans to ensure abundant productivity (Kikuchi 1976:199). However, the purpose of the *loko iʻa* was not to feed the population, but to allow the harvesting of particular fish as needed or desired. As discussed above, certain *loko aʻi* were symbolic of the *aliʻiʻai-moku*. This is explained by Kikuchi (1976): "Fishponds became symbols of the chiefly right to conspicuous consumption and to ownership of the land and its resources. They were manifestations of the chief's political power and his ability to control and tap his resources" (Kikuchi 1976:199).

In contrast to Apple and Kikuchi (1975), Handy and Handy (1991) attributed *loko wai, loko iʻa kalo,* and *loko ʻumeʻiki* to the *makaʻāinana*. Apple and Kikuchi posited that *loko kuapā*, *loko puʻuone*, *loko wai,* and perhaps larger *loko iʻa kalo* (integrated fishpond and *loʻi*) and *loko ʻumeʻiki* (shore fishpond with lanes leading in and/or out of the pond, used for trapping fish) were royal, meaning owned by paramount chiefs, while the *loko iʻa kalo* and *loko ʻumeʻiki* were typically used by the *makaʻāinana.* This variation between authors is likely a consequence of defining *loko iʻa* in Western terms. The following is an excerpt from Handy and Handy that discusses the symbiotic benefits of aquaculture:

> Although the *loko kuapa* just described belonged to the *aliʻi* and was cared for by his *konohiki*, the planters and common fisherfolk also carried on fish farming for themselves, in natural fresh-water ponds (*loko wai*, inside-water) and shore ponds called *puʻu one* (literally sand-heap ponds). In areas of wet-taro cultivation, young mullet were placed in the liquid mud of taro patches and there thrived. It is not unlikely that this latter custom came about as a result of placing the smaller fish in the *loʻi* when a netful was caught, in order to keep them fresh. It was discovered that they not only kept fresh, but thrived and grew. The mullet (*ʻamaʻama*) is a grazing fish, and when the fingerlings (*pua ʻama*) were put into *loʻi* their stirring about and grazing helped keep the water fresh [Handy and Handy 1991:391–392].

Kamakau wrote of the abundance that various types of *loko iʻa* provided, specifically mentioning *ʻōpae*, *limu kalawai* (fresh-water algae; *Spirogyra* spp.), *ʻoʻopu* roe, and *luʻau* (young taro crops) from *loko wai*:

> Thus they lived in the old days, and that is why the "native sons" (*keiki papa*) of places that had taro patches and *puʻuone* [dune bane brackish fishpond] fishponds loved the lands where they dwelt. There would be salted fish, too, in containers of large taro leaves. When one awoke in the morning and was ready to eat, the fish was brought forth and the wrappings opened up; the taro leaves would have wilted and the fish would be shaped like pig tusks. They were laid in a food bowl and one ate until he was full. So too did the native sons love the lands where the freshwater ponds, *loko wai*, were, for they furnished them with fresh *ʻopae*, crisp *limu kala-wai*, reddish *ʻoʻopu* roe, and *luʻau*. The people of the old days who lived on such lands lacked nothing [Kamakau 1976:50].

LATE PRE-CONTACT WARFARE

In 1780, the army of Maui chief Kahekili landed at Waikīkī "carpeting the beaches from Kaʻalawai (near Diamond Head) to Kawehewehe (next to the Halekulani Hotel)" (Kanahele 1995:79). According to Thrum (1925:109), Kahekili dedicated Papaʻenaʻena Heiau, formerly located in the vicinity of Diamond Head, following his victory. Many people were slaughtered during the fighting, including chiefesses. The chiefess Kekela managed to abscond to Kauaʻi, carrying sands from ʻApuakehau, Kahaloa, Waiaʻula, and Kūpalaha at Waikīkī, and deposited them at Hulaia, Kulana, and Kane in Kauaʻi (Kamakau 1992:140). At the time, Kahekili's nephew Kahahana was *aliʻi nui* of the island. Kahahana, along with his wife Kekuapoʻiʻula and his retainer Alapaʻi, fled to the mountains where they were cared for by sympathetic *makaʻāinana* (Kamakau 1992:136). They hid successfully for two and a half years but were then found out. Kahekili had Kahahana and Alapaʻi killed at Waikele and their bodies taken to him in Waikīkī.

In July 1794, Kahekili died at Ulukou, Waikīkī, at over eighty years of age and was succeeded by Kalanikupule (Desha 2000:349). The next year, Kamehameha invaded Oʻahu and made his army base on the sandy beaches from Waiʻalae to Diamond Head to Kālia (Kanahele 1995:87). The final battle ended at Nuʻuanu when Oʻahu warriors became trapped between Kamehameha's warriors and the *pali* (cliff) and chose to leap to their deaths (Tomonari-Tuggle and Blankfein 1998:13). After the battle of Nuʻuanu, Kalanikūpule fled but was later captured and then scarified. Kamakau summarizes the end of the battle and Kamehameha's victory:

> At Laʻimi in Nuʻuanu Ka-lani-ku-pule's side was routed, and there Kaʻi-ana died. The chiefs and warriors of Ka-lani-ku-pule were slaughtered, but Koa-lau-kani escaped and fled to Kauai, and Ka-lani-ku-pule hid in the underbrush for a little over a year and then was captured mauka of Waipiʻo in ʻEwa and killed. His body was brought to Kamehameha and offered in sacrifice to his god, Ku-kaʻili-moku [Kamakau 1992:172].

Kamehameha made his capital at Waikīkī, and the area became the chiefly center of the south coast where the ruling chief and subordinate *aliʻi* (chief or chiefess) resided (Cordy 1996; Nāpōkā 1986; Tomonari-Tuggle 1994). Hawaiian historian John Papa ʻĪʻī (1959) describes Kamehameha's residence in Waikīkī:

> Kamehameha's houses were at Puaaliilii, makai [toward the sea] of the old road, and extended as far as the west side of the sands of Apuakehau [vicinity of Moana Surfrider Hotel]. Within it was Helumoa [vicinity of Royal Hawaiian Hotel], where Kaahumanu *ma* [and company] went to while away the time. The king built a stone house there, enclosed by a fence; and Kamalo, Wawae, and their relatives were in charge of the royal residence. Kamalo and Wawae were the children of Luluka and Keaka, the childhood guardians of Kamehameha.
>
> This place has long been a residence of chiefs. It is said that it had been Kekuapoi's home, through her husband Kahahana, since the time of Kahekili. Haalou, a *makuahine* [female relative] of Kamehameha, lived there with her younger daughter Kekuapoi while en route from Hawaii to Kauai to consult Kapoukahi, a seer of Kauai, for means whereby Kamehameha would gain victory over Keoua Kuahuula [ʻĪʻī 1959:17].

EARLY POST-CONTACT DESCRIPTIONS OF WAIKĪKĪ

Waikīkī is described as a richly productive area in accounts by early European explorers. An early map by Lieutenant C. R. Malden of the Royal Navy shows cultivated land, "Ruins of a Morai," "Fresh Water Ponds," and a coconut grove in Waikīkī (Malden 1825). In 1792, Captain George Vancouver of the HMS Discovery arrived at "Whyteete" and noted the field systems:

> On the shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the sea-side, presented a high degree of cultivation and fertility.
>
> This opened to our view a spacious plain, which, in the immediate vicinity of the village, had the appearance of the open common fields in England; but, on advancing, the major part appeared divided into fields of irregular shape and figure, which were separated from each other by low stone

> walls, and were in a very high state of cultivation. These several portions of land were planted with the eddo or taro root, in different stages of inundation; none being perfectly dry, and some from three to six or seven inches under water. The causeway led us near a mile from the beach, at the end of which was the water we were in quest of. It was a rivulet five or six feet wide, and about two or three feet deep, well banked up, and nearly motionless; some small rills only, finding a passage through the dams that checked the sluggish stream, by which a constant supply was afforded to the taro plantations.
>
> In this excursion we found the land in a high state of cultivation, mostly under immediate crops of taro; and abounding with a variety of wild fowl, chiefly of the duck kind, some of which our sportsmen shot, and they were very fine eating. The sides of the hills, which were at some distance, seemed rocky and barren; the intermediate vallies, which were all inhabited, produced some large trees, and made a pleasing appearance. The plains, however, if we may judge from the labour bestowed on their cultivation, seem to afford the principal proportion of the different vegetable productions on which the inhabitants depend for the subsistence [Vancouver 1798:161–164].

Also aboard the HMS Discovery was surgeon and naturalist Archibald Menzies. He echoed Vancouver's description of a bountiful land:

> The verge of the shore was planted with a large grove of coconut palms, affording a delightful shade to the scattered habitations of the natives. Some of those near the beach were raised a few feet from the ground upon a kind of stage, so as to admit the surf to wash underneath them. We pursued a pleasing path back into the plantation, which was nearly level and very extensive, and laid out with great neatness into little fields planted with taro, yams, sweet potatoes and the cloth plant. These, in many cases, were divided by little banks on which grew the sugar cane and a species of Draecena without the aid of much cultivation, and the whole was watered in a most ingenious manner by dividing the general stream into little aqueducts leading in various directions so as to be able to supply the most distant fields at pleasure, and the soil seemed to repay the labor and industry of these people by the luxuriancy of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with water fowl of various kinds such as ducks, coots, water hens, bitterns, plovers, and curlews [Menzies 1920:23–24].

Several others followed Vancouver and Menzies in describing Waikīkī over the next few decades. Peter Corney wrote of Waikīkī between 1813 and 1818:

> On rounding Diamond hill the village of Wyteetee (Waikiki) appears through large groves of cocoanut and bread-fruit trees; it has a most beautiful appearance, the land all round in the highest state of cultivation, and the hills covered with wood; a beautiful plain extending as far as the eye can reach. A reef of coral runs along the whole course of this shore, within a quarter of a mile of the beach, on which the sea breaks high; inside this reef there is a passage for canoes [Corney 1965:193].

Otto von Kotzebue, commander of the Russian ship Rurick, viewed Waikīkī from the sea in 1816. His description of the land is as follows:

> . . . but you have scarcely sailed round the Yellow Diamond Hill, when you are surprised by the most beautiful landscape. Close to the shore you see verdant valleys adorned with palm and banana-trees, under which the habitations of the savages lie scattered; behind this, the land gradually rises, all the hills are covered with a smiling verdure, and bear the stamp of industry [von Kotzebue 1821:320].

Finally, the naturalist Andrew Bloxam was ashore from the HMS Blonde in 1824–1825 when he noted the abundance of Waikīkī:

> I walked along shore towards the bay of Whyteete to see if I could procure any shells, but I found none worth picking up. The whole distance to the village of Whyteete is taken up with innumerable artificial fishponds extending a mile inland from the shore, in these the fish taken by nets in the sea are put, and though most of the ponds are fresh water, yet the fish seem to thrive and fatten. Most of these fish belong to the chiefs, and are caught as wanted. The ponds are several hundred in number and are the resort of wild ducks and other water fowl. I found it very difficult to get out of the labyrinth of paths which lead among them. Whyteete is about four miles east of Honoruru

> [Honolulu]. It is pleasantly situated and built along the shore among numerous groves of coconut and other trees, and in this respect far better than Honoruru, as scarcely any trees are to be found there [Bloxam 1925:35–36].

This period of political importance ended for Waikīkī in 1809, when Kamehameha moved his capital to Honolulu, which was more accessible to Western visitors (Tomonari-Tuggle and Blankfein 1998:13). In 1829, Kamehameha III funded fifty percent of the construction cost for a new Kawaiahao Church, much grander and stronger than the prior three structures. Related to the current project area offshore, the lime for the church was sourced from the reef:

> The material at this time was largely from the coral reef abreast of the town where there were large fields of it growing in varied thickness. The coral was cut in blocks two to three feet long, two feet in width, and larger and smaller sizes, in blocks weighing from two hundred to twelve hundred pounds. Lime was procured by burning the coral, which gave an excellent quality of the product [Gilman 1903:86].

Following this move, traditional agriculture in Waikīkī waned. The population in the area drastically decreased due to economic changes and the devastation caused by Western diseases. The missionary Levi Chamberlain noted these changes when writing in 1828:

> Our path led us along the borders of extensive plats of marshy ground, having raised banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having once been under cultivation. I entered into conversation with the natives respecting this present neglected state. They ascribed it to the decrease in population [Chamberlain 1957:26].

In 1837, Gideon Laʻanui, a grandnephew of Kamehameha I, wrote of *ʻōkuʻu* (dysentery) spreading in Waikīkī. Several in his family contracted the disease, and some died:

> We returned with my father to Waikiki where we remained. The disease called okuu (dysentery) appeared. Kanahoahoa died, her ashes were taken. My elder caught the disease. We took him with our father to Ewa for intended burial on a small piece of land owned by Kekaulike. When we arrived there, he recovered and the disease went to our father. The sickness grew much worse. We took him back to Honolulu, up to Kaalaa and there our father died. My mother was taken by the younger brother of my father [Laʻanui 1937:1].

The pond dune banks of Kālia were one of many burial grounds for victims of the 1853 smallpox epidemic (and likely other epidemics as well). ʻĪʻī mentions the deaths when describing a traditional trail through Kālia:

> The trail from Kalia led to Kukuluaeo [immediately east of Kālia], then along the graves of those who died in the smallpox epidemic of 1853, and into the center of the coconut grove of Honuakaha [near today's Punchbowl and Queen streets]. On the upper side of the trail was the place of Kinau, the father of Kekauonohi. His houses were made kapu after his death, and no one was permitted to pass in front of them. Piopio and others were in charge [ʻĪʻī 1959:89].

First reported in February of 1853, the epidemic was full-blown by early May, and by the end of the year, between 3,000 and 6,000 people—predominantly Hawaiian in ancestry—had died (Greer 1969). The removal and burial of bodies became an immediate sanitary crisis (Daws 1968:141):

> Teams of wagon drivers patrolled the town, picking up the sick and the dead...they...became so hardened to death that they were able to stop at a tavern for a drink, leaving their load of corpses outside...At the height of the epidemic forty or fifty bodies were buried each day at Kakaako, and before the worst was over more than a thousand corpses were packed into the ground there, many of them laid on their sides to save space, in graves just wide enough to admit a body and only three feet deep.

While some of these burials were in known cemeteries, most were not. Furthermore, because the burial program was expedient and chaotic, burials outside the existing cemeteries were poorly documented.

As Kālia, Kewalo, and Kakaʻako undergo urban redevelopment, some of these burials have been located; the highest densities to date appear to be in the vicinity of Sam's Club and the adjacent Walmart, at Sheridan and Makaloa streets.

FISHING GROUNDS BEFORE THE MAHELE

David Keliʻipiʻo of the Board of Health was appointed Fish Inspector in 1895. It was a new position, created to enforce fishing restrictions in polluted areas and ensure that all fish and other seafood were transported and sold at the fish market in Honolulu, where they could be inspected (PCA 1895). Initially, there was public opposition to the new rules, but his work was soon appreciated. A new market was built with a cement slanted floor, which was thoroughly cleaned every evening (HAS 1985:2). As Inspector, Keliʻipiʻo recorded the types of fish brought to the market, where they were caught, and the quantities, and could order catches destroyed if inspection found them unsuitable. He also wrote articles on traditional fishing and associated spiritual beliefs (Keliʻipiʻo 1900a), shared information on fish, shellfish, crabs, and the identification of edible seaweed (Keliʻipiʻo 1899, 1900b), and recommended techniques for preparing certain fish, which appeared in newspapers and Thrum's Hawaiian Annual. In an article translated and published in the Annual, Keliʻipiʻo described traditional Hawaiian fishing restrictions, particularly in near-shore areas similar to Waikīkī:

> In the olden time certain varieties of fish were tabued and could not be caught at all times, being subject to the kapu of Kuula, the fish-god, who propagated the many tribes of Hawaiian waters. While deep sea fishing was more general, that in the shallow sea, or along-shore, was subject to the restrictions of the konohiki of the land, and alii's, both as to certain kinds as well as periods. The sign of the shallow sea kapu prevailing was by branches of the hau tree placed all along the shore. The people seeing this token of the kapu respected it, and any violation thereof in ancient time was said to be punishable by death. While this kapu prevailed, the people resorted to the deep sea stations for their food supply. With the removal of the hau branches, indicating the kapu was lifted, the people fished as they desired, subject only to the makahiki tabu days of the priest, or alii, when no canoes were allowed to go out upon the water [Keliʻipiʻo 1900:111–114].

In 1839, Kamehameha III issued a written constitution and code of laws in *An Act to Regulate the Taxes*. It included rules for free and prohibited fishing grounds. At Kālia, the fishery was held by the Crown, which divided its use into a part for the *moʻi*, a part for the *konohiki* and tenants, and a part for the *makaʻāina* (Jordan and Evermann 1902: 361). The *makaʻāina* were also given "the fishing grounds without the coral reef, viz., the Kilohee grounds, the Luhee ground, the Malolo ground, together with the ocean beyond" (Chapter III, Section 8, of Laws of 1840 in Kosaki 1954:2). Native Testimony in 1851 noted that Kaʻahumanu lived on the east side of the mouth of ʻĀpuakēhau in several small houses. Upon her death, Kekuanaoa "occupied that part of the land as a *kuleana*" and the *hoʻoʻāina* had the right to fish in the *mulilwai* of ʻĀpuakēhau (Volume No. 1:13).

Within the *konohiki* fishing grounds, the *konohiki* could designate a fish *kapu*:

> But the fishing grounds from the coral reef to the sea beach are for the landlords and for the tenants of their several lands, but not for others. But if that species of fish which the landlord selects as his own personal portion should go on to the grounds which are given to the common people, then that species of fish, and that only, is tabooed; if the squid, then the squid only; or if some other species of fish, that only and not the squid. And thus it shall be in all places all over the islands; if the squid, that only; and if in some other place it be another fish, then that only and not the squid [Jordan and Evermann 1902:361].

Kālia was a fishing ground subject to seasonal *kapu*: "Those fishing grounds which are known by the people to have shoals of fish remaining upon them shall, at the proper season for fishing, be placed under the protective taboo of the tax officers for the King. The fishing grounds on Oahu thus protected are: 1, Kalia" (Jordan and Evermann 1902:362).

In 1845, King Kamehameha III established the Board of Commissioners to Quiet Land Titles. The purpose of the Land Commission was "the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any landed property acquired anterior to the passage

of this act" (Kingdom of Hawai‘i 1846:107). The Land Commission's authority was restricted to determining the "validity of a [land] claim and to bind both the claimant and the government to its verdict" (Chinen 1958:9). On 26 October 1846, the "*Principles adopted by the Board of Commissioners to quiet land titles"* were approved by the Legislative Council, which identified three stakeholders with rights to land: "1st, the government, 2nd, the landlord, and 3rd, the tenant." To retain a property, adult males had to file a claim, provide testimony, pay for a survey, and obtain a Royal Patent. Additional legal clarification was required to resolve "the undivided interests of the King, the chiefs and *konohikis*, and the tenants [*maka‘āinana*]…in the lands" (Chinen 1958:12). This resolution came between 1847 and 1848, when the Privy Council established the Mahele, which "divided the vested rights that Kamehameha III and 245 chiefs had in the ‘āina [land]" (Stover 1997:11).

For *konohiki* land claims, approval by the Land Commissioners was required before the award was made. If approved, then the awardee obtained a Royal Patent (RP) from the Minister of the Interior, which indicated that the government's interest in the land had been settled with a commutation fee. This fee was typically no more than one-third of the value of the unimproved land. This fee was paid either in cash or, more commonly, the return of one-third of the awardee's lands of equal value (King 1945).

In 1845, the boundaries of fisheries ownership were more clearly defined. The people were granted rights to waters seaward of the reefs, and where there was no reef, waters beyond one mile offshore. Likewise, the waters from the seaward edge of the reef to the beach, or, where there was no reef, waters within one mile of the beach.

> The entire marine space without and seaward of the reefs upon the coasts of the several islands comprising the several fishing grounds commonly known as the Kilohee grounds, Luhee grounds, the Malolo grounds, and the fishery of the ocean from said reefs to the limit of the marine jurisdiction in the first article of this chapter defined shall be free to the people of these islands. The people shall not be molested in the enjoyment thereof except as hereinafter provided.
>
> The fishing grounds from the reefs, and where there happen to be no reefs from the distance of one geographical mile seaward to the beach at low water mark, shall in like manner be considered private property of the landlords whose lands by ancient regulation belong to the same; in the possession of which private fisheries the said landlords shall not be molested except to the extent of the reservations and prohibitions hereinafter set forth [Jordan and Evermann 1902:363].

In 1845, revisions made to the constitution were intended to be more specific, but also became more restrictive, complex to interpret, and difficult to enforce:

> These shall be divided equally between the King and fishermen. But on all the prohibited fishing grounds the landlords shall be entitled to one species of fish and those who have walled fish ponds shall be allowed to scoop up small fish to replenish their ponds. If the prohibited fish of the landlord be mingled with the royal fish, then the landlord shall be entitled to one-third of the whole of the fish taken, though this applies only to Molokai, Oahu, and the reefs of Kauai.
>
> All which shall be yearly protected by the king's taboo, to be imposed by the minister of the interior by means of circular from his department, as prescribed in the act to organize the executive ministry; and during the specified season of taboo they shall not be subject to be taken by the people [Jordan and Evermann 1902:363].

Following the Mahele of 1848, two acts were passed in 1850 that changed land ownership in Hawai‘i. On 10 July 1850, the Alien Land Ownership Act was adopted, which allowed foreigners to own land. On August 6, 1850, the Kuleana Act of 1850 was adopted, which allowed *hoa‘āina* (common people of the land, native tenants) to make claims to the Land Commission. The new Western system of ownership led many people to lose their land. Often, *kuleana* (property) claims would be made for discontiguous cultivated plots with varying crops, but only one parcel would be awarded.

In 1850, the government loosened people's fishing rights due to difficulties collecting its share and because the restrictive rights were "a source of trouble and oppression to the people." The new law stated that government fisheries, excluding fishponds, were free to the people, but that the Minister of Interior could impose seasonal taboos. A complication arose regarding coastal land purchased or leased from the

government that assumed fishing rights. So, in 1851, a clear statement regarding the limits of private fishing grounds:

> That no person who has bought or who may hereafter buy any Government land, or obtain land by lease or other title from any party, has or shall have any greater right than any other person resident in this Kingdom over any fishing ground not included in his title, although adjacent to said land. The fish in said fishing ground shall belong to all persons alike, and may be taken at any time, subject only to the taboos of the minister of the interior [Jordan and Evermann 1902:366]

The Civil Code of 1859, passed by the Hawaii Legislature, reiterated the existing rights and restrictions. These laws remained throughout the rest of the nineteenth century, with only additions. For example, in 1872, a law was passed that prohibited the use of dynamite (Jordan and Evermann 1902:368), and in 1888, age and length restrictions were placed on ‘*awa* (kava) (Jordan and Evermann 1902:369).

The Crown Lands became Government Lands when the Hawaiian Government was overthrown in 1895, making them public domain for sale by fee simple (Alexander 1920). Patents were certificates issued for the sale of such lands. Beginning in 1900, when Hawaii became a U.S. territory, the certificates were known as Land Patents or Land Patent Grants (Alexander 1920). The Organic Act abolished private fishing rights, required registration of any private fisheries within a two-year window, and granted the attorney general the right to condemn privately owned fisheries (Kosaki 1954:4).

NAMED FISHERIES

Along the coast in Waikīkī, the fisheries’ boundaries changed from the early 1800s to 1900. This was due to boundary disputes between landholders and the government’s acquisition at the Mahele, as well as the overthrow of the Hawaiian Kingdom. Four fisheries near the project area are discussed below, and landmarks mentioned in claims, testimonies, and awards are depicted on a map in the previously referenced Figure 5.

Keonioku (Keomuku) Fishery

In 1846, Samuel Kuluwailehua objected to the boundaries of Claim 228 by Kalaiheana. ‘Ī‘ī testified on behalf of Kalaiheana that after the Battle of Nu‘uanu, Kamehameha I gave the coconut grove at Helumoa to Kalaiheana. Kuluwailehua counterclaimed that he received the land from his mother. In 1851, Kahiaweawe testified on behalf of Kuluwailehua that Kanekoa, Kuluwailehu’s mother, gave him several pieces of land in 1840, which she had received from Keopulani during the time of Kamehameha I. She lived there until 1848 (the house was *mauka* of today’s Ala Wai Canal), which was when King Kamehameha III awarded her the land. No one objected, and the *ho‘o‘āina* retained their *kuleana* (N.T. 738-739v3 in Hammatt and Shidler 2007:Appendix A).

On the coast at Keomuku, Kuluwailehua claimed:

> 1 cocoanut grove and Keomuku sea;
>
> The boundaries are:
> Mauka, land of Kekuanaoa
> Waikiki, land of Keohokalole named Hamohamo
> Makai, the surf’s breaking point
>
> Ewa, land of Kekuanaoa. February 23, 1851, from page 242, No. 1281, S. Kuluwailehua [Hammatt and Shidler 2007:Appendix A].

According to Native Testimony in 1851, the sea west of Hamohamo was called Keonioku and belonged to Keakuanoa, indicating that the sea beyond Keomuku did not belong to Kuluwailehua. Both the *‘ili* and the fisheries described as between Hamohamo and Kālia were later absorbed into Kālia, as shown inFigure 10. This included Keomuku and the sea of Keomuku.



Figure 10. Portion of 1909 Map of O‘ahu Fisheries by M.D. Monsarrat. Kālia Absorbed pre-Mahele Fisheries

Hamohamo Fishery

Testimony states that the Hamohamo fishery extended from the southwest corner of the *ʻili* at a rock called Paliki above the high tide (near a cattle pen), then seaward to a coral rock called Pōhaku o Kauai on the inner reef, then along the inner surf or reef to a rock called Puʻaliʻiliʻi, and to the east side of the *muliwai* of ʻĀpuakēhau. The squid taken by the women belonging to other lands, on the inner reef, were divided with the *Luna* of Hamohamo" (Maly and Maly 2003b:256). J.O. Dominis was awarded the land of Hamohamo, but not the sea. The Hamohamo fishing privilege was determined by the Boundary Commission to be as described above.

Kaneloa Fishery

The Kāneloa fishery followed the east boundary of Hamohamo to Pōhaku o Kauai and then to a rock on the outer reef called Lae Pōhaku. On the west side, the boundary began at the *muliwai*, then straight out to Puʻaliʻiliʻi, and then to the outer reef (corner unnamed). The fish caught between the inner and outer reefs were divided between the *konohiki* of Hamohamo and Kāneloa. Other testimony stated that the outer reef belonged to the government, but "heard that the Konohiki of Kaneloa, claimed a right to fish on the outer reef. I did not claim the squid taken on the outer reef. I have heard that the sea of Hamohamo is on the inner reef & that Kaneloa runs along outside of it. The persons who told me so are dead. Kailielulu was one" (Maly and Maly 2003b:257).

Kālia Fishery

Kālia Fishery and much of the *ʻili* land, including 23 *kōʻele*, 39 *loko*, and eight *ulu niu* (coconut groves), were claimed by Mahuka, the *konohiki.* In testimony, the shoreline belonging to Kālia was described as from the west side of Hamohamo to ʻĀpuakēhau and included "Olowalu coconut grove to the breaking sea of Kahaone [sandy beach]." It then broke inland, excluding the *muliwai*, Helumoa, and Keomuku, until the west side of Keomuku, where it returned to the shore and continued east to Kukuluaeo (N.T. 275-277 v10 No. 35 FL, Mahuka 12 January 1852 in Waihona Aina 2025). Mahuka was only awarded a fraction of the claim, which did not include the sea. There was also another claim for the sea, Claim 1515 by Kaihuolua, for a *kai* (ocean fishery) called Kukaha at Kālia. In Figure 10**.**, previously referenced above, LCA 1515 (ʻĀpana 2) is slightly west of the *muliwai* of Kawehewehe.

THE DREDGING AND EROSION OF WAIKĪKĪ

During the 1880s, development intensified in Waikīkī, and the area underwent rapid transformation. By the end of the nineteenth century, many *loko* were filled, and rice was planted in place of taro. The productive wetlands came to be seen by some, particularly potential developers, as "deleterious to the public health in consequence of being low, and at times covered or partly covered by water, or of being situated between high and low water mark, or of being improperly drained, or incapable by reasonable expenditure of effectual drainage" (Pinkham 1906:3). This viewpoint would culminate in the dredging of the Ala Wai Canal and the filling of land that had a long history of productive wetland agriculture and aquaculture (Nakamura 1979).

In 1876, a group of prominent businessmen, which included Archibald Cleghorn, John O. Dominis, and James Makee, formed the Kapiʻolani Park Association. Mōʻī David Kalākaua offered a 30-year lease of Kāneloa and Kapua for the endeavor on the east side of Waikīkī, which was at the time crown land. According to the association's charter, the park would serve the purpose "of adorning and putting in order, a tract of land in the vicinity of Honolulu as a place of public resort, and of promoting Agricultural and Stock Exhibitions, and healthful exercise, recreation and Amusements" (Abel 1992:3–4). Kalākaua dedicated the park in June of 1877 in honor of Queen Kapiʻolani. At this time, the eastern portion of the park was sparsely vegetated and sandy, while wetlands and streams characterized the western portion. Consequently, the park's development entailed road building, drainage, and extensive plantings of ironwood, banyan, date palm, and other trees (Abel 1992:4). At the location of today's Honolulu Zoo, Makee and Cleghorn created a water landscape from the existing ponds. The following is a description of this development:

> Through construction of a system of ditches and canals, they drained sufficient water from this portion of the park to create a collection of small islands and shallow ponds. Although the waterways were routinely criticized as stagnant breeding grounds for "limu moss," the general effect was considered agreeable. Erecting rude wooden bridges enabled visitors to meander among the islands. The largest piece of dry land created from the former swamp was called Makee Island after the first Association present, and it became a favorite spot for picnics. [Weyeneth 1991:12].

In 1912, Walter F. Dillingham purchased 84.41 acres in Kālia from the Bishop Estate, which he used as a dump site for coral dredged during the construction of the Ala Wai Canal (Nakamura 1979:70, 111). This major undertaking, called the Waikīkī Land Reclamation Project, began in 1921 and was completed in 1928 (Nakamura 1979; Stephenson 2008:28). An oblique aerial photograph of Waikīkī prior to the construction of the Ala Wai Canal is shown in Figure 11.



Figure 11. Oblique Photography Kālia Area Prior to the Waikīkī Land Reclamation Project (UHM 2025)

The reclamation project was bounded by Sheridan, South Beretania, and South King streets, Kapahulu Avenue, and the ocean (Stephenson 2008:46), and resulted in the draining and filling-in of 1,400 acres, which were once productive ponds, irrigated fields, and home sites. Burned rubbish was also used as a fill material. The city used the wetlands as free dumping sites for incinerated rubbish, without compensating landowners, and justified the practice by arguing that filling the land would increase its value (Department of Environmental Services 2015). According to Nakamura (1979), state laws were passed that

forced property owners to pay for the filling of their land, a matter in which they had no choice (Nakamura 1979). Many Hawaiians and other locals who live on the land were displaced. The following account is from Georgette Meyers, a resident of Nanakuli, whose family was evicted from Kālia in the 1920s:

> In the early 1920s, my mother and her ʻohana moved to the Kalia area on Oʻahu, where Ala Moana is today. They planted taro, bananas, coconuts and vegetables. They raised ducks, chickens and other animals and harvested fish from their pond. Food came from their gardens, and life was pretty good, our kupuna say. In those times, our ʻohana worked together, always sharing what they had. My parents' stories taught me respect for malama -- taking care of the ʻaina. They also know what happened to it.
>
> One day, some foreigners came to their house. They said that a big tidal wave was coming. Everybody should move up to the hills near Punchbowl, they said. Many families left their homes. When they came back, their taro loʻi and fishponds and food gardens were filled with coral rocks and salt water. But it wasn't from a "tidal wave." It was from Dillingham's dredge. The dredge had chewed up the fishing reefs along the shore. They dumped the coral in our taro fields and ponds. The salt water killed everything. Many families were forced to leave [Meyers 1981:2–3].

Until 1913, Kapiolani Park was managed by the Honolulu Park Commission, whose mission was to operate the park as a public space (Abel 1992:5). During this early period, the oceanfront parcels were sold to private individuals in an effort to raise money for the Association through the subleasing of beachfront lots for residences. Some of these lots were reacquired in 1905; however, others became private property with the overthrow of the monarchy in 1893 (Hibbard and Franzen 1986:43). Many were built directly on the beach, and some extend past the shoreline on piers, as shown in Figure 12. The beach infringement led to erosion, which was combated with seawall construction Figures 13 and 14; however, the seawalls only worsened the erosion. In 1917, the Territorial government prohibited seawall construction due to its adverse effects, but enforcement was lacking. As of 1920, there were roughly 37 seawalls spanning most of the shoreline. A photograph from 1926 shows the narrow beach at Waikīkī (Figure 15), which appears renourished in 1928, along with a new groin (Figure 16). Extensive seawalls can be seen in a photograph from 1931(Figure 17).

Multiple sand renourishment projects were undertaken throughout the twentieth century. The following is a summary of events from the late 1800s to 2006 by Dr. Robert L. Wiegel, a civil and environmental engineer who studied the urban coastline:

> A century ago, most of the shore was a narrow, thin ribbon of carbonate sand lying between wetlands, mudflats, duck ponds, fishponds, and a gently sloping fringing reef a few thousand feet wide. Not much sand was in the beach or the thin patches of sand on the reef. Several small streams flowed into the sea. The first encroachment onto the beach with buildings and other works occurred in the 1880s and 1890s — a few homes, several bathhouses, and small hotels, some built partly on piles. Seawalls, groins, and several piers were constructed. The Natatorium was built from shore 200 feet onto the reef in 1927. The Ala Wai Canal and Ala Wai Yacht Harbor were also constructed. Of great importance was the removal of many truckloads of sand from the premises of Queen Liliʻuokalani circa 1909, and the dredging of sand, coral rubble, and rock from the reef for fill of portions of the wetlands at Fort DeRussy in 1909. A dredge was used to clear a channel through the reef to the shoreline, and then parallel to the shore. In 1913, additional dredging was done to permit a 69-ton coast artillery gun to be brought by barge to the reservation. Channels, basins, and ponds have been dredged in the reef for several purposes; they front about one-half of the shore. These have caused changes in wave and current action, and in the transport and deposition of sand and silt. Much of the sand now on the beach segments between Diamond Head and Ala Moana Beach Park has been brought from other locations in Hawaii for beach fill, or for constructing a beach by placing sand on top of a base made of crushed coral rock dredged from the nearshore. Also, sand was dredged in 2000 and in 2006 from small deposits on the reef, pumped to shore at Kuhio Beach, and distributed along the section of beach which is protected by a shore-parallel breakwater (crib wall), elevation about MLLW, and groins connected to shore. Since Duke Kahanamoku's comments in the 1930s, guidelines governing beach nourishment have been to preserve the breakers for

> surfboarding, provide a sand blanket to cover the inshore coral, and stabilize a dry beach for sunbathing [Wiegel 2008:1].

In 1929, sand was pumped from a "reef flat" through the Halekulani Channel to the beach at the Halekulani Hotel. The current project area includes the Halekulani Sand Channel, also known as ʻĀpuakēhau Channel, and other sources have cited the project area location as a sand source for beach replenishment, which suggests the project area is the "reef flat" source for sand in 1929. Photographs from 1938 and 1940 show the renourished beach and a new groin at the Royal Hawaiian, just west of Halekulani (Figures 18 through 20).

By the 1950s, it was clear that shoreline construction, bay dredging, and wetland loss were impacting the Waikīkī coastline. A 1949 study undertaken by the U.S. Beach Erosion Board cost $42,240.58. Beach restoration was estimated to be $6,000,000.00 (Board of Harbor Commissioners 1949). Ironically, the study was named the Waikīkī Beach Reclamation Survey, in contrast to the 1920s Waikīkī Land Reclamation project. The photograph in Figure 20 shows the beach after it was renourished in the 1950s.

Money was appropriated in 1959 to create an easement focused on Kūhio Beach, but property owners opposed the appropriation, and it lapsed (Gill 1963). In the early 1960s, the erosion extended from Duke Kahanamoku Beach to the Elks Club (Williams 1963). According to state rep Kobayashi, "The crucial provision in the proposed agreement would require the owners to quitclaim to the State their interests in the beach makai of the 1928-29 line together with all littoral rights, assuming that the line is acceptable to the State" (Kobayashi 1963). The problem with various bills was the ambiguity of the property line. If the beach grew seaward, then the hotels would gain land. After an erosion study prepared by the USACE in 1963, Act 631 was passed, "to improve Waikiki Beach from Duke Kahanamoku Beach to the Elks Club. The project comprises widening of the beach and groin construction" (MacDonnell 1963).

Waikīkī beach improvement and maintenance in the late twentieth century included the construction and repair of seawalls and groins, and the placement of sand either brought in from another beach source or mined offshore at Waikīkī. More recently, sand was siphoned from offshore onto Waikīkī beaches in 2000. In 2006, 10,000 cubic yards of offshore sand were placed on the shore. Then, in 2012, sand was pumped from 2,000 feet offshore. The most recent effort was in 2021:

The Waikīkī Beach Special Improvement District Association (WBSIDA), in close partnership with the Department of Land and Natural Resources (DLNR), conducted a beach maintenance project for the Royal Hawaiian to Surfrider Moana beach area. The goal of the Waikiki Beach Maintenance Phase II project was to restore and maintain the public beach between the Kuhio Beach Ewa Groin and the Royal Hawaiian Groin. The project includes hydraulic dredging and pumping up to 20,000 cubic yards of marine sand from offshore Waikīkī as a follow up to the 2012 project which brought in 24,000 cubic yards to Waikīkī Beach. The project started on January 26, and stockpiled 20,000 cubic yards of offshore sand, retrieved from shallow water about 1000-feet offshore. The project was completed in May 2021 (DLNR 2025).



Figure 12. Ca 1916 Photograph Showing Buildings Extending to the Water (UHM 2025f).



Figure 13. Oblique Photography of the West End of Waikīkī Beach Prior to Ala Wai Canal Construction (U.S. Air Corps 1920).

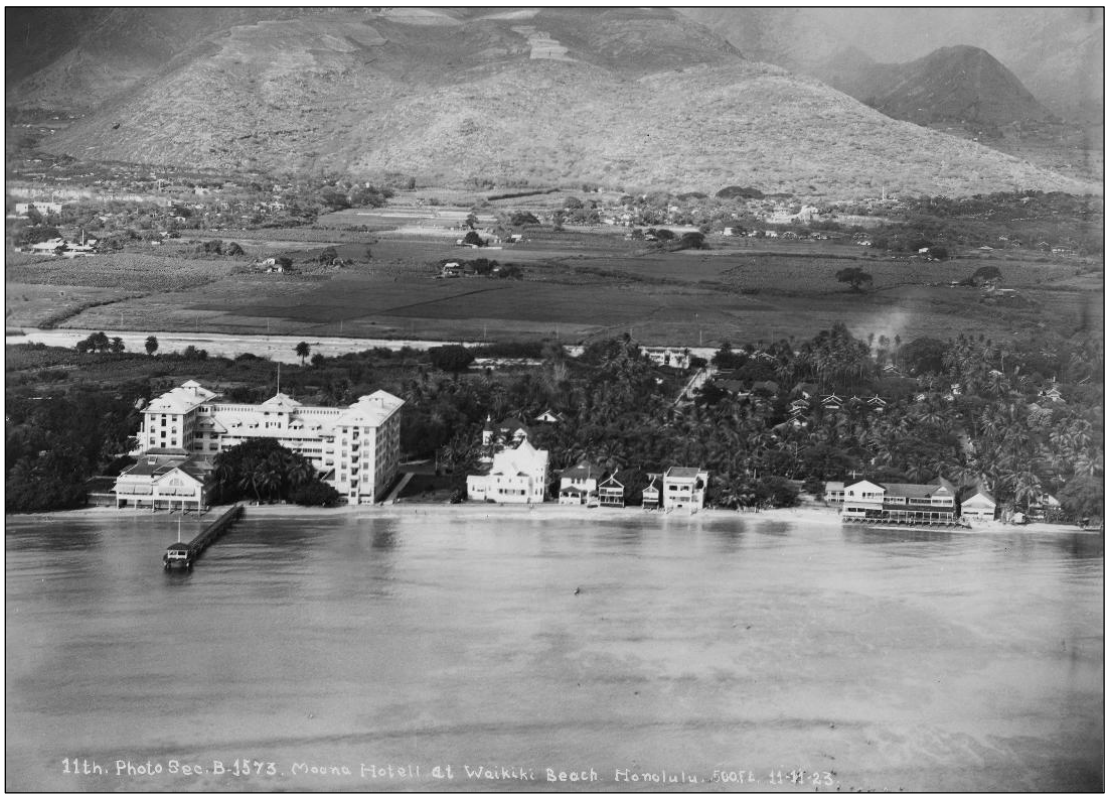


Figure 14. 1923 Oblique Photography of the West End of Waikīkī Beach (U.S. Air Corps 1923).



Figure 15. 1926 Oblique Photography of Waikīkī Facing West Showing Royal Hawaiian Hotel with Seawall at Water's Edge (U.S. Air Corps 1926).



Figure 16. 1928 Oblique Photography of Waikīkī Facing West Showing New Groin and Renourished Beach at Royal Hawaiian Hotel (U.S. Air Corps 1928).



Figure 17. Coast of Waikīkī 1931, facing Diamond Head, Showing Seawalls and Thin Patches of Beach (U.S. Air Corps 1931).

1



Figure 18. 1938 Oblique Photography of West End of Waikīkī Beach (U.S. Air Corps 1938).



Figure 19. Beach East of Royal Hawaiian Hotel in 1940 (UHM 2025).

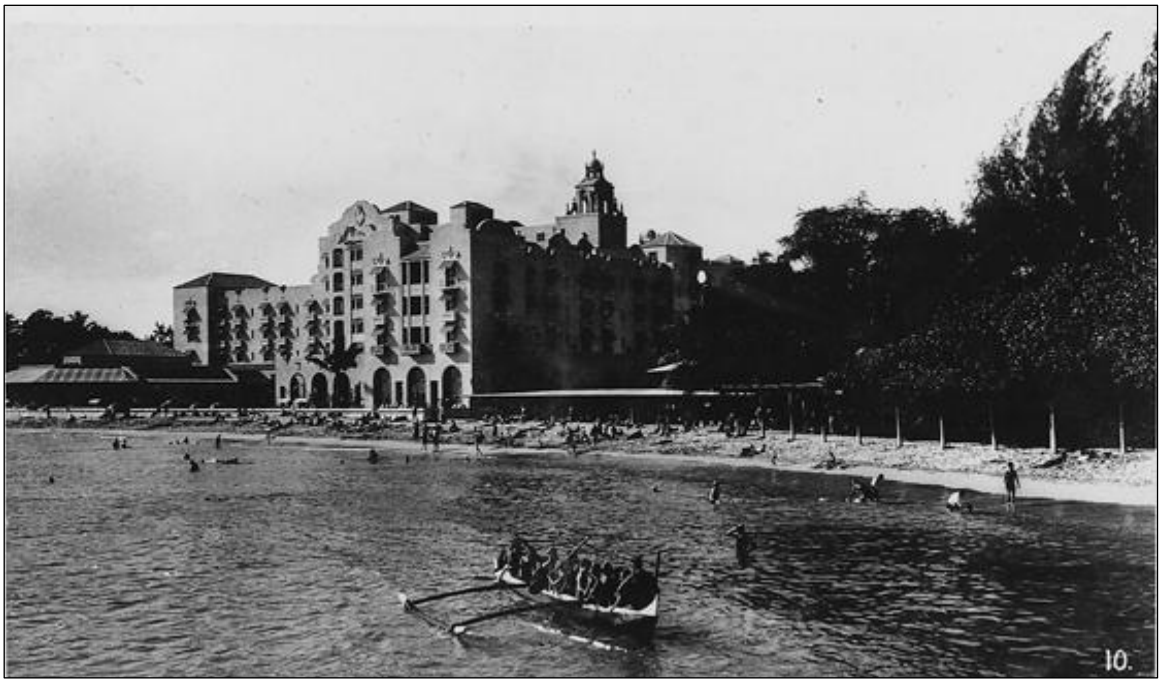


Figure 21. Outrigger Canoe and Beach Goers at the Royal Hawaiian Hotel in 1940 (UHM 2025).



Figure 20. Waikīkī Beach After Beach Replenishment in the 1950s (Bacon 1955).

PREVIOUS ARCHAEOLOGICAL PROJECTS

Many archaeological investigations have been conducted in Waikīkī, and since the early 1900s, numerous traditional Hawaiian burials have been recorded. Undisturbed beach sands (i.e., Jaucas sand), which are associated with traditional Hawaiian burials, have been observed below the historic fill layers throughout Waikīkī. This is also true for cultural deposits and former *loʻi* and *loko iʻa*. Previously identified historic properties are summarized in Table 3[12] and shown in Figure 22.

Offshore of Waikīkī, no archaeological sites or historical shipwrecks have been recorded. However, accumulations of traditional Hawaiian fishing gear within the reef were identified by University of Hawaiʻi Marine Option Program (UH MOP) divers according to a 2017 report:

> One near-shore fishing site was surveyed by the UH MOP student divers in 1996. Students in the field survey, assisted by UH Anthropology Department graduate Michael Pfeffer, mapped an accumulation of hundreds of fishing lures surrounding specific topographical reef features offshore from Waikiki beach on Oʻahu. These bread loaf-shaped basalt sinkers were part of a multicomponent octopus lure, or leho heʻe (Maly and Maly 2003). The distribution of lost lures suggests hundreds of years of fishing activity at this specific location and submerged reef feature. Project records for both of these surveys are held by NOAA's Maritime Heritage Program and the University of Hawaiʻi Marine Option Program [NOAA Maritime Heritage Program 2017:44].

In a report by Van Tilburg, the fishing lure caches identified in 1996 are referred to as submerged traditional fishing sites: "Submerged traditional fishing sites have been located and surveyed in shallow waters near Waikīkī, identified by the accumulation of stone breadfruit-type (octopus) sinkers" (Van Tilburg 2015). A report was identified during background research for this ALR that appears to be a record of UH MOP underwater mapping in 1996; however, it is missing every other page. The report is "a summary of the methodology and findings including a map featuring the density and distribution of Hawaiian stone fishing weights in the near-shore site" (Lovington 1996:1). The report was written by a member of the dive team, Al Lovington. The survey involved plotting the distribution of artifacts; no artifacts were collected. Lovington summarized the project's purpose:

> The site chosen for study is a traditional Hawaiian fishing grounds or *Ko'a. Ko'a* can also mean coral, fishing grounds or the onshore shrines used to mark alignments (transits) so fishermen could find the fishing grounds. The site is located about 500 meters offshore in front of the Waikiki Natatorium, Oahu in about twenty feet of water. . .
>
> The project for MAST '96, the Maritime Archaeology Field School, is to chart the occurrence of Hawaiian lithic fishing artifacts in the offshore site. The 'fishing gear' artifacts are identifiable by their basalt composition and fall into two classes; worked and unworked. The worked class of artifacts includes canoe anchors, plummet weights, handline weights, octopus lure weights, game stones, adzes, and poi pounders, while the unworked stones are various types of sinkers [Lovington 1996:1].

In the methodology section, Lovington writes that the chosen dive was known to contain artifacts:

> MAST '96 selected a primary site to work on under the coordination of Michael Pfieffer, a graduate student in anthropology, who is currently in the process of surveying other selected sites for artifact distribution. The site was specifically chosen for its known abundance of artifacts and easily accessible location. It was hoped that it would provide the ideal training ground for beginning underwater archeaologists [*sic*], but still offer relevant archaeological [*sic*] information.
>
> The site (temporarily designated Natatorium 1) is located in fifteen to twenty feet of water approximately a quarter mile south of the Natatorium. Although it is sufficiently offshore to avoid most surf, heavy surge from the southern swell blanketed the site for several days [Loveington 1996:15].

[12] In Table 3, BPBM=Bernice Pauahi Bishop Museum Site Number.

1 Table 3. Previously Identified Historic Properties in Coastal Waikīkī.

SIHP	Description	Location	Reference
No #	Traditional Hawaiian human burials	James B. Castle property, east end of Waikīkī Beach	See Davis 1984 (recovered in 1901)
No #	Traditional Hawaiian human burials	Outrigger Canoe Club	See Davis 1984 (recovered in 1963)
01974	Traditional Hawaiian human burials and cultural deposit	Moana Surfrider	Simons et al. 1991
02870	Traditional Hawaiian human burials and subsurface features	Hilton Hawaiian Village	Neller 1980; Hurlbett et al. 1992; Tulchin et al. 2011; Yucha and Hammatt 2014; Sroat et al. 2019; Krause et al. 2022
03705	One humerus	Moana Surfrider (former site of Outrigger Canoe Club)	See Davis 1984 (Recovered in 1964, BPBM 50-Oa-A04-024)
03706	Traditional Hawaiian human burial	331 Saratoga Road	See Davis 1984 (Recovered in 1961, BPBM 50-Oa-A04-019)
03707	Traditional Hawaiian human burials	2431 Prince Edward Street	See Davis 1984 (Recovered in 1963, BPBM 50-Oa-A04-023)
04224	Traditional Hawaiian human burials and subsurface features	Pacific Beach Hotel	Beardsley and Kaschko 1998
04570	Traditional Hawaiian human burials and subsurface features	Fort DeRussy	Davis 1989; Streck 1992; Carlson et al. 1994; Denham and Pantaleo 1997a,b; Yucha and Hammatt 2014, Raff-Tierney et al. 2017, Welser and McDermott 2018
04573	Subsurface remnants of Loko Kaipuni	Nimitz Hwy and Ala Moana Blvd	Davis 1989; Pammer et al. 2018
04574	Loko Paweo I	Fort DeRussy	Davis 1989; Simons et al. 1995; Denham and Pantaleo 1997a,b
04575	Loko Ka‘ihikapu	Fort DeRussy	Davis 1989; Denham and Pantaleo 1997b
04576	Loko Paweo II	Fort DeRussy	Davis 1989; Simons et al. 1995; Denham and Pantaleo 1997a
04579	Traditional Hawaiian human burial and subsurface features	Fort DeRussy	Simons et al. 1995; Denham and Pantaleo 1997b
04729	Human remains (scattered)	Waikīkī Aquarium	Cleghorn 1993; Dagher 1993; Dega and Kennedy 1993
04966	Pre-Contact features and human burials	Fort DeRussy	Denham and Pantaleo 1997a
04970	Traditional Hawaiian cultural deposit	Fort DeRussy	Simons et al. 1995; Denham and Pantaleo 1997b; LeSuer et al. 2000
05301	Human burial	Waikīkī Sunset Hotel	Jourdane 1995

SIHP	Description	Location	Reference
05459	ʻAuwai and loʻi remnants	Kalākaua Ave	McDermott et al. 1996
05460	Human burial	Kalākaua Ave	McDermott et al. 1996
05681	Human burial	Ohua St	Cleghorn 2001
05744	Human burials	Ala Wai Blvd	Perzinski et al. 2000
05796	Culturally modified agricultural surface	Waikīkī Shopping Plaza	LeSuer et al. 2000; Yucha et al. 2009; Pammer et al. 2014; Morris and Hammatt 2015; Martel and Hammatt 2017, Beauchan et al. 2016; Farley et al. 2020
05797	Human remains (scattered)	Kalākaua Ave	Winieski and Hammatt 2000
05856	Human burial	Kalākaua Ave	Perzinski et al. 2000; Bush et al. 2002; Winieski et al. 2002
05857	Traditional Hawaiian human burials	Kalākaua Ave	Perzinski et al. 2000; Winieski et al. 2002
05858	Traditional Hawaiian human burials	Kalākaua Ave	Perzinski et al. 2000; Winieski et al. 2001
05859	Traditional Hawaiian human burials	Ulunui Ave and Liliʻuokalani Ave	Mann and Hammatt 2002; Winieski et al. 2002
05860	Two human burials	Kalākaua Ave	Perzinski et al. 2000; Bush et al. 2002; Winieski et al. 2002
05861	Burials (4 individuals); pre-contact cultural deposit, and historic artifacts	Kalākaua Ave	Perzinski et al. 2000; Cleghorn 2001; Winieski et al. 2002; Tome and Spear 2009
05862	Traditional Hawaiian human burials	Kalākaua Ave	Perzinski et al. 2000; Winieski et al. 2001; Winieski et al. 2002
05863	Traditional Hawaiian human burials	Kalākaua Ave	Perzinski et al. 2000
05864	Human burial	Kalākaua Ave	Perzinski et al. 2000; Bush et al. 2002
05883	Discontinuous A horizon	Kalākaua Ave	Winieski and Hammatt 2000
05937	Post-Contact human burials	Royal Hawaiian Hotel	Elmore and Kennedy 2001; Runyon et al. 2015
05940	Subsurface cultural layer	Throughout Waikīkī	Winieski et al. 2001, 2002; Bellville et al. 2014; Davis et al. 2017; Farley et al. 2017, 2018a,b, 2023
05941	Historic Trash pit	Kalākaua Promenade	Winieski et al. 2002
05942	Fragment of light gauge rail	Kalākaua Promenade	Winieski et al. 2002
05943	Low-energy alluvial sediments	Kalākaua Promenade	Winieski et al. 2002
05948	Portion of historic seawall	Kalākaua Ave	Winieski et al. 2001

SIHP	Description	Location	Reference
06369	One in situ burial	Lili‘uokalani Ave and Uluniu Ave	Mann and Hammatt 2002
06372	Historic trash pit	Lili‘uokalani Ave and Uluniu Ave	Mann and Hammatt 2002
06398	Historic trash pit	Lili‘uokalani Ave and Uluniu Ave	Mann and Hammatt 2002
06399	Post-Contact subsurface features	Hilton, Ala Moana Blvd	Putzi and Cleghorn 2002
06636	Buried Kewalo wetland sediment	Ko‘olani	Tulchin and Hammatt 2005; Runyon et al. 2011; Morriss et al. 2013
06641	Layer of burnt trash	Ko‘olani	Tulchin and Hammatt 2005; Runyon et al. 2011
06682	Buried habitation deposit	Ainahau Vista	Chiogioji et al. 2004; Tulchin and Hammatt 2007
06700	Human remains (scattered)	Waikīkī Gateway	Freeman et al. 2005
06701	Coffin burial	Waikīkī Gateway	Freeman et al. 2005
06702	Culturally enriched, buried A-horizon	Waikīkī Gateway	Freeman et al. 2005
06702*	Historic debris/trash deposit	Kapi‘olani Beach Park	Tome and Spear 2005 (*same SIHP, different sites)
06703	Fishpond remnant	Waikīkī Gateway	Freeman et al. 2005
06704	Subsurface cultural layer	Kalākaua Ave	Borthwick et al. 2002
06705	Human skeletal fragments	Ainahau Vista	Chiogioji et al. 2004; Tulchin and Hammatt 2007
06706	Segment of ‘Āpuakehau Stream	Ainahau Vista	Chiogioji et al. 2004; Tulchin and Hammatt 2007
06707	Pre-Contact stone retaining wall	Ainahau Vista	Chiogioji et al. 2004; Tulchin and Hammatt 2007
06819	Human burial	Kalākaua Ave	O’Leary et al. 2005; Hazlet et al. 2008
06848	Cultural layer	Cove Waikiki Condominium	O’Hare et al. 2006; Belluomini et al. 2023
06875	Human burials	Allure Waikīkī	Bell and McDermott 2006
06946	Human burial	Poni Mō‘ī Road	Whitman et al. 2008
07041	Human skeletal remains	Royal Hawaiian and Sheraton	Runyon et al. 2015
07055	Human skeletal remains	Ala Wai	Martel and Hammatt 2017; Belluomini et al. 2016
07065	Human skeletal remains	Princess Ka‘iulani	Runyon et al. 2009; Burke et al. 2014
07066	Cultural layer	Princess Ka‘iulani	Runyon et al. 2009; Burke et al. 2014

SIHP	Description	Location	Reference
07067	Human burial	Princess Kaʻiulani	Runyon et al. 2009; Burke et al. 2014
07068	Cultural layer	Moana Surfrider	Thurman et al. 2009
07069	Historic trash pit	Moana Surfrider	Thurman et al. 2009
07086	Historic trash feature complex	Holomoana St and Kahanamoku St	Mooney et al. 2009
07087	Disturbed human burial	Holomoana St and Kahanamoku St	Mooney et al. 2009
07115	Cultural layer	Koʻolani	Runyon et al. 2011
07116	Buried low-energy alluvial layer	Koʻolani	Runyon et al. 2011
07117	Post-Contact human burials	Koʻolani	Runyon et al. 2011
07118	Cultural layer	Royal Hawaiian and Sheraton	Runyon et al. 2015
07119	Disturbed human burial and cultural layer	Royal Hawaiian	Fong and Hammatt 2010; Lima and Hammatt 2014; Thurman et al. 2011; Bellville-Marrion et al. 2013; Runyon et al. 2015; Moore and Chambers 2022; Kem and Pacheco 2024
07135	Cultural layer and disarticulated human skeletal remains	St. Augustine-by-the-Sea Church	Yucha et al. 2013
07136	Human interment complex	St. Augustine-by-the-Sea Church	Yucha et al. 2013
07208	Subsurface features in dune sand layer; possibly on Makee Island	Honolulu Zoo	Walden et al. 2013; Clark et al. 2014
07307	Subsurface cultural deposit	International Market Place	Hammatt et al. 2012; Enanoria et al. 2024
07308	Subsurface burial/activity area	International Market Place	Hammatt et al. 2012; Enanoria et al. 2024
07309	Moana/Seaside Hotel subsurface infrastructure and deposits	International Market Place	Hammatt et al. 2012; Enanoria et al. 2024
07435	Human skeletal remains	Nimitz Hwy and Ala Moana Blvd	Pammer et al. 2018
07436	Human skeletal remains	Nimitz Hwy and Ala Moana Blvd	Pammer et al. 2018
07514	Human skeletal remains	Cove Waikiki Condominium	Belluomini et al. 2023
07598	Cultural layer	133 Kaʻiulani	Inglis et al. 2014
07599	Human skeletal remains	133 Kaʻiulani	Inglis et al. 2014

SIHP	Description	Location	Reference
07676	Human skeletal remains and disturbed cultural layer	Hilton Hawaiian Village	Yucha and Hammatt 2014
07741	Human skeletal remains	380 Kapahulu Ave	Medina and Hammatt 2016
07813	20th-century infrastructure	Waikīkī Trade Center	Manraith et al. 2015; Farley et al. 2020
07930	Cultural layer and wetland	413 Seaside Avenue	Thurman et al. 2016
07946	Human burial	Princess Kaʻiulani Hotel	Garcia and Shideler 2018
07952	Fishpond sediments (Loko Kaʻohai)	280 Beach Walk	Belluomini et al. 2016
07980	Cultural layer	Waikiki Trade Center	Farley et al. 2020
07981	Historic trash pits	Waikiki Trade Center	Farley et al. 2020
07982	Human skeletal remains	Waikiki Trade Center	Farley et al. 2020
07983	Human skeletal remains	Waikiki Trade Center	Farley et al. 2020
08037	Buried historic surfaces	Nimitz Hwy and Ala Moana Blvd	Pammer et al. 2018
08048	Human skeletal remains	ʻAlohilani Resort	Farley et al. 2023
08168	Buried infrastructure	ʻAlohilani Resort	Farley et al. 2023
08169	Fishpond sediments (Loko Kaipuni)	ʻAlohilani Resort	Farley et al. 2023
08833	Human skeletal remains	Royal Hawaiian	Blahut et al. 2021
08842	Human skeletal remains	Uluniu Ave	Mann and Hammatt 2002
08843	Human burials	Uluniu Ave	Mann and Hammatt 2002
08942	Kuāuna (large berm)	Centennial Park	Farley et al. 2022
08943	Historical infrastructure remnants	Centennial Park	Farley et al. 2022
09240	Human burials	2431 Prince Edward St.	Same as 03707 (BPBM 50-Oa-A04-023)?
09500	Traditional Hawaiian human burials	Hale Koa Hotel	Kimble 1976; Davis 1984 (Recovered 1976, BPBM 50-Oa-A04-025)
09901	Human burials	Moana Surfrider	Griffin 1987
09957	Human burials, post-Contact artifacts	Halekulani Hotel	Neller 1981; Davis 1984 (BPBM 50-Oa-A04-026)
09980	Traditional Hawaiian artifacts	Royal Hawaiian Hotel	See Davis 1984 (recovered in 1925)

1



Figure 22. Previously Identified Traditional Hawaiian Archaeological Sites and Human Burials.

Due to missing pages in the report, the survey results are unclear. The author suggests returning to the site in order to complete the project:

> The most obvious step remaining is to finish the survey of the site. Completion of the survey grid would allow an analysis of artifact distribution to be conducted. Before we were forced off the site by the large southern swell, we had finished a 24m by 60m survey of the grid. In performing this task a possible improvement to the survey method would be to work along narrower areas to allow the transect lines to be moved more easily; that is, work a 20m swath instead of 24m. Initially, to get an overall feel for the site a controlled sweep of the area using a free swimline would be the fastest survey method to get a quick count and rough layout [Lovington 1996:19].

It seems that, due to poor conditions in the 15.0 to 20.0 ft. depth range, the original project site was abandoned, and the survey shifted to "Free Swimline Surveys" at other locations in the bay. Lovington states, "Swells were reaching eight feet and throwing divers around as well as reducing visibility below the minimum necessary to work. The field school was quick to adopt new strategies to deal with the change in conditions. The swimline survey technique would be practiced over the next three days" (Lovington 1996:19). Unfortunately, the following page is missing.

Only one of the three days of the dive survey is included. During two dives on July 24, 1996, a single canoe anchor was plotted approximately l00.0 m southwest of the Natatorium at a depth of 50.0 ft. Dive #2 was 48.0 ft. deep, approximately l00 m south of Ala Wai Boat Harbor. No artifacts were observed. At the end of the report, the author gives six recommendations for future research:

> [F]irst, test selected lithic artifacts to pinpoint their origin (respective volcanic flow) by either trace element fingerprinting or isotope ratios, secondly, chart sediment transport from littoral drift and offshore drift by running a simulation model with colored basalt stones, thirdly, do a randomized survey of the grids with an air lift to remove sediments, fourthly, study accretion rates of coral on basalt stones, fifthly, study wearing of accretion on the basalt due to transport, and lastly, assess the possibilities [*sic*] of basalt deposition due to human disturbance of the old stream beds, old ponds, landfill of the ponds, and the dredging of the Ala Wai Canal [Lovington 1996:29].

No follow-up work or any other underwater archaeological surveys offshore of Waikīkī were identified during an exhaustive literature search for this ALR. In 1998, an underwater investigation in the North Ship Channel outside Kāneʻohe Bay was conducted to investigate fish populations using a submersible equipped with video cameras. Interestingly, out-of-place water-worn cobbles and boulders were recorded on the seafloor. They were identified as *pōhākialoa* (sinker stones), which were used to sink *palu* (chum bags), and their presence was indicative of a traditional Hawaiian deepwater fishing site:

> The numerous rounded basalt rocks scattered throughout the site are typical of rocks found in streams and on cobble/boulder beaches. The paleo shoreline off Oʻahu has been found to be over 1000 m deep so these rocks could possibly have been rounded in place. However, from well over 1,000 submersible dives conducted by HURL since 1980, it is very uncommon to find rounded basalt cobbles on drown carbonate reef terraces off of this island (J. Smith, pers comm). A more plausible alternative explanation is that these stones were collected onshore and used for deep water bottom-fishing. Pinnacles and other areas of abrupt topography emerging from the seafloor such as this site have been confirmed as fertile bottom fishing grounds (Kelley et al. 2006, Leitner, 2018). The round rocks would have specifically been wrapped inside *palu* bait bags and when the line was jerked, facilitated the unwrapping of the bag and release of the *palu* before dropping free to the seafloor. Further supporting evidence of use in bottom-fishing is their narrow size range which is consistent with their use for fishing. In addition, there was no obvious pattern of deposition or sorting of the rocks as might have occurred if they formed in place. The number of stream/beach rocks found at this known bottom-fishing site along with their localized accumulation on this distinct topography feature, suggests the North Ship Channel Pinnacle was known to, and frequented by, early Hawaiian bottom fishers. Their size, shape, and basalt composition are consistent with historic accounts of stones used to transport *palu* to the bottom [Jokiel et al. 2019:57, 59].

The authors state that the dimensions, shape, and material (basalt) of the artifacts on the ocean floor resembled *pōhākialoa* in the Bernice Pauahi Bishop Museum collections. In the 1960s, a similar *pōhākialoa* measuring 20.3 cm by 10.2 cm was found by a diver in shallow water off Waikīkī (Jokiel et al. 2019:59). The diver took the artifact and sold it at an auction. The authors note that identifying and interpreting artifacts in shallow water can be difficult if they have been weathered by sand, and also because of possible transport between land and sea, driven by erosion, wave action, or human interference. In deeper water, "These obstacles do not occur . . . , providing more valid information and allowing for more positive identification as a fishing site" (Jokiel et al. 2019:60).

SUMMARY OF CULTURAL PRACTICES AND IMPACTS

Waikīkī has a strong, well-documented association with Native Hawaiian practices and beliefs, some of which have endured for centuries and continue hold cultural significance. Traditionally, Hawaiians relied on the ocean at Waikīkī for sustenance and recreation through practices such as fishing, gathering, swimming, surfing, and canoeing. *Umu* (fish aggregation devices) and several types of traps were constructed by Native Hawaiians near the Waikīkī shoreline to attract desirable fish for harvesting. *Limu* was cultivated along rocky shorelines for food, medicine, and spiritual practices. Other marine life was also gathered in those rocky areas for sustenance. On shore, several *heiau* (traditional Hawaiian temples) and *ko'a* (fishing shrines) were once located in the Waikīkī Ahupua'a. Numerous Native Hawaiian burials have also been discovered in sands along the Waikīkī shoreline.

Little remains of the constructions of the early inhabitants of Waikīkī. Modern development has replaced the temples and shrines; rocky beach areas have been replenished with imported sand to promote recreational beach use and tourism; *umu* have been degraded by natural processes and beach management practices; and many *iwi kūpuna* (ancestral remains) have been disturbed by development and natural weathering. These factors have contributed to a significant decrease in some of the cultural resources and practices associated with Waikīkī, such as marine resource gathering and fishing. Climate change, over-fishing, pollution, and the loss of natural coral populations have also contributed to the degradation of conditions that once made Waikīkī a bountiful shoreline environment. While some gathering and fishing may continue along the Waikīkī shoreline, the area no longer provides the level of sustenance it once did for Native Hawaiians.

Surfing and swimming remain important and enduring cultural practices along the Waikīkī shoreline. *He'e nalu* (board surfing), *pākākā nalu* (outrigger canoe surfing), *kaha nalu* (body surfing), and swimming attract visitors and local residents alike to the area. No adverse effects on surfing or swimming practices are anticipated to result from the proposed REEFrame project. The project area lies well offshore, in deeper waters where new coral growth would not result in appreciable changes to the nature, size, frequency, or occurrence of the Waikīkī surf breaks. The artificial reef modules (each about 2 meters in height) will be placed approximately 1,000 meters offshore in depths of approximately 12 to 18 meters. The Waikīkī surf breaks occur much closer to shore, approximately 100 to 200 meters offshore, and in shallower waters with depths of 1 to 4 meters.

Canoe paddling, considered a traditional Hawaiian practice, remains a popular recreational activity in Waikīkī; several canoe clubs store their *wa'a* (outrigger canoes) on shore and practice and compete in the area. The proposed action would involve the temporary anchoring of barges and support vessels at the project site (for approximately four weeks) and would require transiting canoes to avoid the anchored vessels. Such avoidance requirements are applicable when encountering any stationary or anchored vessel and would have no adverse effects on the exercise of traditional paddling practices.

The REEFrame project will not involve any actions on shore in Waikīkī. There are no known cultural properties in the offshore project area, and there is no potential for the proposed action to affect *iwi kūpuna* that may be buried on shore or have eroded to near shore areas. Anecdotal accounts indicate that cremation remains are occasionally scattered offshore, potentially in or near the project area. This ongoing

practice would not be impacted by the proposed action. Any previously scattered remains would have been dispersed by ocean currents and are not anticipated to be present in the project area.

The quantity and variety of sea life present in the project area are anticipated to increase as a result of the proposed action. As the new reefs are colonized and grow, they are expected to attract more sea life to the area, as compared to current conditions and the no action alternative. This proposed action is anticipated to improve conditions for fishing in the project area and in adjacent locations as the new reefs mature.

Research has not identified any historic properties within the proposed project area. The nearest historic properties are along the beach, and there is no potential for submerged former terrestrial archaeological sites in the project area. As for isolated artifacts, such as traditional Hawaiian fishing gear, such finds are unlikely because the project area is in the Halekulani Sand Channel, which experiences dynamic and fluctuating water conditions and was previously mined for sand to replenish Waikīkī beaches.

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GLOSSARY OF HAWAIIAN TERMS

ahu—altar, shrine, cairn; stone enclosure for fish

Heap, pile, collection, mound, mass; altar, shrine, cairn; a traplike stone enclosure made by fishermen for fish to enter; laid, as the earth oven (Pukui and Elbert 1986:8)

ahupua'a—land division and community

Land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (*ahu*) of stones surmounted by an image of pig (*pua'a*) or because a pig or other tribute was laid on the altar as tax to the chief. The landlord or owner of an *ahupua'a* might be a *konohiki* (Pukui and Elbert 1986:9)

'āina—land

Land, earth (Pukui and Elbert 1986:11)

'alamihi —Thukuhar shore-crab

A common black crab (Met*opograpsus thukuhar*) (Pukui and Elbert 1986:18)

'ala mihi —path of repentance (Pukui 1983)

alamimo —quick

Quick, fast. *Nā kupua'i alamimo o nā kini maka lehua o nā 'ōpio,* nimble soles [dancing feet] of the many lehua blossoms of youth (Pukui and Elbert 1986:18)

'alaea—reddish brown

Water-soluble colloidal ocherous earth, used for coloring salt, for medicine, for dye, and formally in the purification ceremony called hi'uwai; any red coloring matter; according to Dr. Frank Tabrah, brick-red soil containing hematite. See *'i'o'alaea, kuhi 'alaea. Ua 'alaea* (For. 4:399), red rain [red of the rainbow] (Pukui and Elbert 1986:19)

ali'i—chief or chiefess

Chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander (Pukui and Elbert 1986:20); implies hereditary rank

ali'i'ai-moku—paramount chief

Chief who rules a *moku* (district) (Pukui and Elbert 1986:20)

ali'i nui—high chief or chiefess

akua—a god or goddess

God, goddess, spirit, ghost, devil, image, idol, corpse; divine, supernatural; godly (Pukui and Elbert 1986:15)

'anae—mullet

Full-sized *'ama'ama* mullet fish (Pukui and Elbert 1986:24)

'au kī—ti stalk (*Cordyline terminalis)*

Stem of a ti plant (Pukui and Elbert 1986:32)

'aumakua—family god

Family or personal gods, deified ancestors who might assume the shape of sharks (all islands except Kaua'i), owls (as at Mānoa, O'ahu and Ka'u and Puna, Hawai'i) hawks (Hawai'i), *'elepaio*, *'iwi*, mudhens, octopuses, eels, mice, rats, dogs, caterpillars, rocks, cowries, clouds, or plants. A symbiotic relationship existed; mortals did not harm or eat *'aumakua* (they fed sharks), and *'aumakua* warned and reprimanded mortals in dreams, visions, and calls (Pukui and Elbert 1986:32)

'auwai—irrigation canal

Ditch, canal (Pukui and Elbert 1986:33)

'awa—kava

The kava (*Piper methysticum*), a shrub 1.2 to 3.5 m tall with green jointed stems and heart-shaped leaves, native to Pacific islands, the root being the source of a narcotic drink of the same name used

in ceremonies, prepared formerly by chewing, later by pounding. The comminuted particles were mixed with water and strained. When drunk to excess it caused drowsiness and, rarely, scaliness of the skin and bloodshot eyes. Kava was also used medicinally (Pukui and Elbert 1986:33)

ʻāweoweo—red fish

Various Hawaiian species of Priacanthus, red fishes, sometimes called bigeye (Pukui and Elbert 1986:35)

ʻelepaio—flycatcher (*Chasiempis sandwichensis*)

A species of flycatcher with subspecies on Hawaiʻi (C*hasiempis sandwichensis sandwichensis*), Kauaʻi (*C. sandwichensis sclateri*), and Oʻahu (*C. sandwichensis gayi*) (Pukui and Elbert 1986:35)

haku ʻohana—senior male of an extended family of commoners

The *haku* headed the council of the *ʻohana* (Handy and Pukui 1958:7)

hala—pandanus or screw pine (*Pandanus odoratissimus*)

The pandanus or screw pine (*Pandanus odoratissimus*), native from southern Asia east to Hawaiʻi, growing at low altitudes, both cultivated and wild. It is a tree with many branches, which are tipped with spiral tufts of long narrow, spine-edged leaves; its base is supported by a clump of slanting aerial roots. The pineapple-shaped fruits are borne on female trees whereas the spikes of fragrant, pollen bearing flowers are borne separately on male trees. Many uses: leaves (*lau hala*) for mats, baskets, hats; the yellow to red fruit sections for leis, brushes; male flowers to scent tapa, their leaflike bracts to plait mats (see *hīnano*). (Neal 51.) The aerial root (*uleule*) tip is a good source of vitamin B and cooked in ti leaves was used medicinally, although unpleasant tasting. The tree is called *pū hala*. The *hala lei* is much liked today but formerly was not worn on important ventures because *hala* also means failure. For the same reason some persons will not compose songs about *hala*. Types of *hala* are listed below. Pineapples are hala plus qualifier. See ex., pō 2. *Puna paia ʻala i ka hala*, Puna, its walls fragrant with pandanus [fragrant flowers were placed indoors in house thatching and under mats] (Pukui and Elbert 1986:50) *hala* are listed below. Pineapples are hala plus qualifier. See ex., pō 2. *Puna paia ʻala i ka hala*, Puna, its walls fragrant with pandanus [fragrant flowers were placed indoors in house thatching and under mats] (Pukui and Elbert 1986:50)

Traditional Hawaiian use included thatching, medicine, perfume, plaited items (mats, fans, baskets, sails, bedding), lei, paint brush, food wrapping, sandals (Krauss 1993:7, 17, 31–33, 50, 52, 58–59, 68, 70, 71, 77; Krauss 2001:18)

hano or *hano mālolo*—type of fish net

Fish net, as for mālolo fish or ʻ*iao;* bag net (Pukui and Elbert 1986:57)

hāʻueʻue—slate pencil sea urchin (*Heterocentrotus mammillatus*)

Slate pencil sea urchin (Heterocentrotus mammillatus). Also *hāʻueʻue peni, pūnohu* (Pukui and Elbert 1986:60)

heʻe nalu—to surf

To ride a surfboard; surfing; surf rider. *Lit.*, wave sliding (Pukui and Elbert 1986:63)

heiau—ceremonial structure or place

Pre-Christian place of worship, shrine (Pukui and Elbert 1986:64)

heiau poʻokanaka— a class of *heiau* where human sacrifices were made

A heiau where human sacrifices were offered (Pukui and Elbert 1986:64)

hinakea—stone to attract fish

Type of stone laid near the coral pile *(umu)* to attract fish; it was flat on one side and rounded on the other, and was believed to attract manini and young of other fish which resembled it in color. Lit., white gray (Pukui and Elbert 1986:71)

hoaʻāina (common people of the land, native tenants

Tenant, caretaker, as on a *kuleana* (Pukui and Elbert 1986:73)

ili ʻāina [ʻili]—division of land smaller than an *ahupuaʻa*

Land section, next in importance to *ahupuaʻa* an usually a subdivision of an *ahupuaʻa* (Pukui and Elbert 1986:97)

ʻili kū—division of land smaller than an ahupuaʻa

Land section, next in importance to *ahupuaʻa* an usually a subdivision of an *ahupuaʻa* (Pukui and Elbert 1986:97)

ʻili lele—division of land smaller than an ahupuaʻa

Land section, next in importance to *ahupuaʻa* an usually a subdivision of an *ahupuaʻa* (Pukui and Elbert 1986:97)

imu—underground earth oven

Underground oven; food cooked in an *imu* (Pukui and Elbert 1986:100)

ʻina—small sea urchin

Small sea urchin (wana), as *Echinometra spp.* (Pukui and Elbert 1986:100)

kāhala—greater amberjack (*Seriola dumerili*)

Amberjack or yellowtail (*Seriola dumerilii*) (Pukui and Elbert 1986:110)

kaha nalu—body surfing

Body surfing (Pukui and Elbert 1986:110)

kahawai—stream

Stream, creek, river; valley, ravine, gulch, whether wet or dry (Pukui and Elbert 1986:111)

kahuna—priest

Priest, sorcerer, magician, wizard, minister, expert in any profession (whether male or female); in the 1845 laws doctors, surgeons, and dentists were called kahuna (Pukui and Elbert 1986:114)

kahuna lapaʻau —healer

Medical doctor, medical practitioner, healer. Lit., curing expert (Pukui and Elbert 1986:114)

kahuna nui—high priest

High priest and councilor to a high chief; office of councilor (Pukui and Elbert 1986:114)

kai—sea

Sea, sea water; area near the sea, seaside, lowlands; tide, current in the sea; insipid, brackish, tasteless. *I kai*, towards the sea. *Makai*, on the seaside, toward the sea, in the direction of the sea. *O kai*, of the lowland, of the sea, seaward. *Nā kānaka o kai*, shore dwellers (Pukui and Elbert 1986)

kakelekele—hydropathic cure (Beckwith 1970:553)

kalo—taro

Taro (*Colocasia esculenta*), a kind of aroid cultivated since ancient times for food, spreading widely from the tropics of the Old World. In Hawaiʻi, taro has been the staple from earliest times to the present, and here its culture developed greatly, including more than 300 forms. All parts of the plant are eaten, its starchy root principally as poi, and its leaves as *lūʻau.* It is a perennial herb consisting of a cluster of long-stemmed, heart-shaped leaves rising 30 cm. or more from underground tubers or corms. (Neal [1948]157–60.) Specifically, kalo is the name of the first taro growing from the planted stalk; names of generations as listed for Hawaiʻi Island (Kep. 153) are

(1) *kalo*: see ex., *palili,* (2) *ʻohā* or *muʻu,* (3) *ʻaʻae* or *ʻae,* (4) *ʻōnihinihi,* (5) *kokole,* (6) *pahūpahū*. *Kō mākou kalo kanu o ka ʻāina* (saying), our planted taro of the land [proud and affectionate reference to a chief]. (PPN *talo*.) (Pukui and Elbert 1986:132)

kānāwai—law

Law, code, rule, statute, act, regulation, ordinance, decree, edict; legal; to obey a law; to be prohibited; to learn from experience (Pukui and Elbert 1986:127)

kapa—tapa

Tapa, as made from *wauke* or *māmaki* bark (Pukui and Elbert 1986:130)

kapu—taboo

Taboo, prohibition; special privilege or exemption from ordinary taboo; sacredness; prohibited, forbidden; sacred, holy, consecrated; no trespassing, keep out. (Pukui and Elbert 1986:132)

kauhale—spatially distinct household

Group of houses comprising a Hawaiian home, formerly consisting of men's eating house, women's eating house, sleeping house, cook-house, canoe house, etc. Term was later used even if the home included but a single house, and is sometimes used for a hamlet or settlement (Pukui and Elbert 1986:135)

kaukauali'i—lower chief or chiefess

Class of chiefs of lesser rank than the high chief, the father a high chief and the mother of lower rank but not a commoner (Pukui and Elbert 1986:135)

kī—ti (*Cordyline terminalis*)

Ti, a woody plant (*Cordyline terminalis*) in the lily family, native to tropical Asia and Australia. It consists of a branched or unbranched, slender, ringed stem, ending in a cluster of narrow-oblong, leaves 30 to 60 cm long, from among which at times rises a large panicle of small, light-colored flowers. The leaves were put to many uses by the Hawaiians, as for house thatch, food wrappers, hula skirts, sandals; the thick, sweet roots were baked for food or distilled for brandy. Besides green-leaved tis, which rarely fruit, many ornamental varieties are grown in gardens, having leaves wide to narrow, large to small, the colors purple, crimson, scarlet, rust, pink, or green, striped or plain. Red tis may have red flowers and berries. Green ti leaves are still believed to afford protection from spirits and to purify a menstruating woman (Pukui and Elbert 1986:145)

kiaʻi loko—caretaker, guardian of the pond

Guard of a fish pond (Pukui and Elbert 1986:146)

kilu—*a* game

The player chanted as he tossed the *kilu* towards an object placed in front of one of the opposite sex; if he hit the goal, he claimed a kiss (Pukui and Elbert 1986).

kinolau—forms taken by a god or demigod

Many forms taken by a supernatural body, as Pele, who could at will become a flame of fire, a young girl, or an old hag (Pukui and Elbert 1986:153)

koʻa—fishing altar

Shrine, often consisting of circular piles of coral or stone, built along the shore or by ponds or streams, used in ceremonies as to make fish multiply; also built on bird islands, and used in ceremonies to make birds multiply (Pukui and Elbert 1986:156)

konohiki—land managers

Headman of an ahupuaʻa land division undert the chief; land or fishing rights under the control of the konohiki (Pukui and Elbert 1986:166)

kou—type of tree

A tree found on shores from East Africa to Polynesia (Cordia subcordata), with large, ovate leaves, and orange, tubular flowers 2.5 to 5 cm in diameter, borne in short-stemmed clusters. The beautiful wood, soft but lasting, was valuable to the early Hawaiians and was used for cups, dishes, and calabashes (Pukui and Elbert 1986:167)

kua nalu—back of the wave

Surf just before it breaks, wave crest (Pukui and Elbert 1986:171)

kuhikuhi pu'uone—a site expert

A person skilled in picking good sites (Handy and Pukui 1958:8)

kula—dryland field

Plain, field, open country, pasture. An act of 1884 distinguished dry or *kula* land from wet or taro land (Pukui and Elbert 1986:179)

kūlana nalu—lineup in surfing

Place where the waves swell up and the surf rider starts paddling and racing the wave, usually at the most distant line of breakers. (Pukui and Elbert 1986:179)

kuleana—small piece of land under the responsibility of a tenant

Right, privilege, concern, responsibility, title, business, property, estate, portion, jurisdiction, authority, liability, interest, claim, ownership, tenure, affair, province (Pukui and Elbert 1986:179)

kū'ula—fishing shrine

n. Any stone god used to attract fish, whether tiny or enormous, carved or natural, named for the god of fishermen; heiau near the sea for worship of fish gods; hut where fish gear was kept with *kū'ula* images so that gear might be impregnated with *kū'ula mana*, usually inland and very taboo. Lit., red Kū (Pukui and Elbert 1986:179)

lau—leaf

Leaf, frond, leaflet, greens (Pukui and Elbert 1986:194)

lau 'ōpae—net for catching shrimp

Shrimp net, about a fathom long, placed around a heap of rocks called ahu or imu (fish and shrimp were prodded and frightened from the rock pile into the net); this type of fishing.(Pukui and Elbert 1986:197)

lawai'a— to fish

Fisherman; fishing technique; to fish, to catch fish.(Pukui and Elbert 1986)

leho—cowry shell lure for catching octopus

General name for cowry shell; they were used as octopus lures. *Moe a leho,* lie still as a cowry shell, as to escape detection. (PPN fole, PCP lefo.)

limu kala—seaweed

Common, long, brown seaweeds (*Sargassum echinocarpum*), their stems covered with short branches, bearing rather stiff, twisted, more or less toothed, narrow leaves. Rarely eaten raw because of toughness (though edible); used in ceremonies to drive away sickness and to obtain forgiveness (see kala 1). May be qualified by the terms *lau li'ili'i* or *lau nui.* Also *'ākala*.(Pukui and Elbert 1986:207)

limu kalawai—fresh-water algae (*Spirogyra* spp.),

limu pakaeleawa'a or limu huluhuluwaena—seaweed (*Grateloupia filicina)*

līpoa—type of seaweed

Bladelike, branched, brown seaweeds (Dictyopteris plagiogramma and D. australis) with conspicuous midrib on blade, unique aroma and flavor; highly prized on all islands (Pukui and Elbert 1986:208)

lo'i—wetland taro field

Irrigated terrace, especially for taro, but also for rice (Pukui and Elbert 1986:209)

loko i'a—traditional Hawaiian fishpond

loko i'a kalo—fishpond with *kalo* (taro)

Combination fishpond and taro patch (Pukui and Elbert 1986:210)

loko kuapā— a type of Hawaiian walled fishpond fishpond on the shoreline

Fishpond made by building a wall on a reef (Pukui and Elbert 1986:171)

loko pu'uone (or pu'uone)— dune bank fishpond; a type of Hawaiian fishpond near the ocean

Pond near the shore, as connected to the sea by a stream or ditch (Pukui and Elbert 1986:359)

loko 'ume'iki—Shore pond

Shore fishpond with lanes leading in and/or out of the pond, used for trapping fish and probably only on Moloka'i, (Summers, 1964:12–19, 24.) Lit., small pond drawing in. (Pukui and Elbert 1986:210)

loko wai—fresh-water pond

Fresh-water pond or lake (Pukui and Elbert 1986:210)

lo'ulu—fern

An endemic fern (Coniogramme pilosa) with leaves somewhat like those of the breadfruit tree ('ulu) but the divisions narrower and deeper.

lū'au— young taro tops

Young taro tops, especially as baked with coconut cream and chicken or octopus (Pukui and Elbert 1986:214)

maka'āinana—commoner

Commoner, populace, people in general (Pukui and Elbert 1986:224)

malihini—stranger

Stranger, foreigner, newcomer, tourist, guest, company; one unfamiliar with a place or custom; new, unfamiliar, unusual, rare, introduced, of foreign origin; for the first time (Pukui and Elbert 1986:231)

mālolo—flying fish; *Parexocoetus brachypterus* and others

General term for Hawaiian flying fishes (Parexocoetus brachypterus and others) (Pukui and Elbert 1986:233)

manini—surgeonfish (*Acanthurus triostegus*)

Very common reef surgeonfish (Acanthurus triostegus), also called convict tang, in the adult stage (Pukui and Elbert 1986:239)

māno–dam

Dam, stream, or water source, headwaters, place where water is obstructed for distribution in channels, channels (Pukui and Elbert 1986:239)

manō kumupa'a—ancestral shark

mele—song

Song, anthem, or chant of any kind; poem, poetry; to sing, chant (Pukui and Elbert 1986:245)

moano—goatfish

Goatfish (*Parupeneus multifasciatus*) (Pukui and Elbert 1986:249)

mōʻī—king

King, sovereign, monarch, majesty, ruler, queen (Pukui and Elbert 1986:251)

moku—district

District, island, islet, section, forest, grove, clump, severed portion, fragment, cut, laceration, scene in a play (Pukui and Elbert 1986:252)

moʻo—supernatural lizard

Lizard, reptile of any kind, dragon, serpent; water spirit (Pukui and Elbert 1986:253)

moʻōlelo–legend

Story, tale, myth, history tradition, legend, journal, log, yarn, fable, essay, chronicle, record, article (Pukui and Elbert 1986:254)

mua—type of *heiau* also called a men's house

Men's eating house (Pukui and Elbert 1986:255)

muliwai—estuary

River, river mouth; pool near mouth of a stream, as behind a sand bar, enlarged by ocean water left there by high tide; estuary (Pukui and Elbert 1986:256)

nalo—wave

Wave, surf; full of waves; to form waves; wavy, as wood grain (Pukui and Elbert 1986:260)

ʻohana—family

Family, relative, kin group; related. ʻOhana holoʻokoʻa, ʻohana nui, extended family, clan. Pukui and Elbert 1986:276)

ʻōkuʻu—dysenteric disease, possible cholera

Disease at time of Ka-mehameha I, perhaps cholera, and perhaps so called because it was dysenteric, and people were squatting (ʻōkuʻu) much at stool (Pukui and Elbert 1986:282)

ʻopihi—limpet

Limpets, Hawaiians recognize three kinds: kōʻele (*Cellana talcosa*, the largest), *ʻālinalina* (*C. sandwicensis*), *makaiauli (C. exarata).* Scientists also recognize *C. melanostoma.* (Pukui and Elbert 1986:292)

ʻoʻopu—goby

General name for fishes included in the families Eleotridae, Gobiidae, and Blennidae. Some are in salt water near the shore, others in fresh water, and some said to be in either fresh or salt water. Varieties include bluespotted goby (*Quisquilius eugenius*) and indigo hover goby (*Ptereleotris heteropterus*). *ʻOʻopu ʻai lehua*, poetic description of *ʻoʻopu* found in upland streams where lehua flowers drop into the water; lit., lehua-eating *ʻoʻopu*. *Kau ke alapiʻi a ka ʻoʻopu*, the *ʻoʻopu f*ish form a stairway [*ʻoʻopu* are said to jump over rocks from pool to pool]. See also *alamoʻo*, naniha, *ʻōkuhe, ʻoau 1*. (PCP *kokopu.*) (Pukui and Elbert 1986:290)

paʻakai—salt

Salt (Pukui and Elbert 1986:297)

pāhale—house lot

House lot, yard, fence (Pukui and Elbert 1986:299)

pākākā nalu—canoe surfing

pali—cliff

> Cliff, precipice, steep hill or slope suitable for *olonā* and *wauke*; full of cliffs; to be a cliff (Pukui and Elbert 1986:321)

palu—fish bait

> A relish made of head or stomach of fish, with kukui relish, garlic, chili peppers; fish bait made of fish head or stomach, also used for chumming (Pukui and Elbert 1986:331)

pipipi—nerite (*Nerita picea*)

> General name for small mollusks, including *Theodoxus neglectus* (Pukui and Elbert 1986:331)

pōhaku—stone

> Rock, stone, mineral, tablet (Pukui and Elbert 1986:334)

pōhākialoa—stone used as landmark

> Stone used as a landmark, as of a land boundary, or for locating a fishing ground; stone with a knob at the top, used as a weight for deep-sea fishing; fishing grounds about 260 m deep (Pukui and Elbert 1986:334)

pueo—owl

> Hawaiian short-eared owl (*Asio flammeus sandwichensis*), regarded often as a benevolent ‘*aumakua* (Pukui and Elbert 1986:348)

puhi—eel

> Eel (see below). A hitherto undescribed eel was identified in 1978 as *Gymnothorax ruepelliae*. Some persons considered *puhi* as ‘*aumākua* (Pukui and Elbert 1986:349)

puhiki‘i—any species of young flying fish

> According to some, young of all flying fish; according to others, same as mālolo (Pukui and Elbert 1986:350)

pūlo‘ulo‘u—kapu sticks

> A tapa-covered ball on a stick (*pahu*) carried before a chief as insignia of taboo (Pukui and Elbert 1986:354)

pūpū ālealea— Hawaiian top shell *(Turbo sandwicensis)*

uhu—parrotfish (*Scarus* spp.)

> The parrot fishes, of which *Scarus perspicillatus is* among the most abundant and largest; uhu are plant eaters, the teeth are strong and beaklike, well fitted for clipping off food from coral (Pukui and Elbert 1986:364)

unu—same as *umu*

> Small stone, pebble, stone chip; wedge, prop. Cf. *unu pehi ‘iole*. *Kohala i ka unu pa‘a*, Kohala with the solid stone [firmness]. *ho‘o.unu* To place stones; to pave, macadamize (Pukui and Elbert 1986:372)

u‘u —squirrelfish (*Myripristis* spp.)

wahi pana—legendary place

> Legendary place (Pukui and Elbert 1986:377)

APPENDIX A: CONSULTATION PROCESSES

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CULTURAL CONSULTATION EFFORTS

Pacific Consulting Services, Inc. (PCSI) under contract to Conservation International, prepared a Cultural Impact Assessment (CIA) in accordance with *Guidelines for Assessing Cultural Impacts* adopted by the Environmental Council, State of Hawai'i (November 19, 1997). In accordance with those guidelines, PCSI attempted to identify and recruit individuals and organizations with a knowledge of cultural practices and beliefs to participate in the CIA. Specific outreach efforts performed consisted of the following activities:

Public Notice: A notice was published in the Office of Hawaiian Affairs (OHA) newsletter Ka Wai Ola on November 1, 2025 identifying the REEFrame activities and inviting individuals and organizations with a knowledge of cultural resources, practices, and beliefs in the general area to participate in the CIA. Exhibit A-1 provides a copy of the notice. The notice provided an email address and web page through which interested parties could contact PCSI for additional information or to participate in the CIA.

Web Page: A web page was created and hosted at www.pcsihawaii.com/reef to provide additional information concerning the REEFrame project. The web page encouraged interested parties to participate and included a link to email PCSI for additional information. Exhibit A-2 provides a copy of the web page as it existed on November 1, 2025. The web page is currently still active (as of February 10, 2026).

Direct Outreach: PCSI sent emails to 56 organizations and individuals inviting them to participate in the CIA process. The contacted parties included cultural descendants previously recognized by the Oahu Island Burial Council (OIBC) in the Waikīkī ahupua'a, OHA, other Native Hawaiian Organization (NHOs), civic clubs, and canoe clubs. Exhibit A-3 provides a list of the parties contacted and Exhibit A-4 provides the text of the emails sent. Four of the mails were returned as undeliverable and no response was received to 51 of the emails, as of January 31, 2026. One previously identified cultural descendant replied to the outreach emails indicating a desire to participate in the CIA. PCSI reached out the that individual on several occasions in an attempt to schedule a conversation or interview. However, that individual was unavailable due to other commitments.

No other communications were conducted with individuals or organizations in the preparation of the CIA. Because of the unavailability of informants, the CIA relied only on published literature documenting past studies and ethnographic research.

Exhibit A-1. Public Notice in Ka Wai Ola, November 1, 2025

HOʻOLAHA LEHULEHU
PUBLIC NOTICE

CULTURAL IMPACT ASSESSMENT AND KA PAʻAKAI ANALYSIS: HAWAIIAN CEMENT NEW MINING AREA PROJECT, PŪLEHUNUI, MAUI

Cultural Surveys Hawai'i (CSH), on behalf of Hawaiian Cement, is conducting a cultural impact assessment (CIA) and Ka Pa'akai Analysis for the proposed Hawaiian Cement New Mining Area Project, Pūlehunui, Wailuku, Maui (TMK: [2] 3-8-004:001). Hawaiian Cement proposes to develop a new mining area of approximately 125 acres adjacent to their existing quarry area within a portion of TMK: (2) 3-8-004:001 CPR 2. The subject portion of the parcel is currently owned by MP Central A LLC and Hawaiian Cement. CSH seeks your knowledge, insight, and input on the following topics:

- Your knowledge of traditional cultural practices within the proposed project area and Pūlehunui Ahupua'a
- The different natural resources associated with your specific cultural practice
- Referrals to other kūpuna, kama'āina, and traditional cultural practitioners knowledgeable about the proposed project area and Pūlehunui Ahupua'a
- Your comments or thoughts on the potential impacts the proposed project may have on cultural sites, practices, and resources within the proposed project area and Pūlehunui Ahupua'a

If you are interested in participating in this study, please contact CSH Cultural Researcher, Chantellee Spencer by email at cspencer@culturalsurveys.com no later than Monday, November 17.

KA PAʻAKAI ANALYSIS: PROPOSED KO OLINA WELL, HONOULIULI AHUPUAʻA, ʻEWA MOKU, ISLAND OF OʻAHU

Pacific Legacy, Inc., on behalf of The Resort Group, is conducting a Ka Pa'akai Analysis for the Proposed Ko Olina Well Project in Honouliuli Ahupua'a, 'Ewa Moku, O'ahu [TMK: (1) 9-1-056:015 (por.) and (1) 9-1-056:01745 (por.)]. The project is for the development of an irrigation well in Ko Olina (KO-1 Well) that will connect to the Board of Water Supply's Barbers Point non-potable system. Pacific Legacy, Inc. seeks to consult with individuals and organizations who possess knowledge regarding:

- Cultural associations, mo'olelo, or legendary accounts associated with Honouliuli Ahupua'a.
- Past and present land use or traditional gathering practices within and near the project area.
- Cultural resources which may be impacted by the proposed project, including traditional resource gathering sites, traditional access trails, wahi pana, and/or burials.
- Any other cultural concerns related to traditional Hawaiian or other cultural practices within or near the proposed project area.
- Referrals to other knowledgeable individuals who may be willing to share their cultural knowledge of the proposed project area and wider Honouliuli Ahupua'a.

Those interested in participating are invited to contact Makanani Bell at 808-263-4800 or bell@pacificlegacy.com.

CULTURAL IMPACT ASSESSMENT: PROPOSED WAIKĪKĪ REEFRAME PROJECT

On behalf of Conservation International, LLC, Pacific Consulting Services, Inc. (PCSI) is preparing a Cultural Impact Assessment (CIA) in support of a HRS Chapter 343 Environmental Assessment for the proposed REEFrame project to be located in waters off shore of Waikīkī in the Kona District, on the island of O'ahu. REEFrame is a project designed to foster the recovery of a severely degraded coral-reef ecosystem, thereby restoring reef fisheries, providing vital food sources for endangered monk seals and green sea turtles, and enhancing local community livelihoods. The REEFrame project team will install permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. All of the concrete reef frameworks will be placed on sand at depths of 40 to 60 feet below the ocean surface, starting approximately ½ mile off shore, and at least 100 feet from existing coral habitat. PCSI seeks to consult with individuals and organizations possessing knowledge regarding cultural resources, practices, and beliefs within the Waikīkī ahupua'a and the Kona District that could potentially be affected by the project. Additional project information is available at www.pcsihawaii.com/reef. A link is available at that site to contact the project team to request more information or volunteer to share your knowledge. You may also email us directly at info@pcsihawaii.com. Mahalo!

CONSULTATION FOR SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT OF 1966, AS AMENDED (SECTION 106)

The City and County of Honolulu, Department of Design and Construction (DDC) seeks to utilize funding from the Federal Highway Administration for the construction phase for the Replacement of Waialua Beach Road Bridge (Bridge No. 605) over Ki'iki'i Stream located within Kamananui Ahupua'a, Waialua District, O'ahu, Hawai'i, Tax Map Keys: Waialua Beach Road Right-of-Way; (1) 6-6-022: 001 por., 004; 6-7-001: 010 por., 014, 017; 6-7-009: 002. The project is considered a federal undertaking pursuant to 36 Code of Federal Regulations §800.16(y).

The project consists of the replacement of Waialua Beach Road Bridge with a new concrete bridge supported by drilled-shaft abutments and single center pier. The new bridge will be located along the same alignment as the existing bridge. A temporary bypass bridge will be constructed along the upstream side of the existing bridge to maintain traffic flow during the project's construction.

Pursuant to Section 106, Native Hawaiian Organizations and Native Hawaiian descendants with ancestral, lineal or cultural attachments to historical resources within the area of potential effect, as well as other individuals and organizations with demonstrated legal, economic or historic preservation interest in the undertaking are requested to contact DDC with any information.

Please submit responses within 30 days of this notice to our planning consultant, Jim Niermann, R.M. Towill Corporation via email at jimn@rmtowill.com or mail to R.M. Towill Corporation, Attn.: Jim Niermann, 2024 North King Street, Suite 200, Honolulu, Hawai'i 96819. ■

HOʻOHUI ʻOHANA
FAMILY REUNIONS

E nā ʻohana Hawaiʻi: If you are planning a reunion or looking for genealogical information, *Ka Wai Ola* will print your listing at no charge on a space-available basis. Listings should not exceed 200 words. OHA reserves the right to edit all submissions for length. Listings will run for three months from submission, unless specified. Send your information by mail, or e-mail kwo@OHA.org. E ola nā mamo a Hāloa!

SEARCH

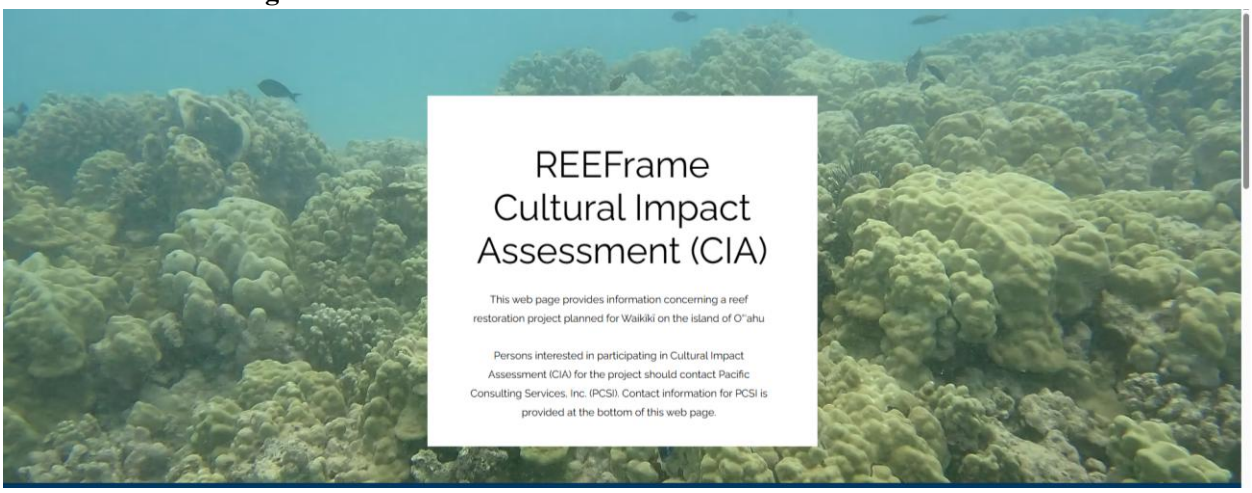
DUVAUCHELLE - ʻOhana Reunion 2026 on Molokaʻi. The Duvauchelle ʻohana invites you to reconnect and celebrate our shared legacy at One Aliʻi Park on Molokaʻi, July 23–26, 2026. For info or to register go to www.duvauchelleohanareunion.org beginning 10/1/25. NOTE: Flights to Molokaʻi on Mokulele Airlines for July 2026 may be booked starting January 2026. Flights are limited so ʻohana should plan early. Let's strengthen our moʻokūʻauhau, enjoy fellowship, and build new memories for generations to come.

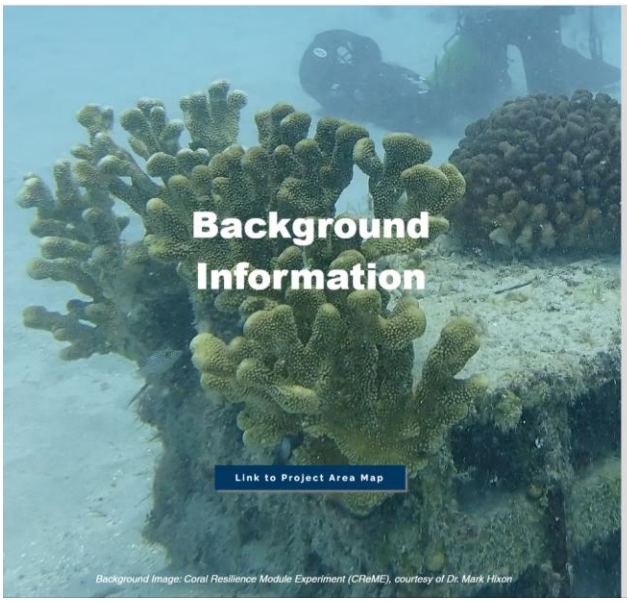
KELEPOLO - Calling the descendants of Maikaʻaloa and Annie (Kumulau) Kelepolo of Kainaliu, Kona, Hawai'i and their seven keiki: Albert, Peter, Josephine, William, Joseph, Isabella, and Lillian. We are planning an ʻohana reunion for July 17-19, 2026, in Kona, Hawai'i. Contact Monico Galieto (grandson of William Kelepolo) at kelepoloohana@gmail.com or call (808) 936-5682. When emailing, provide your name, phone number, mailing/email addresses. and how you're related, I will send an information packet.

KUPIHEA - ʻOhana of Solomon N. Kupihea and M. Hattie Kuapahi Kupihea – join us on Kauaʻi July 12-19, 2026! Daily activities to strengthen bonds and learn family faces. Let all your ʻohana know! Visit our website and complete the Interest Survey: bit.ly/Kupihea-Kuapahi-reunion-2026. Email: kupihea.reunion@gmail.com.

PIO - Descendants of Kepio and Keoahu of Kaupō, Maui, are having a family reunion on Maui, Labor Day weekend, Sept. 4-6, 2026 at Pukalani Community Center. Their six children early on used the surnames Kepio or Pio: Sampson Kahaleuahi (Anadasia Kealoha); Victoria Nakoaelua (Kahaleauki); Maria Malaea (Keahi/Adams, Sam Akahi Sr.); Samuel Kaukani (Mele Kakaio, Rebecca Malulu); Ipoaloha (Kalalani Kekiwi); and Joseph Kaleohano (Elizabeth Nakula, Minnie Aloiau). Contact: Kaʻapuni Peters-Wong 808-375-4321; Toni Kowalski-Dacquel 808-436-1845; Valda Baisa Andaya 808-572-9245; Ululani Opiana Glass 808-446-9309; Kapiolani Adams 808-778-6383; or email pioohana@gmail.com. ■

Exhibit A-2: Web Page





On behalf of Conservation International, PCSI is preparing a Cultural Impact Assessment (CIA) and a Ka Pa'akai analysis in support of a HRS Chapter 343 Environmental Assessment for the proposed REEFrame project to be located in waters off-shore of Waikīkī in the Kona District, on the island of O'ahu.

REEFrame is a project designed to foster the recovery of a severely degraded coral-reef ecosystem, thereby restoring reef fisheries, providing vital food sources for endangered monk seals and green sea turtles, and enhancing local community livelihoods.

The REEFrame project team will install permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. All of the concrete reef frameworks will be placed on sand at depths of 40 to 60 feet below the ocean surface, starting approximately 3/4 mile off shore. All of the reef frameworks will be at least 100 feet from any existing coral habitat.

The link on the left will open a map showing the proposed project area.

Request for Consultation

Per Hawaii Revised Statutes (HRS) Chapter 343, an Environmental Assessment (EA) is being prepared for the REEFrame project. The EA will include a CIA that follows the *Guidelines for Assessing Cultural Impacts* adopted by the State of Hawaii Environmental Council in 1997. In addition, a Ka Pa'akai analysis will be prepared following the analytical framework established by the Hawaii Supreme Court to ensure the preservation and protection of traditional and customary practices exercised by Native Hawaiians.

PCSI seeks to identify and consult with individuals and organizations with expertise concerning the types of cultural resources, practices, and beliefs associated with the area. The goal of the consultation is to identify those cultural considerations and determine if there is a potential for the REEFrame project to have any affect on cultural resources, practices, or beliefs. If potential adverse effects are identified, the consultation will also seek to identify possible ways to mitigate those effects.

Individuals and organizations wishing to share their knowledge to inform the assessment efforts for this project are requested to contact PCSI no later than December 1, 2025.

Interested parties are requested to contact Doug Hazelwood at PCSI, 1130 North Nimitz Highway, Suite C300, Honolulu, Hawaii 96817 (email info@pcsihawaii.com, telephone (808) 546-5557). The link below will generate an email to PCSI.

Mahalo for your consideration of this request.

Email PCSI

Exhibit A-3: Parties Contacted Through Direct Email Outreach

NHO/DESC	LAST NAME	FIRST NAME	EMAIL	RESPONSES
DESCENDANT	Arakaki	Stephanie	stephanie.arakaki@tsa.dhs.gov	No Response
DESCENDANT	Arcalas	Carla	carcalas.3@gmail.com	No Response
DESCENDANT	Ayau	Edward Halealoha	halealohahapai64@gmail.com	No Response
DESCENDANT	Caceres	Hiehie	caceresk@hawaii.edu	No Response
DESCENDANT	Caceres	Mana	couldnttakethemana@gmail.com	No Response
DESCENDANT	Caceres	Makoa	k17kecace@gmail.com	No Response
DESCENDANT	Caceres	Kalehua	kekama3@gmail.com	No Response
DESCENDANT	Haole	William (Bill)	whaole54@gmail.com	Expressed initial desire to participate but unable to participate due to other commitments
DESCENDANT	Kaleikini	No`eau	honua34@gmail.com	No Response
DESCENDANT	Kamohalii	Olana	kamohalii@yahoo.com	No Response

NHO/DESC	LAST NAME	FIRST NAME	EMAIL	RESPONSES
DESCENDANT	Keli`ipa`akaua	Chase	chase.k.keliipaakaua@gmail.com	No Response
DESCENDANT	Keli`ipa`akaua	Justin	kepoo82@gmail.com	No Response
DESCENDANT	Kini	Debbie Norman	kekahili@gmail.com	No Response
DESCENDANT	Kini-Lopes	Kamaha'o	kini3@hawaii.edu	No Response
DESCENDANT	Kini-Lopes	Puahone	puahonelopes@yahoo.com	No Response
DESCENDANT	Norman	Kaleo K.	kaleonorman@gmail.com	No Response
DESCENDANT	Norman	Theodore R. Kekua	kekua1@msn.com	No Response
DESCENDANT	Norman	Keli‘inui K.	keliinui9@msn.com	No Response
DESCENDANT	Paishon	Kamuela (Kamohalii)	kamohalii@yahoo.com	No Response
DESCENDANT	Peyton	Nicole K. (Suzuki)	nickipeyton808@gmail.com	No Response
DESCENDANT	Suzuki	Ashley	ashley.w.suzuki@gmail.com	No Response

NHO/DESC	LAST NAME	FIRST NAME	EMAIL	RESPONSES
ʻAha Mālama, Corp	Jackson	ʻĀnela	ahamalama.anela@gmail.com	No Response
ʻĀina Momona	Ritte	Walter	walter@ritte.org ainamomona1893@gmail.com	No Response
	Watson	Trisha Kehaulani	community@honuaconsulting.com	No Response
ʻApoākea Native Hawaiian Innovation Institute	Hyden	Brandi-Lynn Makalani Kupau	makalani@apoakea.org	No Response
Brian Kaniela Naeʻole Naauao	Naauao	Brian Kaniela Naeʻole	naeoleohana5@yahoo.com	No Response
Coucil for Native Hawaiian Advancement	Lewis	Joseph Kūhiō	info@hawaiiancouncil.org	No Response
E Ola Kākou Hawaiʻi	Cummings	Roslyn	mana.eolakakouhawaii@gmail.com	No Response
Hale Mua Cultural Group	Madarang	Renson	renson@rmvoicestudio.com	No Response
Hawaiian Islands Land Trust	Campbell	ʻOlu	info@hilt.org	No Response
Honua Consulting, LLC	Watson-Sproat	Trisha Kehaulani	admin@honuaconsulting.com	No Response
Hua Nani Impact	Barnes	Aimee Elise Kelii	aimee@hnimpact.org	Email undeliverable

NHO/DESC	LAST NAME	FIRST NAME	EMAIL	RESPONSES
Kalihi Palama Hawaiian Civic Club	Khan	Leimomi	mkhan@hawaiiantel.net	Email undeliverable
Kamehameha Schools	Makāula	Roz Kahalelehua	romakaul@ksbe.edu	No Response
*Kānehūnāmoku Voyaging Academy	Kahapea-Tanner	Bonnie	kahapea@kanehunamoku.org	No Response
Kanu o ka ʻĀina Learning ʻOhana	Wise	Taffi	taffi@kalo.org	No Response
Kapule Organization	Kapule	Nicholas	info@kapulellc.com	No Response
Kawaileo Law A Limited Liability Law Company	Kamaliʻi	Naʻunanikinau	contact@kawaileolaw.com	No Response
Kiaʻi Kanaloa	Keliʻikipikāneokolohaka	Roxane	kiaikanaloa@gmail.com	No Response
Koʻolau Foundation	Cypher	Mahealani	malamapono744@aol.com	No Response
Kuaʻāina Ulu ʻAuamo	Chang	Kevin	info@kuahawaii.org	No Response
Kululoiʻa Lineage - I ke Kai ʻo Kululoiʻa	Kululoio	Manuel	manuel.kululoio@gmail.com	No Response
	Vedder	Leināʻala Kululoio	puniawalei@hotmail.com	No Response

NHO/DESC	LAST NAME	FIRST NAME	EMAIL	RESPONSES
Mahu Ohana	Mark	Keona	keonamark@gmail.com	No Response
Na Koa Ikaika Ka Lahui Hawaii	Trask	Mililani	mililani.trask@icllchawaii.com	No Response
Native Hawaiian Hospitality Association	Sanders	Mālia	info@nahha.com	No Response
Nohopapa Hawai‘i, LLC	Uyeoka	Kelley	kelley@nohopapa.org	Email undeliverable
O‘ahu Canoe Racing Association	Schultz	Clinton	info@ohcra.com	No Response
Office of Hawaiian Affairs	Ferreira	Stacy Kealohalani	stacyf@oha.org	No Response
‘Ohana Keaweamahi	Norman	Carolyn Keala	ckeala@hotmail.com	No Response
‘Ohana Keohokālole	Keohokalole	Emma Emalia	eek@hawaii.edu	Email undeliverable
Papa Ola Lokahi	Daniels	Sheri-Ann	sdaniels@papaolalokahi.org	No Response
Partners in Development Foundation	Kana‘iaupuni	Shawn	pid@pidfoundation.org	No Response
Pele Defense Fund	Dedman	Palikapu	palidedman@gmail.com	No Response

NHO/DESC	LAST NAME	FIRST NAME	EMAIL	RESPONSES
Pu‘uhonua o Wailupe	Hikalea	Michael	puuhonuaowailupe@gmail.com	No Response
Wai Koa Kaua‘i	Cummings	Jesse	jessekekoacummings@yahoo.com	No Response

Exhibit A-4: Outreach emails Posted November 1, 2025

Subject: Cultural Impact Assessment for REEFrame – A Project to Restore Severely Degraded Coral Reefs in Hawai‘i via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks

Purpose of This Announcement

On behalf of Conservation International, Pacific Consulting Services, Inc. (PCSI) is preparing a Cultural Impact Assessment (CIA) in support of Hawaii Revised Statutes, Chapter 343 Environmental Assessment for the proposed REEFrame project. The project is proposed to be located in waters off-shore of Waikīkī, within the Waikīkī ahupua'a, in the Kona District, on the island of O‘ahu. A Ka Pa‘akai analysis will also be prepared for the project. This announcement is being provided to invite individuals and organizations to participate in the Cultural Impact Assessment (CIA) study.

Description of the Proposed REEFrame Project

REEFrame is a project designed to foster the recovery of a degraded coral-reef ecosystem, thereby restoring reef fisheries, providing vital food sources for endangered monk seals and green sea turtles, and enhancing local community livelihoods. The REEFrame project team will install permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. All of the concrete reef frameworks will be placed on sand at depths of 40 to 60 feet below the ocean surface. No REEFrame activities will take place within 100 feet of any existing coral habitat.

The project site is planned at a location approximately three-quarters of a mile offshore of the iconic Waikīkī Beach, Honolulu, on the island of O‘ahu. This is the location of some of the most degraded reefs in Hawai‘i. The attached figure shows the REEFrame project site in relation to several known landmarks.

REEFrame is currently in the planning stage. Current efforts include consultations with community members and agencies to help inform the project design. After the final plan is completed, the project team will apply for the necessary State and Federal permits. Once permitted, a barge will take the fabricated REEFrame structures and carefully deploy them from the barge to the seafloor at the site in Waikīkī. The final step in the project would be sourcing and affixing natural coral pieces found unattached on the ocean floor (known as “corals of opportunity”) onto the REEFrame structures, which will then continue to grow on the modules, creating a new coral reef off Waikīkī.

Consultation Request

Individuals and organizations with a knowledge of cultural resources, practices, or beliefs that could potentially be affected by the proposed REEFrame project are encouraged to share their knowledge by participating in the CIA process. To submit information for consideration, or to request additional information concerning the proposed undertaking, please contact PCSI at:

Pacific Consulting Services, Inc.
1130 North Nimitz Highway, Suite C300

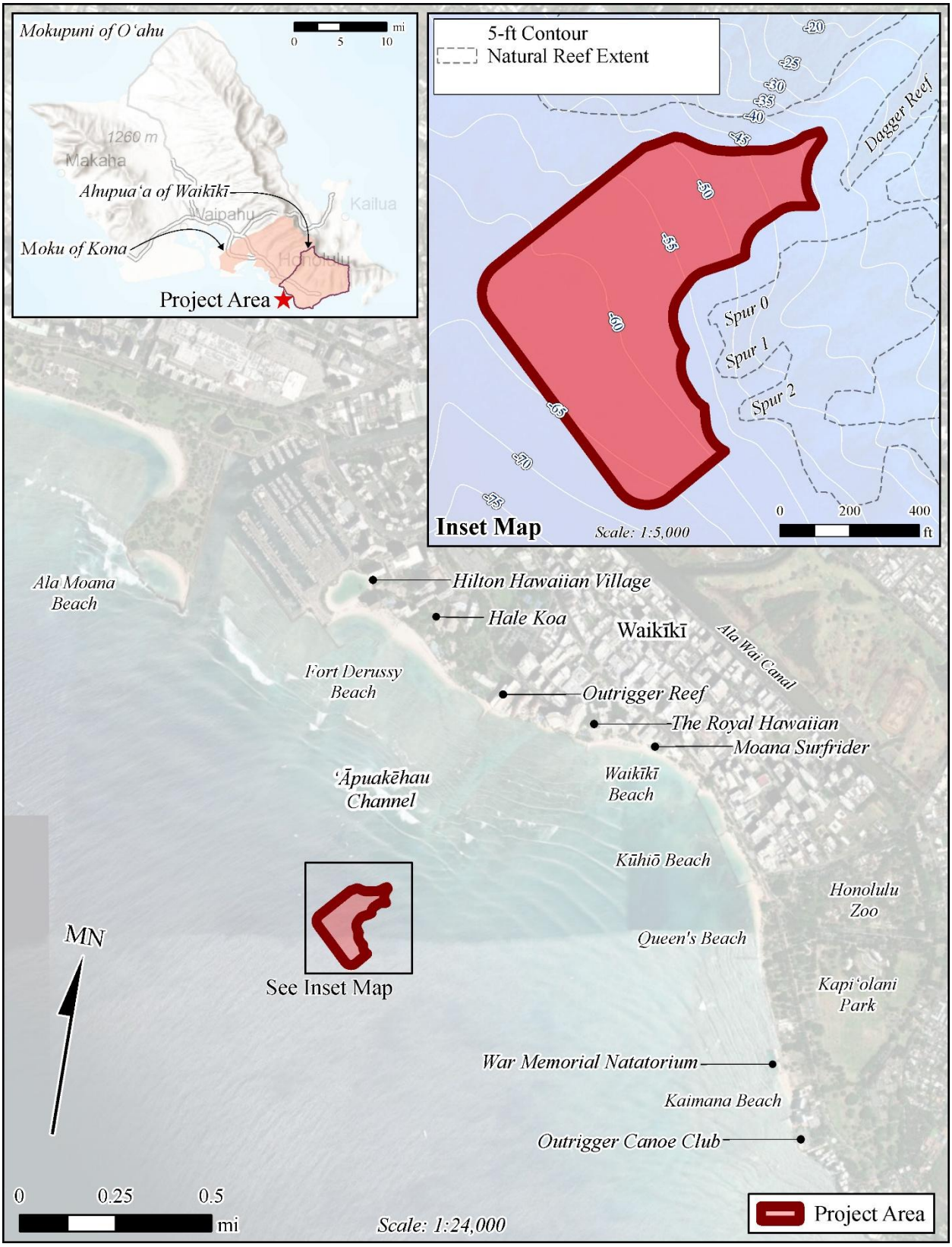
Honolulu, Hawaii 96817
info@pcsihawaii.com

Parties wishing to submit information or engage in consultation are requested to contact PCSI no later than December 1, 2025

In addition to conducting a CIA, the REEFrame project is required to comply with additional resource protection requirements. In meeting those obligations, you may be invited by the project team to participate in other related public outreach and consultation efforts. Those additional efforts are anticipated to focus on the evaluation of potential impacts to historic properties and environmental resources. You are encouraged to participate in all public outreach and consultation activities where you believe you have information to share.

Additional project information is available at www.pcsihawaii.com/reef. A link is available at that site to contact the project team to request more information or volunteer to share your knowledge.

Mahalo for your consideration of this request.


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Fort Derussy Beach
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The Royal Hawaiian
Moana Surfrider
'Āpuakēhau Channel
Waikīkī Beach
Kūhiō Beach
Honolulu Zoo
Queen's Beach
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Project Area

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APPENDIX B: KA PA'AKAI ASSESSMENT

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INTRODUCTION

Under contract to Conservation International, Pacific Consulting Services, Inc. (PCSI) has prepared a Cultural Impact Assessment (CIA) report and a Ka Paʻakai assessment in support of REEFrame: Restoration of Severely Degraded Coral Reefs in Hawaii via Permanent Coral Nurseries on 3D Printed Concrete Reef Frameworks, Waikīkī Ahupuaʻa, Kona Moku, Island of Oʻahu, State of Hawaiʻi. Funding for the Proposed Action is being provided by the National Oceanic and Atmospheric Administration's (NOAA) Office of Habitat Conservation. In addition to NOAA, entities from the public, private, and nonprofit sectors are involved in this project, including Conservation International, the University of Hawaiʻi at Mānoa, the Hawaiʻi Division of Aquatic Resources, ocean technology firm Natrx, ocean engineering firm Oceanit, and workforce development nonprofit ClimbHI. The project is in ocean waters under the jurisdiction of the State of Hawaiʻi.

This Ka Paʻakai assessment provides a summary of the proposed REEFrame project and its potential impacts on valued cultural, historic, and natural resources

REGULATORY CONTEXT

Pursuant to Hawaii Environmental Policy Act (HEPA), Chapter 343 of the Hawaii Revised Statutes (HRS), an Environmental Assessment (EA) is required for the Proposed Action. A CIA was prepared in accordance with the *Guidelines for Assessing Cultural Impacts* adopted by the Environmental Council, State of Hawaiʻi (November 19, 1997) in support of the EA The Guidelines provide methodological and content protocol for projects/actions that may have the potential to affect cultural resources, stipulating specific matters that should be addressed in all CIAs.

An alternative analytical framework, commonly termed a Ka Paʻakai assessment, can be used for addressing the preservation and protection of cultural practices specific to Native Hawaiian communities. This approach resulted from a 2000 Hawaii Supreme Court ruling (*Ka Paʻakai O Ka ʻAina versus Land Use Commission).* In its decision, the court established the following three-part analytical approach:

> Part 1, identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary Native Hawaiian rights are exercised;
>
> Part 2, identify the extent to which those resources and rights will be affected or impaired; and
>
> Part 3, specify any measures to be taken to reasonably protect Native Hawaiian rights if they are found to exist.

This Ka Paʻakai assessment was prepared for the Proposed Action following the above analytical approach. Detailed background on cultural and historical resources present in the project area is provided in the EA and CIA documents prepared for the proposed REEFrame project and is summarized here.

ASSESSMENT METHODOLOGY

This assessment was prepared based on historical records and past ethnographic research identified and reviewed by PCSI. PCSI also attempted to recruit informants to participate in the assessment process through a notice posted in the Office of Hawaiian Affairs (OHA) newsletter, Ka Wai Ola, a dedicated web page, and directed outreach. A total of 56 individuals and organizations with a knowledge of cultural practices and features in the Waikīkī area were contacted and invited to consult in the preparation of this assessment. These included 21 cultural descendants identified from past CIA reports and burial treatment planning efforts, the Office of Hawaiian Affairs, several Native Hawaiian Organizations (NHOs), community groups, civic organizations, and businesses. None of the parties contacted provided any information to inform this assessment. Details of the consultation outreach are provided in Appendix A of the CIA report.

PROJECT AREA

The REEFrame Project Area is at the mouth of the ʻĀpuakēhau Channel along the coast of Waikīkī in Honolulu, Hawaiʻi and is depicted in Figure 23. The Project Area is approximately 0.75 to 1 mile off Waikīkī Beach in water depths between 40 to 60 feet. The state's management authority extends seaward up to three nautical miles. Tax Map Key (TMK) plats along the coast near the project area include (1) 2-6-001, 002, and 004. No work will be conducted on land (i.e., the beach or shoreline).

PROPOSED ACTION

The Proposed Action is the REEFrame project. It is a four-year, collaborative coral reef restoration project in Hawaiʻi that seeks to foster coral growth and improve habitat by building permanent coral nurseries. Innovative DryForming™ technology will be used to create naturally shaped concrete modules that will provide an ideal habitat for both recruiting and growing coral, fish, and other reef life.

REEFrame modules are digitally designed, 3D printed, concrete reef systems. A module comprises five total units, including four units which form the base and the fifth unit on top. Up to 150 REEFrame modules are planned to be installed approximately 0.6 miles (1.0 kilometer) off the coast of Waikīkī Beach, at depths of approximately 40.0–60.0 feet (approximately 12.0–18.0 meters), and serve primarily as coral nurseries, providing attachment sites for corals that will support reef restoration projects. Simultaneously, these permanent structures will also provide shelters for a variety of species, as they are naturally colonized by corals, fish, and other sea life. Eventually, they will become de facto natural reefs.

The modules comprise concrete material with steel hardware covered in concrete coatings and contain holes, crevasses, ledges and other intentional design elements to help mimic a natural reef structure. These features vary between modules, and aim to provide habitat for coral, fish and other sea life. Each module measures six feet wide and six feet tall. The design weight is an average of five tons and structurally designed to be stable in a 50-year southern swell storm event where wave heights may reach or exceed 18 feet with a sustained 18 second period.

The REEFrame modules will be fabricated at the Natrx facility in Amelia, Louisiana, and transported to Hawaiʻi. Placement of REEFrame modules will require construction barges with heavy equipment to carefully place the units on the sandy sea floor. To help control the risks of inadvertently placing a structure on the natural reef, construction will proceed only during fair weather conditions at the site (calm waves, currents and winds). GPS will be used to confirm the placement locations of each module. Additionally, observation divers will assist with the operation, ensuring the accuracy of each placement and avoiding damage to sensitive species and habitats. On-site deployment of the REEFrame modules is anticipated to last two to four weeks. Vessel traffic in the project area will be temporarily restricted during deployment.

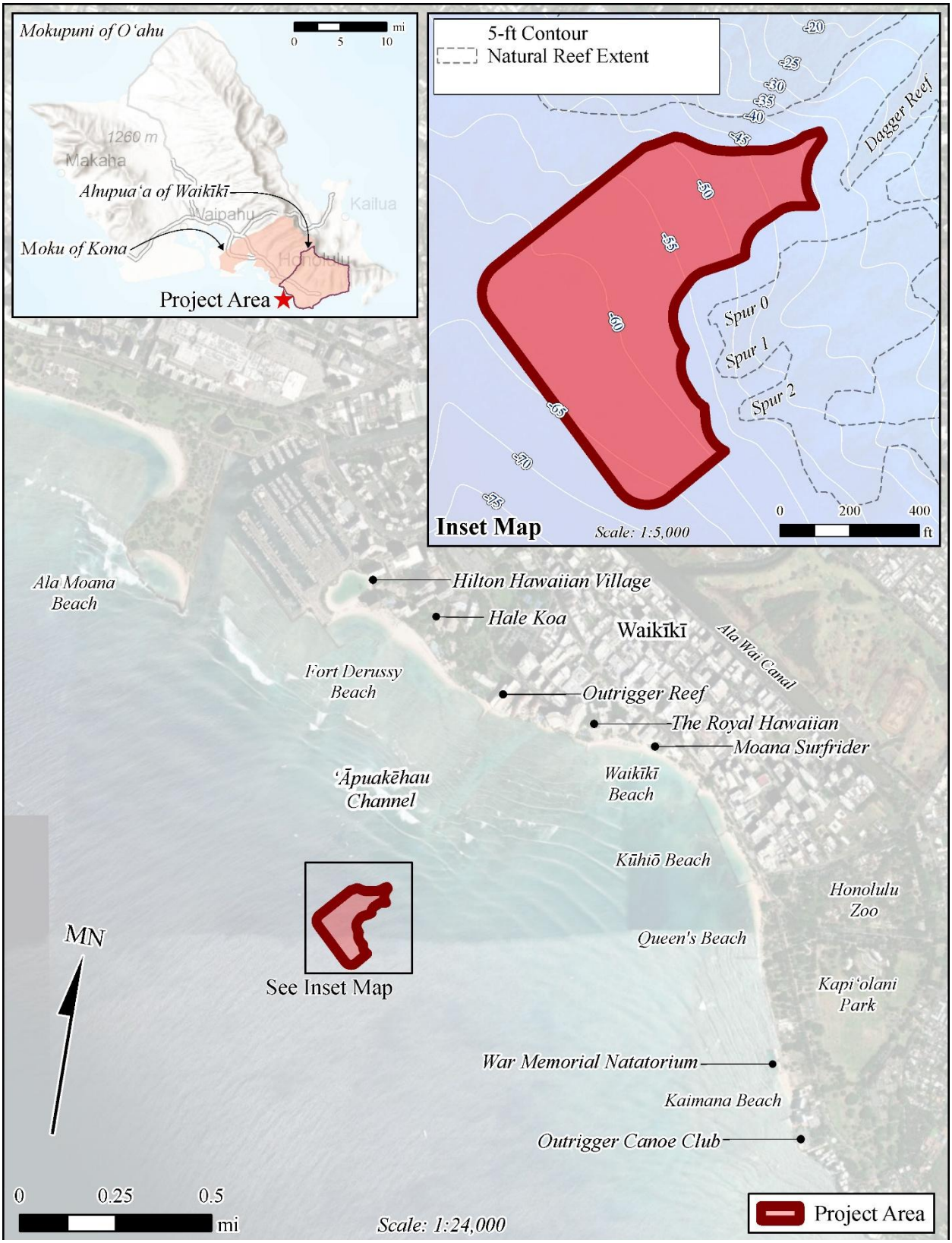


Figure 23. Aerial Imagery Showing REEFrame Project Area in Relation to Coastal Waikīkī (ArcGIS Map Service 2025).

CULTURAL PRACTICES AND IMPACTS

The 2000 Hawaii Supreme Court ruling (in Ka Paʻakai O Kaʻ Aina vs Land Use Commission, 96 Hawaii 31 [2001]) established a three-part analytical approach to identify, assess impacts, and mitigate impacts to traditional and customary Native Hawaiian rights associated with a Proposed Action. The evaluation of the REEFrame project, following the Ka Pa'akai assessment protocols, is summarized below:

The identity and scope of valued cultural, historical, or natural resources, including the extent to which traditional and customary native Hawaiian rights are exercised.

Waikīkī has a strong, well-documented association with Native Hawaiian practices and beliefs, some of which have endured for centuries and continue hold cultural significance. These include surfing, canoe paddling, and swimming. Prior development activities in Waikīkī have severely impacted resources associated with other traditional practices, including fishing and gathering.

Traditionally, Hawaiians relied on the ocean at Waikīkī for sustenance and recreation through practices such as fishing, gathering, swimming, surfing, and canoe paddling. *Umu* (fish aggregation devices) and several types of traps were constructed by Native Hawaiians near the Waikīkī shoreline to attract desirable fish for harvesting. *Limu* was cultivated along rocky shorelines for food, medicine, and spiritual practices. Other marine life was also gathered in those rocky areas for subsistence. On shore, several *heiau* (traditional Hawaiian temples) and *koʻa* (fishing shrines) were once located in the Waikīkī Ahupuaʻa. Numerous *iwi kūpuna* (Native Hawaiian ancestral remains) have also been discovered in sands along the Waikīkī shoreline.

Little remains of the constructions of the original inhabitants of Waikīkī. Modern development has replaced the temples and shrines; rocky beach areas have been replenished with imported sand to promote recreational beach use and tourism; *umu* have been degraded by natural processes and beach management practices; and many *iwi kūpuna* have been disturbed by development and natural weathering. These factors have contributed to a significant decrease in some cultural resources and practices associated with Waikīkī, such as marine resource gathering and fishing. Climate change, over-fishing, pollution, and the loss of natural coral populations have also contributed to the degradation of conditions that once made Waikīkī a bountiful shoreline environment. While some fishing and gathering may occur along the Waikīkī shoreline, the area no longer provides the level of subsistence it once did for Native Hawaiians.

Surfing and swimming remain important and enduring cultural practices along the Waikīkī shoreline. *Heʻe nalu* (board surfing), *pākākā nalu* (outrigger canoe surfing), *kaha nalu* (body surfing), and swimming attract visitors and local residents alike to the area. Canoe paddling, considered a traditional Hawaiian practice, remains a popular recreational activity in Waikīkī; several canoe clubs store their *waʻa* (outrigger canoes) on shore and practice and compete in the area.

The extent to which those resources—including traditional and customary native Hawaiian rights—will be affected or impaired by the proposed action.

The proposed action is not anticipated to impair any traditional or customary native Hawaiian rights, or valued resources. The proposed action is anticipated to have positive impacts on aquatic resources within the project area and surrounding locations, with an associated positive impact on fishing practices.

No adverse effects on surfing or swimming practices are anticipated to result from the proposed REEFrame project. The project area lies well offshore, in deeper waters where new coral growth would not result in appreciable changes to the nature, size, frequency, or occurrence of the Waikīkī surf breaks. The artificial reef modules (each about 2 meters in height) will be placed approximately 1,000 meters offshore

in depths of approximately 12 to 18 meters. The Waikīkī surf breaks occur much closer to shore, approximately 100 to 200 meters offshore, and in shallower waters with depths of 1 to 4 meters.

The proposed action would involve the temporary anchoring of barges and support vessels at the project site (for up to four weeks) and would require transiting canoes and fishing vessels to avoid the anchored vessels. Such avoidance requirements are typical when encountering any stationary or anchored vessel and would have no impact on the exercise of traditional paddling practices.

The REEFrame project will not involve any actions on shore in Waikīkī. There are no known cultural properties in the offshore project area, and there is no potential for the proposed action to affect *iwi kūpuna* that may be buried on shore or have eroded to near-shore areas. Anecdotal accounts indicate that cremation remains are occasionally scattered offshore, potentially in or near the project area. This ongoing practice would not be impacted by the proposed action. Any previously scattered remains would have been dispersed by ocean currents and are not anticipated to be present in the project area.

The quantity and variety of sea life present in the project area are anticipated to increase as a result of the proposed action. As the new reefs are colonized and grow, they are expected to attract more sea life to the area, as compared to current conditions and the no action alternative. This proposed action is anticipated to improve conditions for fishing in the project area and in adjacent locations as the new reefs mature

The feasible action, if any, to be taken by the agency to reasonably protect native Hawaiian rights if they are found to exist.

Traditional and customary Native Hawaiian practices continue to be exercised near the project area, including surfing, paddling, swimming, and fishing. The proposed action is not anticipated to impair those practices. The proposed action is anticipated to result in long-term improvements to the aquatic habitat offshore of Waikīkī, a valued natural and cultural resource, with a corresponding improvement in the opportunities for fishing and recreation.

The lack of any identified potential for the REEFrame project to impair Native Hawaiian rights precludes the need for any additional protective measures. The REEFrame project will be restricted to a relatively small, offshore location and will entail activities that would not impair Native Hawaiian rights or resources. Research has not identified any cultural or historic properties within the proposed project area. The nearest historic properties are along the beach, and there is no potential for submerged former terrestrial archaeological sites in the project area.

APPENDIX E

PRE-CONSULTATION PACKAGE

DATED OCTOBER 2025

REEFrame

E HĀPAI WAʻA KĀKOU

If we all help to lift and carry the canoe, we can move it forward

Pre-Consultation Package

October 2025

REEFrame is a habitat restoration project intended to restore Waikīkī's coral reefs by creating and installing permanent coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. This $9 million project is funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Habitat Conservation. The following lists REEFrame team partners and roles.

Team Partner	Role
Conservation International	Project management and administration
NOAA Office of Habitat Conservation	Technical assistance and environmental compliance
Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR)	State partner
University of Hawai'i at Mānoa	Scientific lead
Natrx	Design and production of concrete modules
Oceanit	Marine engineering and permits / approvals
Pacific Consulting Services, Inc.	Archaeological and cultural studies
ClimbHI	Public engagement, outreach, and education
Hawaiian Music Perpetuation Society	Cultural and community engagement guidance

Waikīkī Project Area

Urbanization, pollution, fishing impacts, and climate change have accelerated the decline of Waikīkī's coral reef ecosystem. Today, this ecosystem is among the most degraded in Hawai'i. It is estimated that there is only 18% live coral cover remaining,[1] and this area has the lowest herbivorous fish density in Hawai'i.[2] REEFrame is a proactive step towards restoring this vital Waikīkī coral reef ecosystem.

[1] *Franklin, Erik & Jokiel, Paul & Donahue, Megan. (2013). Predictive modeling of coral distribution and abundance in the Hawaiian Islands. Marine Ecology Progress Series. 481. 121-132. 10.3354/meps10252.*

[2] *Donovan, Mary & Counsell, Chelsie & Donahue, Megan & Lecky, Joey & Gajdzik, Laura & Marcoux, Stacia & Sparks, Russell & Teague, Christopher. (2023). Evidence for managing herbivores for reef resilience. Proceedings of the Royal Society B. 290. 10.1098/rspb.2023.2101*

The project area is located near the 'Āpuakēhau Channel offshore of Waikīkī and is depicted in Figure 1.

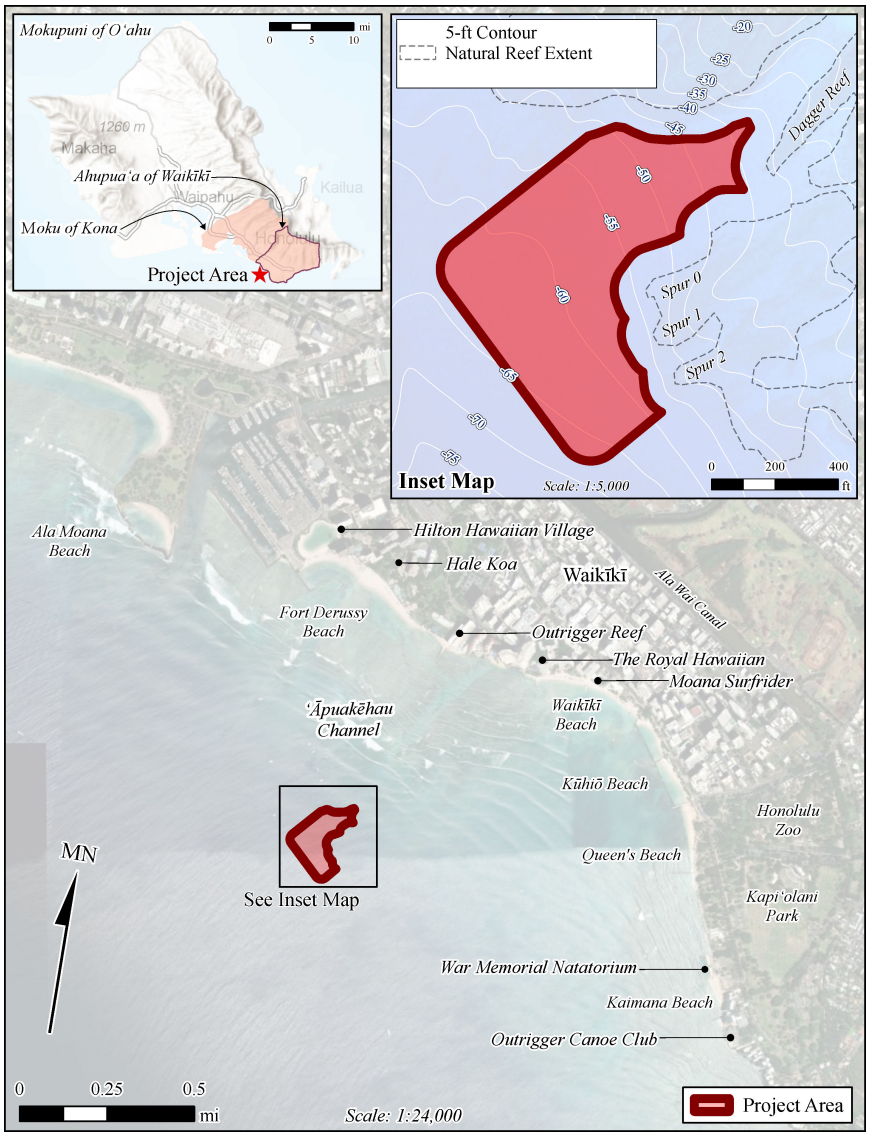


Figure 1: Project Area and Location

The site was selected based on the following three considerations:

1. **Proximity to Restorable Coral Reef:** The REEFrame project should be adjacent to an area suitable for coral reef restoration. The adjacent reefs were surveyed for indications that transplanted corals from the REEFrame nursery would have suitable conditions for coral growth. Additionally, a proof-of-concept project in the vicinity has shown success (see CReME discussion and Figure 2 on page 4).

2. **Water Depth:** Water depth at the REEFrame site needs to meet criteria to avoid impacts and optimize project efficiency. To balance depth considerations, REEFrame was designed to be installed at a depth of about 40 to 60 feet. Shallower water makes coral nurseries more accessible

and more practical for restoration activities via SCUBA. Greater water depth helps to do the following:

- Reduce the likelihood that wave forces will cause damage to the nursery
- Reduce the likelihood that the project will cause changes to nearby surf sites and impact safe navigation by ocean vessels

3. **Seafloor Composition:** Selecting a site consisting primarily of sand ensures that no existing corals are affected by the project. To reduce negative impacts on wildlife, the chosen deployment area consists of unconsolidated sand and sediments with minimal algal cover.

Based on these criteria, the selected REEFrame location is approximately 0.75-1 mile off Waikīkī Beach in water depths between 40 to 60 feet. The proposed project will cover an area that measures 1,700 feet by 1,200 feet, or approximately 47 acres. This area will be included in permit applications because it encompasses all possible areas that might be used in construction and installation activities. The actual footprint of the REEFrame modules is hereafter described.

The REEFrame team is dedicated to collaborating with the stewards, users and traditional and cultural practitioners in Waikīkī. Through shared kuleana, the community works to honor the legacy of the ʻōpū aliʻi (servant leaders) who have called Waikīkī home. For generations, Hawaiʻi's servant leaders cared for the Waikīkī ahupuaʻa, recognizing the vast importance of our actions on this delicate ecosystem. Building permanent coral nurseries off Waikīkī Beach is a critical step for maintaining the deeply connected culture while restoring the ecosystem and the important species that inhabit the reef. REEFrame has engaged with community stakeholders since the project began and will continue to proactively connect with stakeholders through project implementation, including but not limited to:

Resource management agencies
Waikīkī residents
Cultural groups and kūpuna
Surfing community
Fishers
Scuba dive tour companies
Waʻa (canoe) clubs
Youth / schools
Visitor industry
Scientific community

REEFrame Technology

REEFrame will help restore Waikīkī's coral reefs by creating permanent coral habitat. REEFrame modules are high-relief concrete structures onto which "corals-of-opportunities" will be attached both temporarily (nursery function) and permanently (restoration reef function), as well as attracting native species that benefit corals (e.g., herbivores). The project is designed to provide a suitable nursery for "corals of opportunity," which are living coral colonies previously dislodged by storms, ship groundings, anchor drags and other disturbances. These corals will be attached to the REEFrame modules, thereby creating coral reef habitat. Urchins from the State of Hawaiʻi Department of Land and Natural Resources Division of Aquatic Resources' coral nursery will also be added to the modules and serve as natural grazers.

By mimicking the complex shapes and surface textures of natural coral reef formations, REEFrame will be home to a diverse assemblage of herbivorous fishes and other marine life, such as urchins, that

will help to control algae that compete with corals. Over time, the complex structure of the REEFrame nurseries will be colonized by naturally settling coral larvae and eventually become coral reefs in their own right.

The REEFrame module concept is based on a successful small-scale, proof of concept experiment that deployed concrete structures to serve as habitat for coral, fish and other marine life. Figure 2 shows the success of the Coral Resilience Module Experiment (CReME) in coral growth from 2016 to the present. CReME is located in the vicinity of the proposed REEFrame project footprint and illustrates the suitability of the project area.

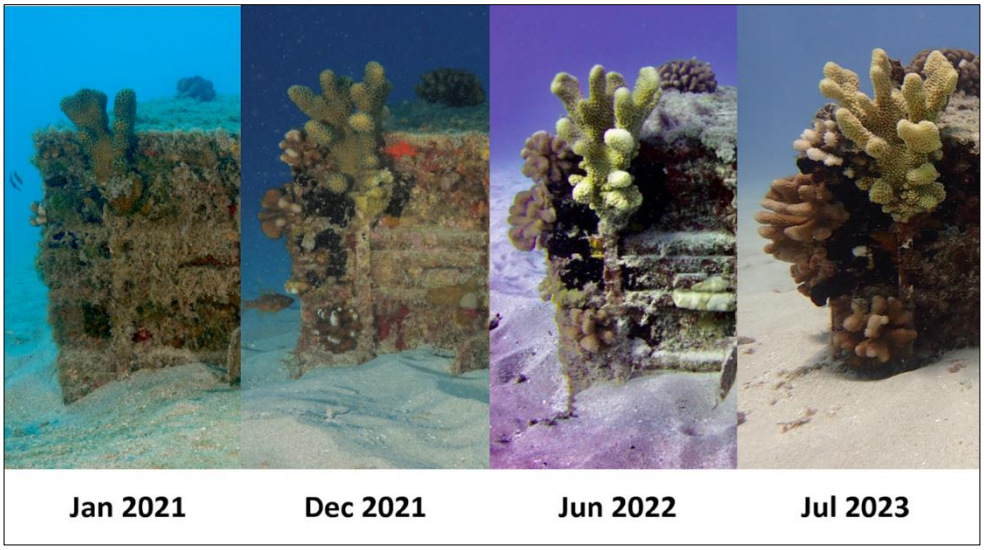


Figure 2: Coral Resilience Module Experiment (CReME) from 2016 to 2023

The REEFrame technology is a strategic use of building blocks to foster coral growth. A REEFrame module comprises five total units, including four units that form the base and the fifth unit on top. REEFrame modules are digitally designed 3D printed concrete reef systems. The modules comprise concrete material with steel hardware covered in concrete coatings. Each module measures six feet wide and six feet tall. The design weight is an average of five tons and structurally designed to be stable in a 50-year southern swell storm event where wave heights may reach or exceed 18 feet.

Coral attachment points will be incorporated on the REEFrame modules. Figure 3 shows a typical REEFrame module.



Up to 150 REEFrame modules will be deployed in Waikīkī and arranged in a pattern that complements the nearby natural reef formations. If 150 modules are installed, the total installation will have a footprint of approximately 12,675 sq. ft. on the seafloor.

Figure 4 contains a potential site plan for the REEFrame project. The exact layout is subject to change within the project area.

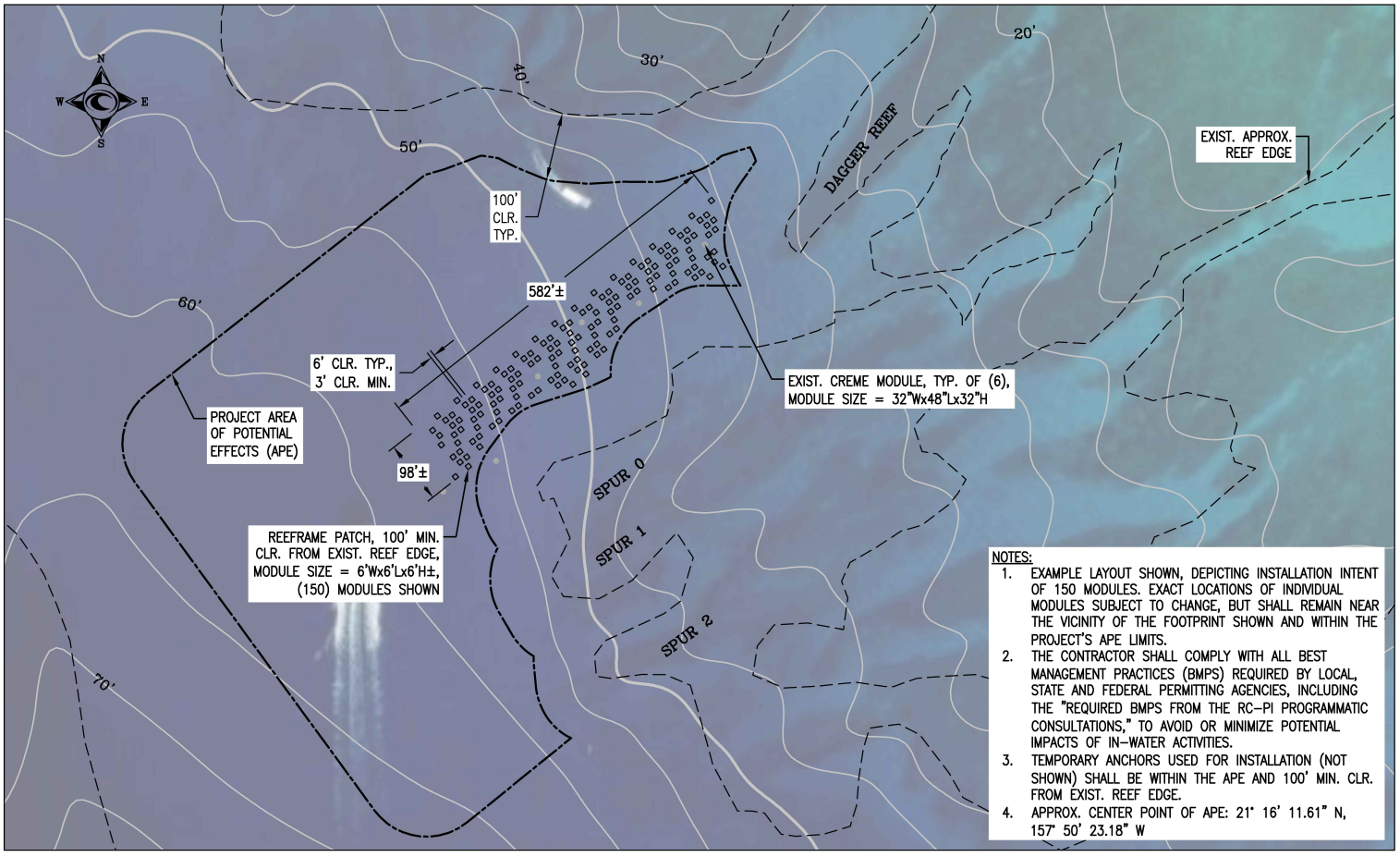


Figure 4: Potential REEFrame Site Plan

Construction

The REEFrame modules will be fabricated at the Natrx facility in Amelia, Louisiana, and transported to Hawai‘i.

Construction of REEFrame will require construction barges with heavy equipment to carefully place the units on the sandy sea floor. To help control the risks of inadvertently placing a structure on the natural reef, construction will proceed only during fair weather conditions at the site (calm waves, currents and winds). GPS will be used to confirm the placement locations of each module. Additionally, observation divers will assist with the operation, ensuring the accuracy of each placement and avoiding damage to sensitive species and habitats.

To help control the short-term risks of the construction activities on ocean water quality and the benthic environment, Best Management Practices (BMPs) will be established prior to the deployment of REEFrame. BMPs may include pre-rinsing materials prior to ocean deployment, turbidity curtains around the work zone, maintaining a 100-foot buffer from existing reefs, and monitors to watch for wildlife and cultural resources.

Construction activities will commence upon obtaining permits and approvals, which is estimated to be in late 2026/early 2027. Once approvals are issued, on-site construction activities (deployment) are expected to take two to four weeks.

APPENDIX F

DRAFT EA PRE-CONSULTATION CORRESPONDENCE

Berna Senelly

From: CEPOH-RO, POH <CEPOH-RO@usace.army.mil>
Sent: Tuesday, November 4, 2025 7:57 PM
To: reeframe
Cc: CEPOH-RO, POH
Subject: [External] RE: Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī (POH-2025-00265)

Follow Up Flag: Follow up
Flag Status: Flagged

Aloha Berna,

The US Army Corps of Engineers (Corps) received your request for comments on November 3, 2025, for the proposed REEFrame coral nursery project offshore of Waikiki, on the island of O'ahu. After review of the provided information, it appears that jurisdictional waters are present within your proposed project boundaries. Your project has been assigned Department of the Army (DA) file number POH-2025-00265. Please reference this number in all future correspondence with our office.

The Corps' regulatory authorities are based on Section 10 of the Rivers and Harbors Act (RHA) of 1899 and Section 404 of the Clean Water Act. Section 10 of the RHA of 1899 prohibits the obstruction or alteration of any navigable water of the U.S. (WOTUS) without a Department of the Army (DA) permit. Section 404 of the Clean Water Act prohibits the discharge of dredged or fill material into WOTUS without a DA permit. When your project is being developed, we ask that you identify areas that may fall within the Corps jurisdiction as WOTUS such as the ocean, streams, rivers, and wetlands.

Based on your proposed plans, work would occur in Apuakehau Channel. As this is a tidally influenced, navigable waterbody, a DA permit is required from the Corps for the work you have proposed. Please contact us directly for the most recent version of our permit application. Under NEPA, we must also evaluate the project for any impacts to resources such as threatened or endangered species, historic properties, and/or essential fish habitat. As your project is funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Habitat Conservation, NOAA would be the lead federal agency for this action, and it responsible for providing all necessary documentation and consultation concurrence letters with the permit application. In addition to the application and consultation information, please include detailed plans/drawings of the proposed project, to include (at a minimum) a vicinity map, plan view and cross-section(s).

Please visit https://www.poh.usace.army.mil/Missions/Regulatory/ to find more information about our program and to apply for a permit. Email permit applications to CEPOH-RO@usace.army.mil, as we have gone paperless. Feel free to contact me with any further questions.

Mahalo,

Jen Martin
Chief, Regulatory Branch
US Army Corps of Engineers, Honolulu District

808-835-4300





From: reeframe <reeframe@oceanit.com>
Sent: Monday, November 3, 2025 5:35 AM
To: reeframe <reeframe@oceanit.com>
Cc: Bryson Gonzalez <bgonzalez@oceanit.com>
Subject: [Non-DoD Source] Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī

Aloha kākou~

On behalf of Conservation International, Oceanit is preparing a Draft Environmental Assessment (EA) regarding the proposed REEFrame project on the island of O'ahu. REEFrame is a habitat restoration project intended to restore Waikīkī's coral reefs by creating and installing permanent coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. This $9 million project is funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Habitat Conservation. Urbanization, erosion and climate change have accelerated the decline of Waikīkī's coral reef ecosystem, and today this ecosystem is among the most degraded in Hawai'i. REEFrame will help to restore Waikīkī's coral reefs by creating permanent coral habitat that mimic the complex shapes and surface textures of natural coral reef formations. Over time, the complex structure of the REEFrame nurseries will be colonized by naturally settling coral larvae and eventually become coral reefs in their own right.

We are conducting a thorough environmental review pursuant to Chapter 343, Hawai'i Revised Statutes, and Hawai'i Administrative Rules Chapter 11-200.1, and invite you to submit pre-consultation comments on this project. Attached is a pre-consultation package that provides project information that is the basis for environmental review. Your comments and mana'o would be very helpful in the preparation of environmental review documents.

Please transmit your comments to reeframe@oceanit.com by ***Thursday, December 4, 2025***. You may also mail your comments via US Postal Service to the address provided below.

Your comments and our responses will be included in the Draft Environmental Assessment that will be published in *The Environmental Notice* issued by the Hawai'i State Office of Planning and Sustainable Development Environmental Review Program. Please email me if you have questions.

We look forward to your comments.

Sincerely,

Berna Cabacungan Senelly

Berna Cabacungan Senelly
Senior Regulatory and Community Lead
Oceanit
828 Fort Street Mall Ste 600 Honolulu, HI 96813
Email: bsenelly@oceanit.com
Office: 808.531.3017 ext. 221
Fax: 808.531.3177
Direct: 808.954.4221
Mobile: 817.422.1372

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May 8, 2026

Jen Martin
Chief, Regulatory Branch
US Army Corps of Engineers, Honolulu District
Fort Shafter, HI 96858

Transmitted via email: CEPOH-RO@usace.army.mil

Aloha Ms. Martin:

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī**
Response to Pre-Consultation Comments (POH-2025-00265)

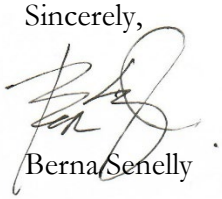
Mahalo for your November 4, 2025, comment on the REEFrame Draft Environmental Assessment (EA).

We note your comment that jurisdictional waters are present within the proposed project boundaries, and that the location at Āpuakēhau Channel is tidally influenced, navigable water body. We appreciate your discussion of regulatory requirements. Section 4.1, Federal, in the Draft Environmental Assessment (EA) discusses how the project is related to the Clean Act Section 404, Rivers and Harbors Act Section 10, the Fish and Wildlife Coordination Act and Endangered Species Act, the Magnuson Stevens Fishery Conservation Act, and Section 106 of the National Preservation Act. Studies on marine biology, essential fish habitat, endangered species and historic properties are summarized in and appended to the Draft EA.

The REEFrame project is designed to restore the site and surrounding aquatic environment to a more natural ecological condition and will qualify for one or more Nationwide Permits (NWPs), including NWP 27 for Aquatic Habitat Restoration, Enhancement, and Establishment Activities. Pre-consultation with USACE has been initiated and the project was assigned POH-2024-00195. A Pre-Construction Notice (PCN), including detailed plans and drawings of the proposed project, will be submitted for USACE review. NOAA will serve as the lead federal action agency and will be responsible for providing all necessary documentation and consultation concurrence letters with the permit application.

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development. Thank you again for your comment.

Sincerely,



Berna Senelly

Regulatory Lead

Berna Senelly

From: Benjamin Stablow - NOAA Affiliate <benjamin.stablow@noaa.gov>
Sent: Wednesday, November 5, 2025 4:29 PM
To: reeframe
Cc: Ron Dean - NOAA Federal
Subject: [External] REEFrame Coral Nursery Project in Waikīkī
Attachments: Non-Federal Rep Designation Letter Example.pdf; Action Agency xLOC Guidance.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

You don't often get email from benjamin.stablow@noaa.gov. Learn why this is important

Aloha!

My name is Ben Stablow and I'm a contracted endangered species biologist with NMFS's Pacific Islands Regional Office (PIRO). Thanks so much for reaching out to us for pre-consultation comments on your coral nursery project. This sounds like a wonderful project, and I'm happy to provide what assistance I can. As a note, I'm currently the only biologist on staff with PIRO able to work during the shutdown. I am able to provide feedback regarding Endangered Species Act (ESA) Section 7 consultation. However, someone from the Habitat Conservation Division will have to be in touch once the government reopens to provide feedback regarding Essential Fish Habitat (EFH) consultation under the Magnuson-Stevens Act. I will also note that for both ESA and EFH consultations, NMFS is legally required to consult with the federal nexus on a project, which in this case would of course be NOAA's Office for Habitat Conservation (OHC). NOAA OHC may designate Oceanit as a non-federal representative for purposes of conducting the consultation/s on their behalf. I've attached an example letter that they may use as a template should they wish to pursue that route.

I appreciate the information that you've provided as it already gives me a pretty good idea of what the project will entail. This early coordination should really help streamline the consultation. For the ESA consultation, we'll just need a few more pieces of information, which I've listed below:

1. Will the REEFrame modules be transported to Hawaii by sea? If so, we'll need to include offshore species in the consultation that may be impacted along the transport route.
2. What kind of heavy equipment will be used to place the modules?
3. What species of corals and urchins will be outplanted?
4. How will corals be attached to the modules? What kinds of epoxy or cement will be used, and how much is expected to be needed?
5. What does maintenance of the artificial reef entail? How frequently will corals and urchins be outplanted, and how long will nursery corals be staged for? We'll need detailed protocols for these activities.

In addition to the above information, NOAA OHC may opt for an expedited informal consultation, which has a 30-day turnaround following initiation of the consultation, rather than the normal 60-day period. This requires a comprehensive effects analysis using specific language to describe potential effects to ESA-listed resources (*insignificant* and *discountable*) while citing applicable best management practices (BMPs). I've attached a document that provides guidance for how to prepare a biological evaluation for

an expedited informal consultation. The potential effects I would expect from this action are listed below:

1. Elevated turbidity from placement of modules
2. Disturbance from the presence of humans
3. Entanglement in lines used to anchor or place modules
4. Vessel strike
5. Direct physical impact from placement of modules and other equipment
6. Exposure to waste or discharge

The following nearshore species and critical habitat may be affected:

1. Central North Pacific green turtles and their proposed critical habitat
2. Hawksbill turtles
3. Hawaiian monk seals and their designated critical habitat

If the modules are going to be transported by sea, the following offshore species should be included as well:

1. Leatherback turtles
2. North Pacific loggerhead turtles
3. Olive ridley turtles
4. Hawaiian Insular False Killer whales and their designated critical habitat
5. Blue whales
6. Fin whales
7. North Pacific right whales
8. Sei whales
9. Sperm whales
10. Giant manta rays
11. Oceanic whitetip sharks

You can find more info on the above species here: https://www.fisheries.noaa.gov/pacific-islands/endangered-species-conservation/marine-protected-species-hawaiian-islands
Below are descriptions of the essential features of the critical habitat mentioned above:

Central North Pacific Green Sea Turtle
In areas of the MHI, the proposed critical habitat for green sea turtles includes the marine environment from the mean high water line to 20 m depth. The specific areas within the proposed designation, with their physical and biological features are:

1. From the mean high water line to 20 m depth, sufficiently dark and unobstructed nearshore waters adjacent to nesting beaches are proposed as critical habitat by USFWS, to allow for the transit, mating, and internesting of reproductive individuals, and the transit of post-hatchlings.
2. From the mean high water line to 20 m depth, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and “potholes”) and food resources (i.e., seagrass, marine algae, or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, or reproduction.

Detailed information on proposed green sea turtle critical habitat is available at: https://www.fisheries.noaa.gov/action/proposed-rule-designate-critical-habitat-green-sea-turtles

Hawaiian monk seal

In designated areas of the Main Hawaiian Islands (MHI), critical habitat for monk seals includes the marine environment with a seaward boundary that extends from the 200-meter depth contour line (relative to mean lower low water), including the seafloor and all subsurface waters and marine habitat within 10 meters of the seafloor, through the water's edge 5 meters into the terrestrial environment. Detailed information on Hawaiian monk seal critical habitat is available at https://www.fisheries.noaa.gov/action/critical-habitat-hawaiian-monk-seals.

The specific areas within the designation, with their physical and biological features are:

1. Terrestrial areas preferred by monk seals for pupping and nursing with adjacent shallow, sheltered aquatic areas
2. Marine areas from 0 to 200 meters in depth with water quality and sediment characteristics that support adequate prey quality and quantity for juvenile and adult monk seal foraging
3. Significant areas used by monk seals for hauling out, resting or molting

False Killer Whale

Critical habitat for MHI insular false killer whales (IFKW) includes the geographic area of the 45-m depth contour to the 3200-m depth contour in waters that surround the MHI from Niihau east to the Island of Hawaii. Critical habitat for the MHI IFKW consists of one essential feature comprised of four characteristics:

1. Space for movement and use within shelf and slope habitat
2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth
3. Waters free of pollutants of a type and amount harmful to MHI IFKW
4. Sound levels that would not significantly impair IFKW's use or occupancy.

Detailed information on MHI IFKW critical habitat is available at https://www.fisheries.noaa.gov/action/final-rule-designate-critical-habitat-main-hawaiian-islands-insular-false-killer-whale.

From the information provided, I've also identified the following BMPs that should be implemented to avoid adverse effects to ESA-listed resources:

General

1. Constant vigilance shall be kept for the presence of ESA-listed marine species (sea turtles, marine mammals, sharks, rays) during all aspects of the proposed action.

2. A responsible party (i.e. permittee/site manager/project supervisor) shall designate an appropriate number of competent trained observers to survey the areas adjacent to the authorized work area (i.e. proposed action) for ESA-listed marine species. The competent observer will not be simultaneously engaged in any other activity (e.g. captaining, operating equipment, etc).

3. Surveys shall be made prior to the start of work each day, and prior to resumption of work following any break of more than one half hour. Additional periodic surveys throughout the work day are strongly recommended.

4. All work shall be postponed or halted when ESA-listed marine species are within 50 meters (54.7 yards, 164 feet) of the proposed work, and will only begin/resume after the animals have voluntarily departed the area.

    - If ESA-listed marine species are noticed within 50 meters (54.7 yards, 164 feet) after work has already begun, that work may continue only if, in the best judgement of a biologist, the activity will not adversely affect (i.e. disturb or harm) the animal(s). For example: divers performing underwater work such as surveys would likely be permissible, whereas operation of heavy equipment is not.

5. Project-related personnel shall NOT conduct activities resulting in a take of an ESA-listed species, or listed or proposed critical habitat. "Take" as defined under the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct". Activities that would qualify as take include attempting to disturb, touch, ride, feed, or otherwise intentionally interact with any protected species.

6. Sensitive resource areas, such as corals, coral reefs and seagrass beds known to occur within a project area must be identified on project figures. Project staff must be instructed to avoid the sensitive resource areas to the greatest extent practicable, including avoiding anchoring in these areas, flagging the areas if appropriate, and securing all in-water equipment in a manner that will prevent the equipment from being dragged across the substrate.

7. If an ESA-listed species is adversely affected as a result of the project, all work must stop until coordination with the Corps and NMFS has been completed.

<u>Waste and Discharge</u>

1. A pollution control plan for the project site and adjacent areas must be prepared and implemented. At a minimum, this plan shall include:

    - Proper installation and maintenance of equipment diapers, or drip pans.
    - A contingency plan to control and clean spilled petroleum products, hydraulic leaks, and other toxic materials.
    - Appropriate materials to contain and clean potential spills will be stored at the work site and be readily available.
    - All project-related materials and equipment placed in the water will be free of pollutants.
    - Daily pre-work inspections of heavy equipment and vessels for cleanliness and leaks, with all heavy equipment operations and vessel use postponed or halted until leaks are repaired and equipment is cleaned.
    - Debris and other wastes will be prevented from entering or remaining in the marine environment during the project.

<u>Direct Physical Impact</u>

1. Before any equipment, anchor(s), or material enters the water, a responsible party, i.e., permittee/site manager/project supervisor, shall verify that no ESA-listed marine animals are in the area where the equipment, anchor(s), or materials are expected to contact the substrate. If practicable, the use of divers to visually confirm that the area is clear is preferred.

2. All objects lowered to the bottom shall be lowered in a controlled manner. This can be achieved by the use of buoyancy controls such as lift bags, or the use of cranes, winches, or other equipment that affect positive control over the rate of descent.

Entanglement

1. Temporary in-water tethers, as well as mooring lines for vessels and marker buoys shall be kept taut to the minimum length necessary, and shall remain deployed only as long as needed to properly accomplish the required task.

Vessel Strike

1. When piloting vessels, vessel operators shall alter course to remain at least 100 meters (109 yards) from whales (if transporting modules via sea), and at least 50 meters (54.7 yards, 164 feet) from other ESA-listed marine animals.

2. Vessel speed will be reduced to 10 knots or less when piloting vessels in proximity of ESA-listed marine mammals, sharks, and rays.

3. Vessel speed will be reduced to 5 knots or less when piloting vessels in areas of known or suspected sea turtle activity.

4. If despite efforts to maintain the distances and speeds described above, a marine mammal or turtle approaches the vessel, the vessel operator will put the engine in neutral until the animal is at least 15 meters (~50 feet) away, and then slowly move away to the prescribed distance.

NOAA OHC may reach out to me directly with any questions that they have.

Best,
Ben

Ben Stablow
Endangered Species Act Section 7 Analyst, Contractor/Affiliate with Ocean Associates Inc. in support of
NOAA Fisheries Office of Protected Resources | U.S. Department of Commerce
Office: (301) 427-7813

www.fisheries.noaa.gov



Expedited Informal Consultation Requests

Guidance for Pacific Islands Region Action Agencies

Updated May 09, 2023

The goal is to increase efficiency in completing informal consultations on well-documented action agency projects that pose a low risk to ESA-listed resources. To qualify for an expedited letter of concurrence (xLOC), the informal consultation request package must contain the following information:

a. An adequate description of the proposed action
b. An adequate description of the action area
c. Identification of each ESA-listed species and/or designated critical habitat that may be affected by the action along with a reference to the most recent listing/designation notice in the Federal Register and any applicable species recovery plans
d. An adequate discussion of each potential effect on the ESA-listed species and/or essential features of designated critical habitat along with an adequate rationale why the effect meets the applicable not likely to adversely affect standard (discountable, insignificant, entirely beneficial)
e. Certification that the action agency used the best scientific and commercial data available.

If the consultation request package fails to include all of the required information, NMFS will ask the action agency for supplemental information to fill the gap or an updated biological evaluation/assessment. For more minor omissions, we may fill the gap in the record supporting the xLOC. Should we fill the gap for the action agency, we will inform the action agency of the deficiency so the action agency learns for future consultations. However, beyond this minor information, we may elect to proceed with the standard informal consultation process (60 days).

Remember that an expedited consultation does not mean that NMFS or the action agency can take shortcuts in consultations. This process requires action agencies to do a thorough effects analysis, with the result that PIRO's xLOC response is expedited (15-30 days). The consultation request analysis needs to be akin to the analysis NMFS would conduct ourselves in a regular LOC. Therefore, our team is available to assist during pre-consultation as needed.

Request Requirements Specifics

Project Description: Make sure your document is in terms of "authorize, fund, or carry out" and explains your office's authority. A good project description should leave NMFS asking no questions about the project (it answers who, what, when, where, why, and most importantly, *how*). Did you include all pertinent best management practices? If there is a shutdown zone due to sound, has it been calculated correctly using an appropriate source level and NMFS calculator? Have you included activities caused by the proposed action, but not part of the proposed action? For example, vessel transit routes.

Action Area: Does your consultation request define the full extent of the action's modifications to land, water, and air as affected directly or indirectly by the Federal action, and not merely the immediate area involved in the action (50 CFR §402.02)? Do you provide a reasonable

justification for how your office defines the action area (usually a stressor that extends away from the project location, like sound)?

Species/Critical Habitat List: Does your consultation request provide a complete species and critical habitat list that is not overly inclusive? If not, have you reached out to NMFS for assistance with this list of species? Do you correctly specify which DPSs?

Effects of the Action: Are all effects appropriately defined? Does your document include all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action? A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur (CFR 402.17). Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. For example, increased vessel activity and/or runoff are effects of the action.

Stressors: Have all stressors been identified (e.g., noise, disturbance from human activity, increased turbidity, direct physical impact, entanglement in anchor and mooring system, vessel collisions, etc.)? For example, using the effects listed above (increased vessel activities and/or runoff) the effects will have stressors associated with them such as vessel strikes, disturbance from human activity, noise, or increased turbidity, etc.

Species Effects Assessment: For each project stressor identified, are *each* species appropriately analyzed? Was an exposure-response framework used to conclude the effect and/or stressor is either discountable or insignificant, conforming to the following definitions:

1. **Discountable:** Did your office describe the likelihood of exposure of each species using factors like species distribution and density, areal extent of stressor, timing of action, animal behavior, etc? Did your office justify concluding the effects were discountable for any stressor/species combinations that exposure is extremely unlikely? On those, you can stop here. Otherwise, did your office analyze significance?
    a. Discountable effects are those extremely unlikely to occur.
2. **Insignificant**: For each project stressor, for each species whose exposure is not discountable, did your office justify why effects are insignificant using factors like intensity of the stressor, magnitude, and duration of the stressor, or low consequence of the response, to the stressor? Does this evaluation appropriately determine the effect will not reach the scale where harm or harassment occur?
    a. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs.
    b. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur

Critical Habitat Effects Assessment: Did your office analyze critical habitat separately from the species? Did your office use the same steps as the species above analyzing each stressor on each essential feature of critical habitat? Did you clearly conclude the effects are discountable or insignificant for each stressor/feature combination?

Effects Determinations: Does your consultation request provide a clear effects determination for each species and critical habitat? It is best if your office uses these words exactly: *may affect, but not likely to adversely affect*.

Common Questions/Errors

Action Area Too Restricted: Action agencies often understate the size of the action area, taking a narrow view of the scope of the project using only what is within the regulatory authority to control. However, the action area includes the full extent of consequences of other activities that would not occur but for the proposed action. Example: If the project is building a new dock, vessels using it (as well as their noise and potential strikes) are a consequence of the action. Wherever these project-related effects and/or stressors occur, is part of the action area.

But For: Action agencies sometimes do not include or provide enough detail on project activities that are outside of the regulatory authority. As in the dock example above, your office needs to include all reasonably certain consequences that will not occur "but for" the project. This includes consequences that may occur later in time and/or outside the immediate area involved in the action (CFR 402.17).

Poorly Worded Best Management Practices: Are the BMPs written in a way that makes them unenforceable or unclear? Do not use passive voice. Make sure the BMPs define who is responsible for doing what (e.g. project personnel, vessel operators, observers). BMPs should say 'will' instead of 'may' or 'shall'.

Unjustified Declarations: Ensure your office is not declaring things to be so, without providing adequate justification. E.g., "we do not expect the sound from this project will affect hauled-out monk seals because project sound is not expected to be very loud". Be specific about why you have determined that. Provide supporting scientific or project-based evidence.

Unsupported Acoustic Threshold Distances: It is common that sound source levels, transmission losses, or their corresponding references used in calculations of shutdown and monitoring zones are inappropriate for the project at hand. Ensure your office uses the NMFS acoustic calculator (https://www.fisheries.noaa.gov/southeast/consultations/section-7-consultation-guidance) in all calculations. Use more conservative estimates when data are lacking.

Discountable vs. Insignificant: Don't confuse the concepts of discountable and insignificant. Discountable comes first and examines the probability of the species/critical habitat exposure to the stressor. The probability of exposure must be extremely unlikely to be discountable. Insignificant examines the magnitude of the effect of exposure. Will the resulting effect be too small to rise to the scale of harm or harassment?

Combining Discountable and Insignificant: Don't combine discountable and insignificant or combine the *degree of effects with the probability of effect*s. It is incorrect to say: "The *probability* of effect due to stressor A is *insignificant* because…" Insignificance refers to the degree of effects, not the probability of occurring.

No Effect Management: Do not include species/critical habitat that your office has determined will not be affected by your proposed action. No-effect calls are strictly your office's discretion and a memorandum to your administrative record is sufficient. NMFS does not concur with no effect determinations.

Maybe it is Not Worth the Effort: Sometimes you may have a new or inexperienced person or applicant. It may be easier for you to do a standard LOC than to bring your expedited consultation request package up to par.

If you would like to discuss the xLOC process further or have an upcoming project that you want to discuss, please email EFHESAconsult@noaa.gov and one of our ESA section 7 consultation biologists will contact you. Or please contact me at benjamin.stablow@noaa.gov or 301-427-7813.

United States Department of the Interior
OFFICE OF THE SECRETARY
Washington, DC 20240

September 13, 2024

via electronic mail: efhesaconsult@noaa.gov
Ms. Dawn Golden
Assistant Regional Administrator
NOAA Fisheries
Office of Protected Resources
Pacific Islands Regional Office
1845 Wasp Boulevard, Building 176
Honolulu, Hawaii 96818

Mr. Gerry Davis
Assistant Regional Administrator
NOAA Fisheries
Habitat Conservation Division
Pacific Islands Regional Office
1845 Wasp Boulevard, Building 176
Honolulu, Hawaii 96818

SUBJECT: Designation of Non-Federal Representative under Section 7 of the Federal Endangered Species Act and Essential Fish Habitat consultation in accordance with Section 305(b)(2) of the Magnuson-Stevens Act (MSA)

Dear Ms. Golden and Mr. Davis:

I am writing to inform you that pursuant to 50 CFR § 402.08 50 and 50 CFR Section 600.920(c), *Designation of non-Federal representative*, the Department of the Interior (DOI), Office of Insular Affairs (OIA) has designated the Government of the Commonwealth of the Northern Mariana Islands (CNMI) as our non-Federal representative for the purposes of initiating the consultation process, coordinating, requesting technical assistance, and preparing a biological and essential fish habitat assessment, if necessary, under Section 7 of the Federal Endangered Species Act (ESA) and in accordance to Section 305(b)(2) of the Magnuson-Stevens Act (MSA), respectively, for certain projects funded under the OIA Capital Improvement Project (CIP) program.

DOI OIA CIP programs must comply with a number of Federal legal requirements, including ESA and the MSA. Please note that the CNMI may be assisted in its role as OIA's non-Federal representative by a professional environmental consultant, Micronesian Environmental Services (MES).

Responsibilities of Non-Federal ESA Representative for CNMI CIP Projects

OIA will continue to be ultimately responsible for compliance with the Section 7 requirements of the ESA. OIA requires through grant award provisions that the CNMI evaluates potential effects to listed species and designated critical habitat and to implement measures determined necessary or appropriate during the ESA Section 7 consultation process to avoid adverse effects to listed species (including incidental take) or adverse modification of designated or proposed critical habitat. Failure to implement such measures or steps may result in OIA curtailment of financing, interest penalties, requirements of

corrective action or other enforcement action as deemed necessary. Should the CNMI fail to properly enforce the implementation of such measures, OIA may take appropriate steps, including corrective action authorized by Federal regulations, which may involve the withholding of payments.

Designation of Non-Federal Representative for Essential Fish Habitat Consultations

Under Section 305(b)(2) of the MSA, Federal agencies are required to consult with NMFS if a Federal activity or action may adversely affect "essential fish habitat" (EFH) as defined by BMFS under that Act. OIA's Federal action of funding CIP program grants requires appropriate compliance with MSA Section 305(b)(2). We emphasize that OIA remains ultimately responsible for compliance with Section 305(b)(2) and 305(b)(4)(B) of MSA and the CNMI needs to be familiar with these responsibilities. Therefore, OIA expects close coordination with the CNMI in complying with MSA.

OIA is by this letter notifying NMFS that it has designated the CNMI as the non-Federal representative to conduct any required EFH Consultations, as provided for in 50 CFR Section 600.920(c). Under the terms of that regulation, OIA will continue to be ultimately responsible for compliance with the consultation requirements of the MSA.

Should you have any questions or require additional information regarding these designations, please contact me at (202) 219-8536, or by email at Krystina_Alfano@ios.doi.gov.

Sincerely,

KRYSTINA ALFANO
Digitally signed by KRYSTINA ALFANO
Date: 2024.09.13 12:28:57 -04'00'

Krystina Alfano
Grants Management Specialist
Office of Insular Affairs

cc: Ron Dean, Protected Resource Division, Branch Chief
Malia Chow, Habitat Conservation Division, Branch Chief

EFH Consultation Verification Form

NOAA OHC Restoration Center- Pacific Islands

And

NOAA Fisheries/PIRO/Habitat Conservation Division

The NOAA OHC Restoration Center- Pacific Islands (RC-PI) will use this Notification and Verification Form to notify PIRO HCD of proposed activities that meet the conditions of the Essential Fish Habitat (EFH) Programmatic. The RC-PI will submit this form together with supporting project information to EFHESAconsult@noaa.gov. Within 15 days of receipt of the *EFH Notification and Verification Form*, NMFS will email RC-PI to confirm whether the given activities comply or do not comply with the EFH Programmatic.

NMFS and/or the RC-PI can propose modifications to the verification form language by written agreement (email is acceptable) by the RC-PI and the PIRO EFH Branch Chief.

EFH MUS in the project area:

Present in Project Area?	Management Unit Species (Groups)	EFH for Eggs and Larvae	EFH for Juveniles and Adults
Yes	Bottomfish	Overall water column down to 400 m (Marianas and American Samoa) and 700 m depth (Hawaii) from shoreline out to the 200-mile U.S. Exclusive Economic Zone (EEZ) boundary. For eggs in Hawaii, out to 50 nautical miles and in Marianas and American Samoa out to EEZ.	Water column and all bottom from shoreline down to 400m depth
No	Seamount Groundfish	Water column down to 200m depth of all EEZ waters north of 28° and west of 180°	Water column and bottom from 120m to 600m depth, north of 28° and west of 180°, all EEZ
Yes	Pelagics	Water column down to 200m depth from shoreline out to EEZ boundary	Water column down to 1000m depth from shoreline out to EEZ boundary
No	Precious Corals	Known precious coral beds in the Hawaiian Islands located at: Keahole point, between Milolii and South Point, the Auau Channel, Makapuu, Kaena point, the southern border of Kauai, Wespac bed, Brooks bank bed, and 180 Fathom Bank	
Yes	Crustaceans	Crab: Water column down to 150m depth from shoreline out to EEZ boundary	Crab: Bottom from shoreline down to 100m depth

Type of Action:

☒ Vessel Operation

- ☒ Small Vessels (50ft or less)
- ☒ Large Barges

☒ Monitoring, Mapping, and Data Collection

☒ Coral Reef Restoration and Interventions

- ☒ Coral Collection and Transport
- ☒ Coral Outplanting
- ☐ Coral Nursery Development, Expansion, and Maintenance
- ☐ Coral Sexual Propagation
- ☐ Rubble Stabilization
- ☒ Reef Structure Installation
- ☐ Other intervention

☐ Watershed, River, Wetland, and Estuary Restoration

☐ Reduce Physical Impacts to Coral Reef Ecosystems

☒ Education and Outreach

Project Description:

REEFrame is a habitat restoration project intended to restore Waikīkī's coral reefs by creating and installing reef structures as permanent coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. REEFrame is a collaborative project led by Conservation International in partnership with the University of Hawai'i at Mānoa, the Hawai'i Division of Aquatic Resources, Natrx, Oceanit, ClimbHI, and Pacific Consulting Services Inc., and funded by NOAA's Office of Habitat Conservation.

The REEFrame technology is a strategic use of building blocks to foster coral growth. A REEFrame module comprises five total units, including four units that form the base and the fifth unit on top. The modules comprise concrete material with steel hardware covered in concrete coatings. Each module measures six feet wide and six feet tall. The design weight is an average of five tons and structurally designed to be stable in a 50-year southern swell storm event where wave heights may reach or exceed 18 feet. Approximately 150 modules will be placed on the sandy sea floor off Waikīkī'. Coral restoration activities will consist of attaching corals of opportunity and coral pyramid modules from the State of Hawai'i Division of Aquatic Resources Hawai'i Coral Restoration Nursery to the REEFrame modules.

Education and outreach activities include engaging community stakeholders, including but not limited to: resource management agencies, Waikīkī residents, cultural groups and kupuna, surfing community, fishers, scuba dive tour companies, wa'a (canoe) clubs, youth / schools, visitor industry, and the scientific community.



Figure 1: Typical REEFrame Module

Project Number:

Applicant:

Conservation International

Geographic Location (latitude/longitude):

21°16'11.61"N, 157°50'23.18"W

Project Purpose:

Waikīkī is the most iconic beach in Hawai'i, yet is one of the most degraded reefs in the islands, with low coral cover, structural complexity, and fish abundance. REEFrame will help restore Waikīkī's coral reefs by creating permanent coral habitat. REEFrame module structures are high-relief concrete structures onto which "corals-of-opportunities" will be attached both temporarily (nursery function) and permanently (restoration reef function), as well as attracting native species that benefit corals (e.g., herbivores). The project is designed to provide a suitable nursery for "corals of opportunity," which are living coral colonies previously dislodged by storms, ship groundings, anchor drags and other disturbances. These corals will be attached to the REEFrame modules, thereby creating coral reef habitat. By mimicking the complex shapes and surface textures of natural coral reef formations, REEFrame will be home to a diverse assemblage of herbivorous fishes and other marine life, such as urchins, that will help to control algae that compete with corals. Urchins from the State of Hawai'i Division of Aquatic Resources' coral nursery will also be added to the modules and serve as natural grazers. Over time, the complex structure of the REEFrame nurseries will be colonized by naturally settling coral larvae and eventually become coral reefs in their own right.

A preliminary feasibility study (Hixon CReME modules), initiated in 2016, has demonstrated the effectiveness of concrete structures in this location. The test structures have successfully attracted naturally settling coral larvae, fish, and invertebrates. Furthermore, both naturally settled colonies and corals of opportunity transplanted onto the test structures have shown high survival and growth. This success provides confidence that a scaled-up nursery will be effective for restoring Waikīkī reefs.

Describe project area:

The REEFrame location is approximately 0.5 miles off Waikīkī Beach off south Oahu in water depths between 40 to 60 feet in the Āpuakēhau Channel. The deployment area consists of unconsolidated sand and sediments with minimal algae cover. The proposed project will cover an area that measures 1,700 feet by 1,200 feet, or approximately 47 acres. The project area encompasses all possible areas that would be used in construction and installation activities and is much larger than the estimated footprint of the REEFrame modules.

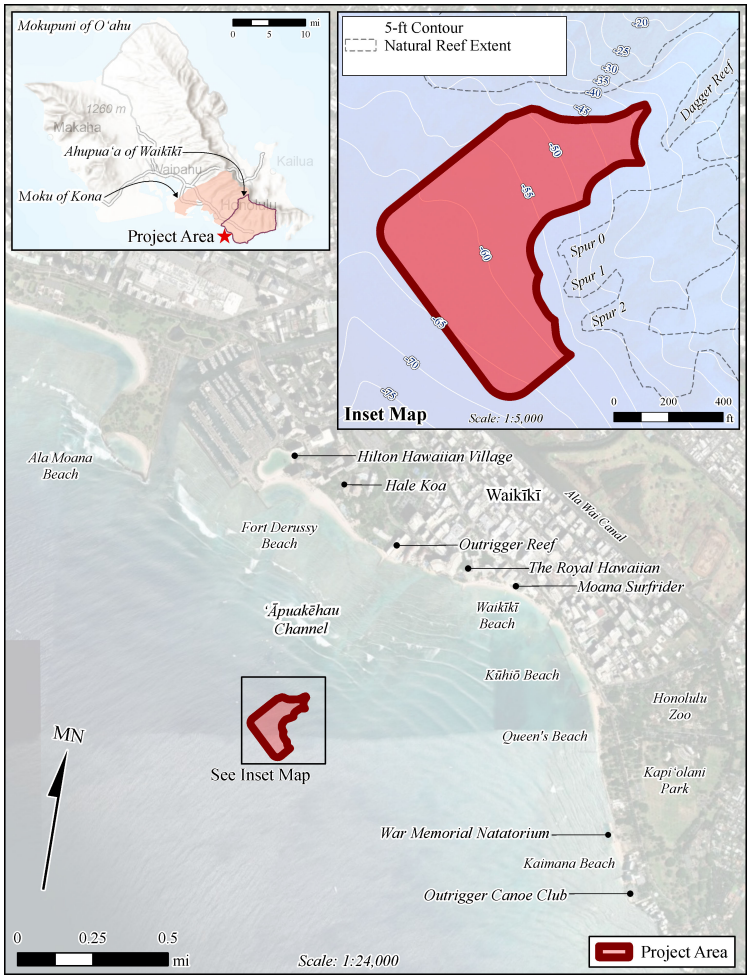


Figure 2: REEFrame site location.

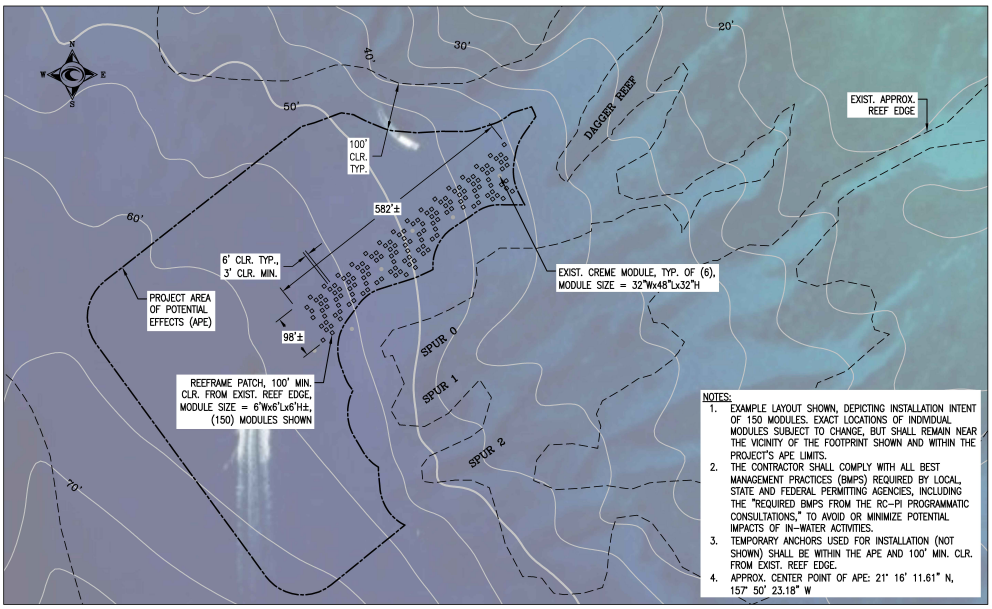


Figure 3: Example site plan for REEFrame. Exact locations of individual modules are subject to change.

Size of impact area:
47 acres

Presence or absence of in-water vegetation and/or corals:
Corals present on adjacent reef

In-water work duration:
Deployment: 2-4 weeks
Monitoring: 1-4 weeks per year
Coral Collecting and Outplanting: 2-8 weeks per year

Water depth:
40-60 feet

Are special aquatic sites in the project area? ☒ Yes ☐ No

☐ Sanctuaries and refuges
☐ Wetlands
☐ Mudflats
☐ Vegetated shallows
☒ Coral reefs
☐ Riffle and pool complexes

Type of Equipment to be Used to Complete Work:

REEFrame Module Installation: Barges, tugboats, or vessels to install and assist with installation. Barges and vessels may use dynamic positioning or a 4-point mooring system to remain on site. Project personnel will use cranes from a barge to lower the modules into place.

Monitoring: Small vessels will be used to transport divers and/or snorkelers to/from the REEFrame site to conduct visual or photographic surveys. These monitoring activities may include the temporary placement of tapes, light chains, or quadrats directly on the reef or seafloor. Long-term monitoring projects may use transect markers secured in hard ground, rubble, or sediment areas where they will not affect living corals. Long-term makers will be rebar or stainless steel rods or pins, no larger than 0.63-2.54 centimeters (cm) (0.25-1 in) diameter, which are driven into the seabed by divers using hand-held hammers. Divers may also use hand-held pneumatic drills to drill a hole no larger than 1.9 3.2 cm (0.75-1.25 in diameter) in the seabed to insert long-term markers. These holes may be filled with a marine safe epoxy (such as All-Fix, Marine Weld TM, and Splash Zone TM) to hold the pin in place. Divers may also mark pins with small floats on short stainless steel leaders and label them with tags to assist with relocation. Divers using Structure-from-Motion will use cameras to capture underwater photographs over reefs. Projects may also deploy cameras to monitor reef fish or other motile species. Moored instruments may be deployed to passively collect physical data (e.g. temperature recorders).

Coral Collecting and Outplanting: Small vessels will be used to transport SCUBA divers to/from the REEFrame site. Divers will attach corals using variety of methods including direct attachment, the use of a tile (e.g., ceramic, aragonite, or concrete tile or “plug”), or restoration modules (e.g., a disk or pyramid made from concrete or limestone). Project personnel may affix tiles or restoration modules using stainless steel rods and pins. The outplanting method used will depend on the size of the coral colonies, type (colony, fragment, or module), or the location (modules or nearby control site) where they will be transplanted. Divers may need to prepare substrates and remove fouling organisms before attaching corals. Coral attachment will use marine safe epoxy, cement/concrete, or other mechanical devices (e.g., plastic cable ties). When concrete is used, only Portland Type II cement, mixed with aggregates such as sand, gravel, recycled concrete, crushed stone will be used. Divers will use the minimum amount of epoxy or concrete needed to accomplish the project. To transport colonies, project personnel may use any of the following: baskets/trays, lift bags or buoyancy control device for baskets/trays holding coral, underwater drills, Diver Propulsion Vehicles (DPVs).

Provide the methodology and installation for the project activities (type of method, type of equipment to be utilized, etc.) and how equipment may affect the resource.

The REEFrame modules will be fabricated at the Natrx facility in Amelia, Louisiana, and transported to Hawai‘i. Construction of REEFrame will require construction barges with a mounted crane to carefully place the units on the sandy seafloor. Up to 150 REEFrame modules will be deployed and arranged in a pattern that complements the nearby natural reef formations. If 150 modules are installed, the total installation will have a footprint of approximately 12,675 sq. ft. on the seafloor. Coral attachment points will be incorporated on the REEFrame modules to aid in future coral outplanting to the modules.

To reduce negative impacts on existing coral habitat and wildlife, the chosen deployment area consists of unconsolidated sand and sediments with minimal algal cover. Additionally, all modules will be placed a minimum distance of 100 feet away from existing reef. REEFrame untis will be free

of any material that may risk water quality (dirt, dust, etc.) before they are deployed at the site. To help control the risks of inadvertently placing a structure on the natural reef, construction will proceed only during fair weather conditions at the site (calm waves, currents and winds). GPS will be used to confirm the placement locations of each module.

To help control the short-term risks of the construction activities on ocean water quality, the benthic environment, wildlife, and cultural resources, Best Management Practices (BMPs) will be established prior to the deployment of REEFrame.

Construction activities will commence upon obtaining permits and approvals, which is estimated to be in late 2026/early 2027. Once approvals are issued, on-site construction activities (deployment) are expected to take two to four weeks.

What are the substrate types on/in the project area? (http://www.pacioos.hawaii.edu/voyager/)

☐ Aggregate reef	☐ Aggregate patch reef
☒ Individual patch reef	☐ Pavement
☐ Pavement with sand channels	☐ Rock/boulder
☐ Reef rubble	☐ Scattered coral/rock
☒ Spur and groove	☐ Artificial
☐ Mud	☒ Sand
☐ Open water	☐ Other:

Has a survey been completed for the project area? ☒Yes ☐ No

Are photographs and/or videos of the project area available? ☒ Yes ☐ No

What are the potential adverse impacts expected from the action?
3.2 Physical Damage – Accidental physical abrasion may occur during REEFrame module installation, monitoring, or coral collecting and outplanting.

3.3 Iron Enrichment – May be caused by coral outplanting with pins. The steel inside the REEFrame units is enclosed in cement so is not expected to have an adverse impact.

3.4 Sedimentation - Resuspension of sediment during REEFrame module installation, monitoring, or coral collecting and outplanting may briefly cause sediment to resettle on corals in the immediate vicinity and increase turbidity.

3.5 Invasive Species - Species can be introduced via transport on equipment or vessel hulls.

3.6 Disturbance of infauna – Disturbance of infauna may occur during REEFrame module installation and coral collection.

3.8 Noise Pollution – The use of vessels, DPVs, and underwater drills may modify behavior of fishes or other coral reef inhabitants.

3.10 Removal/collection - The removal and collection of corals during coral collecting.

3.12 FAD effect – The installation of the REEFrame modules may naturally attract aggregations of fish.

Avoidance measures and best management practices to be implemented. Refer to conservation recommendations listed in the Programmatic:

All relevant Programmatic EFH Conservation Recommendations will be implemented, including recommendation 1, 2, 3, 4, 5, 6,7, 8, and 9.

RC-PI Initiation of EFH Programmatic Consultation

By submitting this Notification and Verification Form, the RC-PI indicates that the proposed activity meets the description of activities provided in the Programmatic EFH Consultation.

Conservation Recommendations:

☒ All conservation recommendations described in the EFH Programmatic Agreement will be implemented.

RC-PI Project Manager
Name: Shannon Ruseborn

Date:12/8/2025

By providing your name, you are certifying that to the best of your knowledge, the information provided in this form is accurate and based upon the best available scientific information.

NMFS Regional Office Determination (To be completed by PIRO EFH Coordinator):

After receiving the Notification and Verification Form, PIRO will contact RC-PI with any concerns and indicate whether PIRO concurs with the RC-PI determination within 15 days.

☒ PIRO concurs with RC-PI determination that the project complies with the Programmatic EFH Consultation.

☐ PIRO does not concur with RC-PI determination that the project complies with the Programmatic EFH Consultation, and additional information may be required. Please follow up for further discussion.

☐ PIRO does not concur with RC-PI determination that the project complies with the Programmatic EFH Consultation, and the RC-PI should initiate a separate individual consultation.

Authorization by NMFS Personnel

Name: DELANEY.DAVID.GRANAHAN.1595803329

Digitally signed by DELANEY.DAVID.GRANAHAN.1595803329
Date: 2025.12.09 07:28:35 -10'00'

Date:

NOAA Office of Habitat Conservation (OHC) Restoration Center – Pacific Islands (RC-PI)

Required Best Management Practices (BMPs) from the RC-PI Programmatic Consultations

Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) BMPs

RC-PI will implement the following BMPs for use during all activities to avoid or minimize potential impacts of in-water activities (i.e., monitoring, mapping, data collection, coral restoration, reduction of physical impacts, and outreach activities), watershed restoration activities, and vessel use to EFH resources, whenever practical and possible.

General BMPs

- Fueling of land-based vehicles and equipment shall take place at least 50 m away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
- Chemicals that are toxic/not marine-safe are excluded from use under this programmatic unless explicitly discussed and described in the activity descriptions in section 3
- All required Federal, State, and local permits will be in place before implementation of any RC-PI activities.

Vessel Operations and Anchoring

- Vessels used in implementing activities must meet all EPA Vessel General Permit and Coast Guard requirements for the control of pollution from air emissions, vessel discharges, and trash.
- Vessels should maintain a safe operating speed consistent with the area through which it is transiting. All vessels will operate at 'no wake/idle' speeds at all times while in water depths where the draft of the vessel provides less than a 2 meter (6 foot) clearance. All vessels will follow deep-water routes (e.g. marked channels) whenever possible. If operating in shallow water, all vessels will use a dedicated lookout to assist the pilot with avoiding large coral colonies.
- To reduce the risk of vessel impacts to coral reefs, colonized hard bottom, and seagrass areas, the vessel operator will carry and consult appropriate nautical charts, benthic habitat maps and aerial photographs, and/or use real-time data (e.g., global positioning system with nautical chart and depth finder on boat) to continuously observe and verify water depths and vessel location.
- Vessel operators should use recreational mooring buoys or live boating (boat operator keeps engine on to keep boat on station without anchoring) when possible. If anchoring, operators will only use designated anchoring areas or anchor in mud or sand.
- If anchoring is necessary, vessels should be anchored on uncolonized bottom. Vessels should not be anchored on a hard bottom that contains hard and/or soft coral, regardless of the percentage of coral cover present. The type of bottom present will be confirmed by divers/snorkelers, or from the vessel using a glass-bottom bucket or by other appropriate means, prior to anchoring.
- Commercial vessels will be operated by experienced staff who have applicable training and certifications to do so.

- Operational and maintenance standards for vessels will be practiced.
- Operations will only occur during preferable ocean conditions with contingency plans to cancel or delay the action for favorable weather conditions.
- In case of an emergency or safety situation, the captain and crew will rely on their expertise to anchor the vessel following the other established BMPs, if it is safe to do so.
- PI-RC and NMFS will be notified within 48 hours in the event a vessel is grounded and/or abandoned during the proposed action.
- Depending on the action, vessels will wait at a safe distance in deeper waters after deploying personnel overboard to avoid anchoring.
- Established moorings will be used to the greatest extent practicable.
- Anchors will be routinely monitored for slippage by the vessel crew and a watch will be maintained when personnel are onboard.
- Vessels will follow established transportation channels whenever practicable.
- Fueling operations will be done internally or in designated refueling areas.
- Vessels will take reasonable steps to alert other vessels in the vicinity of whale(s).
- Vessels will not allow lines to remain in the water, and no trash or other debris will be thrown overboard, thereby reducing the potential for marine mammal entanglement.
- The transit route for the vessels will avoid designated critical habitat to the extent practicable.
- Avoid direct contact such as anchor impact to corals, seagrass, or other sessile ESA- listed resources.
- Use designated anchorage areas when available.
- Avoid anchoring in and immediately adjacent to coral and seagrass.
- In-water tethers, as well as mooring lines for vessels and marker buoys will be kept taut and to the minimum lengths necessary, and will remain deployed only as long as needed to properly accomplish the required task.
- All objects and equipment will be lowered to the bottom in a controlled manner. This can include the use of equipment, divers, or buoyancy controls such as lift bags that affect positive control over the rate of descent.
- A contingency plan to control toxic materials will be required. A hard copy of the plan will be available on board the vessel, and will be discussed with all personnel to ensure quick response in case of spills, fires or materials unintentionally entering the water column.
- Appropriate materials to contain and clean potential spills will be stored on the vessel or at the worksites and be readily available.
- Fueling of land-based vehicles and equipment will take place at least 50 feet away from the water, preferably over an impervious surface. Fueling of vessels will be done at approved fueling facilities.

Self-Contained Underwater Breathing Apparatus (SCUBA)/Snorkel

- SCUBA divers/snorkelers involved in in-water activities will have proper training and be capable of responsible dive/snorkel practices (e.g., proper buoyancy) such that they minimize injury to organisms or cause unnecessary habitat impacts. It is the responsibility of NOAA and/or its grantees/contractors to ensure that divers/snorkelers are trained to a level commensurate with the type and conditions of the diving activity being undertaken. The organization must have the capacity (appropriate insurance, safety policies, etc.) to oversee all proposed diving/snorkeling activities.
- To minimize disturbances and damage (to animals and habitats), divers should use low-impact techniques, which include employing neutral buoyancy, point of entry/exit, the use of appropriate dive equipment and tools, expert boat anchoring (e.g., hand placement by divers/snorkelers or verified non-living bottom habitat before deployment), job-specific diver training, and diver awareness.

- Before entering the water, all divers shall be made aware of ESA-listed corals, and the requirement to avoid contact with the corals while performing their duties. This shall include taking measures to avoid kicking the reef with fins and to secure dive and survey equipment in a manner that will prevent these from being drug across the substrate.
- Divers should stay off the bottom and should never stand or rest on corals or other sessile benthic invertebrates.
- During all in-water activities, participants in education programs and other activities should avoid stepping on/standing on corals, and kicking coral colonies while swimming.

Coral Restoration

Coral Collection

- Corals collected for purposes of micro- fragmentation, propagation and outplanting will be collected from the same general location that they will be outplanted to, to mitigate for the spread of coral disease, aquatic invasive species, or parasitic organisms.
- Collection/sampling design of corals of opportunity will ensure that collection activities are distributed across shoreline/reef flat/benthic areas, so as not to consolidate the impacts of collection.
- Projects proposing the collection of coral fragments for use in laboratory/research/restoration studies shall take less than 15% of the colony unless it is clearly demonstrated that the removal of a larger amount will not negatively impact the survival of the coral or impact the local population of that species. For some species, greater than 50% of the colony including entire colonies will be collected, but the need to do this should be clearly demonstrated.

Coral Restoration/Transplantation/Relocation

- Projects involving the collecting corals for transplantation should only collect a minimal portion of the wild colony (e.g., no more than 15% of an attached wild colony is removed, when possible, colonies are removed from areas where there are competitive interactions and are likely to die or be overgrown), but these amounts will vary and can be greater when a need is demonstrated.
- Corals will be transported from source site to recipient site using methods that minimize high exposure to UV light, high temperatures, and will not be exposed directly to air during transport, if above surface (i.e. will be maintained in temperature-stable, clean, shaded seawater during transport).
- Upon arrival at the outplanting site (if using baskets/containers/platforms for transportation), team will confirm that the basket/container/platform is not lowered down into mud or sediment or raised or lowered without control or appropriate speed (i.e. containers holding corals will not be dropped onto sea floor without control).
- Methods will be utilized that enable the safe transport of colonies or fragments without abrading polyps or coral tissue through the transport method (e.g. careful placement of colonies or fragments in baskets or transport containers, low density of fragments per load and single layering of colonies). Divers will assist transport of colonies across the reef to ensure the stability of the platform and the buoyancy of the lift bags/surface buoys (if utilizing these tools).
- Tools and equipment will not be placed on live bottom substrate or any organism unless contact with the organism is a necessary component of the project. Divers will avoid contact with organisms wherever possible.
- Caching will only be used at sites and times of year where there is low energetic water motion, to avoid corals being dislodged from an upright position and abraded, broken, scoured or covered with sand or rubble.

Coral Nurseries

- A nursery maintenance and monitoring plan and timeline will be developed and included with the proposed project. The plan will include method(s) to be used to remove structures that are no longer needed, functional, or for a design that has become obsolete. Structures must be constructed in a manner that ensures the structures will not move or flip during storm events or due to human impacts such as anchor drag.
- Stabilization of structures can be achieved with the use of weights and/or penetrating anchor systems such as Duckbill® or Helix® anchors or rebar driven to sufficient depth to prevent movement or lifting of the structures.
- Floating structures that use lines as part of the support system or for attaching corals must be constructed in a manner to eliminate or minimize the chances of entanglement.:
    - Line nurseries must have, at a minimum, either horizontal or vertical components that are rigid (e.g., PVC pipe) to prevent the structures from collapsing and potentially causing entanglement of animals.
    - Vertical lines for anchoring structures to the seafloor must have sufficient tension created by buoys on the line to avoid slack or loops from forming and to keep the lines off the seafloor.
    - Buoys should be tied to the rigid component of the structure with the minimum use of line such that less than 50 cm (20 in) of line is exposed between each buoy and the structure.
    - Line used to attach corals vertically to the nursery structures must be no longer than 20 cm (8 in).
    - Horizontal lines must be at least 20 cm (8 in) apart and must be kept taut and supported by a rigid frame structure (PVC or similar) in order to avoid slack in the horizontal lines.
    - The use of monofilament lines instead of steel cables to reduce the need to replace cables regularly is acceptable as long as the lines for floating structures are kept taut and follow the recommendations above for new floating structures to avoid entanglement of marine organisms.

<u>In-Water Equipment and Sampling</u>

ROV/AUV

- ROV/AUV operators should have the training necessary to maintain and operate these vehicles at a depth above the seafloor and coral structures in order to avoid contact.
- ROV/AUVs will be operated at a max speed of 56 knots.
- Stiffer line materials should be used for towing and kept taut during operations to reduce the potential for entanglement in bottom features such as coral habitats.
- All vessel operation BMPs will also be followed during ROV/AUV operations.

Buoy Installation

- Buoys should only be installed at locations with no or low vertical relief and no coral colonization within a 3-m (~10- ft) radius from the buoy anchor location to avoid breakage or abrasion of sessile benthic organisms from the movement of buoy and tackle.
- A mid-line float should be attached to the buoy chain approximately 0.6 m (2 ft) above the chain attachment point to the bottom anchor in order to prevent the anchor chain from dragging on the seafloor should the chain become detached from the anchor.
- A helical screw anchor or drill and epoxied pin anchor, depending on substrate type,

should be used to minimize the footprint of the anchor in the marine bottom.
- An oversight vessel should be used to ensure no marine mammals or sea turtles are in the area during buoy installation. If marine mammals or sea turtles are observed within 50 meters, operations will cease until the animal has left the area.

Acoustic/Echosounder Use
- The following deployments are expressly excluded from coverage under this programmatic; the deployment of active acoustic devices, with the exception of systems that operate in frequency bands well outside the hearing ranges of ESA-listed marine life (such as certain wave and current monitoring systems operating above 200 kHz), and moorings with acoustic release devices that only transmit a brief signal during deployment, then again during recovery of the mooring.
- Use directional echosounders with the smallest beam width practicable to concentrate noise directly under the vessel to the maximum extent practicable.
- Minimize the use of all active acoustic systems (e.g., turn off all non-navigational echosounders when not actively mapping)
- Power down or turn off a mapping echosounder if a marine mammal is observed closely approaching or within 100 m of the vessel.

Moored Instruments
- The installation and removal of in-water structures for research equipment should be performed by divers. All equipment must be removed once the study is complete. Exceptions include anchors under the substrate which may be cut even with the seafloor so as not to disturb the benthos.
- Moored instruments should be securely placed on/anchored into uncolonized hard bottom areas of rubble or sand.
- Any lines associated with moored instruments should be taut to avoid the possibility of entanglement of protected species.

Reduce Impacts of Fishing Gear
- Projects involving the use of traps, nets, or other types of fishing gear used to sample fish populations should include measures to ensure the use of these gear types minimizes impacts to benthic habitats.
- Nets should be monitored at all times to ensure ESA-listed species and other non-target species do not become entangled. If entanglement does occur, the animals will be freed immediately in accordance with any existing guidelines (https://www.fisheries.noaa.gov/national/resources-fishing/fishing-tips-protect-sea- turtles-and-marine-mammals) and PIRC and NFMS PRD notified

Bottom sediment disturbing activities (to reduce sediment impacts to habitat and protected species)
- Turbidity and siltation from project-related work shall be minimized and contained through the appropriate use of erosion control practices, effective silt containment devices, the curtailment of work during adverse weather and tidal/flow conditions, and slow, gentle deployment of structures onto the seafloor.
- If operations are anticipated to increase sedimentation or suspended material longer than 24 hours, a plan will need to be submitted outlining actions to avoid impacts to coral spawning and recruitment.

Invasive Species and Disease
- When working in areas where there is an identified risk of spreading invasive species or

disease or if a particular activity can increase the chance of spreading invasive species or disease, grantees/principle investigators should ensure spread does not occur by decontaminating gear, vessels, and other equipment (see field manual by Woodley et al., 2008 and Coral Disease Decontamination Protocol 2019 for recommendations https://nmsfloridakeys.blob.core.windows.net/floridakeys-prod/media/docs/coral-disease-decontamination-protocol.pdf).

- Laboratory studies involving the use of live plants, animals, bacteria, and viruses should ensure proper steps are taken so that non-native species or pathogens are not introduced or spread as a result of the work.

Discharge, Waste, and Pollution Controls

On-site Pollution Controls

- A contingency plan to control toxic materials is required.
- Appropriate materials to contain and clean potential spills shall be stored at the work site, and be readily available.
- Heavy equipment in and near water bodies should consider the use of biofuels and non-petroleum-based hydraulic fluids.
- All project-related materials and equipment placed in the water shall be free of pollutants.
- The project manager and heavy equipment operators shall perform daily pre-work equipment inspections for cleanliness and leaks. All heavy equipment operations shall be postponed or halted should a leak be detected, and shall not proceed until the leak is repaired and equipment cleaned.
- Fueling of land-based vehicles and equipment shall take place at least 50 m away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
- Turbidity and siltation from project-related work shall be minimized and contained through the appropriate use of erosion control practices, effective silt containment devices, and the curtailment of work during adverse weather and tidal/flow conditions.
- A plan shall be developed to prevent debris and other wastes from entering or remaining in the marine environment during the project.
- Properly confine, remove, and dispose of construction waste, including every type of debris, discharge water, concrete, cement, grout, debris and sediment from the washout facility, welding slag, petroleum product, or other hazardous materials generated, used, or stored on-site.
- All vehicles and other heavy equipment will be (a) operated in a safe manner; (b) stored, fueled, and maintained in a vehicle staging area set back from any natural waterbody or wetland; and (c) inspected daily for fluid leaks before leaving the vehicle staging area.
- Generators, cranes, and any other stationary equipment operated within (50 m) of any natural waterway or wetland will be maintained as necessary to prevent leaks and spills from entering the water.
- Use procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities if a spill occurs. Heavy equipment can also leak oil and fluids. Equipment is always refueled away from stream corridors, and operators are required to have a spill response plan in place in case of a leak.

Watershed Restoration

Erosion Control

- Temporary erosion controls will be in place before any significant alteration of the

restoration site and will be monitored during construction to ensure proper function. The following erosion control structures or approaches may be used: turbidity curtains, hay bales, and erosion mats may be used where appropriate. When possible, stream flow would be diverted from work areas to prevent excess turbidity.

- Vegetation and soil disturbance will be confined to the minimum area and minimum length of time necessary to complete the action, and to otherwise prevent or minimize erosion associated with the action.
- Reduce the potential for erosion and head cuts through grade control structures or bank recontouring.
- Work will cease under high flows or seasonal conditions that threaten to disturb turbidity reduction measures, except for efforts to avoid or minimize resource damage.
- Exposed areas will be mulched and seeded after ground-disturbing activities are complete.
- Any woody debris, mature native vegetation, topsoil, and native channel material displaced by construction will be stockpiled for use during site restoration. When construction is finished, all streambanks, soils, and vegetation will be cleaned up and restored as necessary to renew ecosystem processes that form and maintain productive fish habitats.

Methods to Reduce Soil Compaction

- Existing access ways will be used whenever possible. Temporary access roads will not be built on slopes greater than 50%, where grade, soil, or other features suggest a likelihood of excessive erosion or failure. Soil disturbance and compaction will be minimized within 46 m (150 ft) of a natural waterbody or wetland. All temporary access roads will be removed when the action is completed, the soil will be stabilized, and the site will be revegetated. Temporary roads in wet or flooded areas would be restored shortly after the work period is complete.
- Heavy equipment will be selected and operated in a manner that minimizes adverse effects to the environment (e.g., minimally-sized, low-pressure tires, minimal hard turn paths for tracked vehicles, temporary mats or plates within wet areas or sensitive soils).
- To the extent feasible, heavy equipment will work from the top of the bank, unless work from another location would result in less habitat disturbance.

Adequate training of volunteers

- Training should be provided to ensure minimal impact to the restoration site by volunteers. Volunteers shall be trained in the use of low-impact techniques for planting, equipment handling, and moving around the restoration site to avoid unnecessary impacts on native flora and fauna.

Minimize pollution impacts on habitat and protected species

- Avoid using products with large concentrations of pesticides. All pesticides usage will require a Pesticide Usage Plan and follow guidelines provided by our office.
- Avoid planting vegetation when a severe storm is approaching.

Unmanned Aerial Vehicles (UAS) operations:

- All UAS will undergo a pre-flight test prior to deployment to ensure that the equipment is working properly and weather conditions are conducive to flying a mission.
- All UAS operations will be conducted with a pilot and a spotter to ensure that the UAS is monitored at all times.
- Should any UAS make an emergency landing in the water, small boats will be deployed immediately to retrieve the equipment to minimize potential for pollution (e.g. loss of gas or batteries into the marine environment).

Other

- All required Federal, State, and local permits will be in place before implementation of any RC-PI activities.
- Vessels used in implementing activities must meet all EPA Vessel General Permit and Coast Guard requirements for the control of pollution from air emissions, vessel discharges, and trash.
- Projects involving laboratory studies will follow the laboratory's environmental compliance guidelines and ensure that chemicals are disposed of in a proper manner, and comply with the ethical treatment of animals.

Endangered Species Act (Section 7) BMPs

National Marine Fisheries Service [NMFS]-managed species only

General BMPs that apply to all activities:

- Do not attempt to feed, touch, ride, or otherwise intentionally interact with any ESA- listed marine species.
- Observers will report when motile ESA-listed marine species are within 50 m of the proposed work and halt work, and work will only begin/resume after the animals have voluntarily departed the area.
- If ESA-listed motile marine species are noticed within 50 m after work has already begun, that work may continue only if the activity will not adversely affect the animal(s).
- Fueling of land-based vehicles and equipment will take place at least 50 m away from the water, preferably over an impervious surface. Fueling of vessels will be done at approved fueling facilities.
- Chemicals that are toxic/not marine-safe are excluded from use under this programmatic unless explicitly discussed and described in the activity descriptions
- All required Federal, State, and local permits will be in place before implementation of any RC-PI activities.
- All structures and equipment will be removed from the environment and discarded appropriately onshore when they are no longer needed
- All objects and equipment will be lowered to the bottom in a controlled manner. This can include the use of equipment, divers, or buoyancy controls such as lift bags that affect positive control over the rate of descent.
- A contingency plan to control toxic materials will be required. A hard copy of the plan will be available on board the vessel, and will be discussed with all personnel to ensure quick response in case of spills, fires, or materials unintentionally entering the water column.
- Appropriate materials to contain and clean potential spills will be stored on the vessel or at the worksites and be readily available.
- A contingency plan to control toxic materials is required.
- Heavy equipment in and near water bodies should consider the use of biofuels and non- petroleum-based hydraulic fluids.
- All project-related materials and equipment placed in the water shall be free of pollutants.
- The project manager and heavy equipment operators shall perform daily pre-work

equipment inspections for cleanliness and leaks. All heavy equipment operations shall be postponed or halted should a leak be detected, and shall not proceed until the leak is repaired and equipment cleaned.

- Fueling of land-based vehicles and equipment shall take place at least 50 m away from the water, preferably over an impervious surface. Fueling of vessels shall be done at approved fueling facilities.
- A plan shall be developed to prevent debris and other wastes from entering or remaining in the marine environment during the project.

Vessel operations and anchoring:

- Constant vigilance will be kept for the presence of ESA- or MMPA-listed marine species during all aspects of the project, particularly in-water activities such as boat operations, diving, and deployment of anchors and mooring lines.
- When piloting vessels, vessel operators will alter course to remain at least 50 m from marine mammals and sea turtles.
- Reduce vessel speed to 10 knots or less when piloting vessels at or within the ranges described above from marine mammals and sea turtles. Operators will be particularly vigilant in watching for turtles at or near the surface, and if practicable, reduce vessel speed to 5 knots or less.
- Vessels will maintain a safe operating speed consistent with the area through which it is transiting. All vessels will operate at 'no wake/idle' speeds at all times while in water depths where the draft of the vessel provides less than a 2 meter (6 foot) clearance. All vessels will follow deep-water routes (e.g. marked channels) whenever possible. If operating in shallow water, all vessels will use a dedicated lookout to assist the pilot with avoiding large coral colonies.
- Marine mammals and sea turtles will not be encircled or trapped between multiple vessels or between vessels and/or the shore.
- When whales are sighted, maintain a distance of 100 meters or greater between the whale and the vessel.
- Vessel operators should use recreational mooring buoys or live boating (boat operator keeps engine on to keep boat on station without anchoring) when possible. If anchoring, operators will only use designated anchoring areas or anchor in mud or sand.
- Operations will only occur during preferable ocean conditions with contingency plans to cancel or delay the action for favorable weather conditions.
- Depending on the action, vessels will wait at a safe distance in deeper waters after deploying personnel overboard to avoid anchoring.
- Vessels will follow established transportation channels whenever practicable.
- The transit route for the vessels will avoid designated critical habitat to the extent practicable.
- Avoid direct contact such as anchor impact to corals, seagrass, or other sessile ESA-listed resources.
- In-water tethers, as well as mooring lines for vessels and marker buoys will be kept taut and to the minimum lengths necessary, and will remain deployed only as long as needed to properly accomplish the required task.

SCUBA and Snorkel Operations:

- Before entering the water, all divers shall be made aware of ESA-listed corals, and the requirement to avoid contact with the corals while performing their duties. This will include taking measures to avoid kicking the reef with fins and to secure dive and survey equipment in a manner that will prevent these from being drug across the substrate.
- If a sea turtle or marine mammal is observed within 50m while using DPVs or drills, the equipment will not be used until the animal has exited the area of its own accord.
- Divers should stay off the bottom and should never stand or rest on corals or other sessile benthic invertebrates.
- During all in-water activities, participants in education programs and other activities will avoid stepping on/standing on corals, and kicking coral colonies while swimming.

Coral Restoration:

- Corals collected for purposes of micro- fragmentation, propagation and outplanting will be collected from the same general location that they will be outplanted.
- Collection/sampling design of corals of opportunity will ensure that collection activities are distributed across shoreline/reef flat/benthic areas, so as not to consolidate the impacts of collection.
- Corals will be transported from source site to recipient site using methods that minimize high exposure to UV light, high temperatures, and will not be exposed directly to air during transport.
- Upon arrival at the outplanting site, the team will ensure that the container is not lowered down into mud or sediment or raised or lowered without control or appropriate speed (i.e. containers holding corals will not be dropped onto sea floor without control).
- Divers will assist with the transport of colonies across the reef to ensure the stability of the platform and the buoyancy of the lift bags/surface buoys (if utilizing these tools).
- Tools and equipment will not be placed on live bottom substrate or any organism unless contact with the organism is a necessary component of the project. Divers will avoid contact with organisms wherever possible.
- Caching will only be used at sites and times of year where there is low energetic water motion, to avoid corals being dislodged from an upright position and abraded, broken, scoured or covered with sand or rubble.
- A nursery maintenance and monitoring plan and timeline will be developed and included with proposed projects. The plan will include method(s) to be used to remove structures that are no longer needed, functional, or if a design has become obsolete. Structures must be constructed in a manner that ensures the structures will not move or flip during storm events or due to human impacts such as anchor drag.
- Stabilization of structures will be achieved with the use of weights and/or penetrating anchor systems anchors or rebar driven to a sufficient depth to prevent movement or the lifting of the structures.
- Floating structures that use lines as part of the support system or for attaching corals must be constructed in a manner to eliminate or minimize the chances of entanglement.

- Line nurseries must have, at a minimum, either horizontal or vertical components that are rigid to prevent the structures from collapsing and potentially causing entanglement of animals.
- Vertical lines for anchoring structures to the seafloor must have sufficient tension created by buoys on the line to avoid slack or loops from forming and to keep the lines off the seafloor.
- Buoys should be tied to the rigid component of the structure with the minimum use of line such that less than 50 cm of line is exposed between each buoy and the structure.
- Lines used to attach corals vertically to the nursery structures must be no longer than 20 cm.
- Horizontal lines must be at least 20 cm apart and must be kept taut and supported by a rigid frame structure to avoid slack in the horizontal lines.

<u>In-water Equipment and Sampling</u>:

- ROV/AUV operators should have the training necessary to maintain and operate these vehicles at a depth above the seafloor and coral structures in order to avoid contact.
- ROV/AUVs will be operated at a max speed of 5 knots.
- Stiffer line materials should be used for towing and kept taut during operations to reduce the potential for entanglement in bottom features such as coral habitats.
- All vessel operation BMPs will also be followed during ROV/AUV operations.
- Buoys will be installed at locations with no or low vertical relief and no coral colonization within a 3m radius from the buoy anchor location.
- A mid-line float will be attached to the buoy chain above the chain attachment point to the bottom anchor in order to prevent the anchor chain from dragging on the seafloor.
- Minimize the use of all active acoustic systems (e.g., turn off all non-navigational echosounders when not actively mapping)
- Power down or turn off a mapping echosounder if a marine mammal is observed closely approaching or within 100 m of the vessel.
- The installation and removal of in-water structures for research equipment will be performed by divers.
- All equipment must be removed once the study is complete. Exceptions include anchors under the substrate, which may be cut even with the seafloor so as not to disturb the benthos.
- Moored instruments should be securely placed on/anchored into uncolonized hard bottom areas of rubble or sand.
- Lines associated with moored instruments will be taut to avoid the possibility of entanglement of protected species.
- Turbidity and siltation from project-related work shall be minimized and contained through the appropriate use of erosion control practices, effective silt containment devices, the curtailment of work during adverse weather and tidal/flow conditions, and slow, gentle deployment of structures onto the seafloor.
- If operations are anticipated to increase sedimentation or suspended materials longer than 24 hours, a plan will need to be submitted outlining actions to avoid impacts to coral spawning and recruitment.

Watershed restoration:

- Work will cease under high flows or seasonal conditions that threaten to disturb turbidity reduction measures, except for efforts to avoid or minimize resource damage.

Unmanned Aerial Vehicle Operations:

- All UAS operations will be conducted with a pilot and a spotter to ensure that the UAS is monitored at all times.
- All flights will be high enough in elevation so as not to disturb ESA-listed species (minimum: 200 ft.). Additionally, UAS should not hover over any ESA-listed species.

Pesticide or Herbicide Use:

- Apply the minimum amount of pesticide necessary to meet site objectives.
- Consider removal of invasive plants via mechanical means, such as hand pulling, where such treatments may be effective and would pose a lesser risk to ESA-listed fish and critical habitat than pesticide treatments.
- Mixing, container transfer, and storage of herbicides and application equipment must not occur within 150 feet of surface water.
- Pesticide will not be applied when a precipitation event is forecasted to take place within 48 hours following an application.
- No broadcast spraying of pesticides may be used within riparian reserves/riparian buffers (i.e., within 100 feet of a stream or other surface water).
- Require spot spraying or hand-application techniques when applying pesticides within 100 feet of a stream or other water body.
- Keep all spray applicators as low to the ground as possible to reduce wind drift.
- Pesticides will not be applied when sustained wind conditions exceed 5 mph in riparian areas, or 8 mph in upland areas.

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May 8, 2026

Ben Stablow
Endangered Species Biologist
Pacific Islands Regional Office
NOAA National Marine Fisheries Service

Transmitted via email: benjamin.stablow@noaa.gov

Aloha Mr. Stablow,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī**
Response to Pre-Consultation Comments

Mahalo for your comments dated November 5, 2025, on the REEFrame Draft Environmental Assessment (EA). We note your questions related to project deployment, construction and maintenance, as well as your guidance regarding the Endangered Species Act (ESA) species, critical habitats and Best Management Practices (BMPs) to avoid adverse impacts. The Draft EA Section 3.1.7 summarizes findings from a benthic study conducted for this project, provides an overview of findings from the ESA Section and Essential Fish Habitat (EFH) reviews, and summarizes project impacts and proposed mitigation. Draft EA Appendix A contains the Benthic Survey report.

Pursuant to requirements under the Endangered Species Act and the Magnuson-Stevens Act, NOAA's Office of Habitat Conservation consulted with the NOAA Pacific Islands Regional Office (PIRO) using the Programmatic Consultation. PIRO concurred that the REEFrame activities fit within the scope of the included activities and signed the verification forms contained in Appendix B of the Draft EA, including the EFH consultation verification form and required BMPs, as well as the ESA Consultation Verification Form.

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development. Thank you again for your comments.

Sincerely,

Berna Senelly

Regulatory Lead

Oceanit Center 828 Fort Street Mall, Suite 600 Honolulu, Hawaii 96813 Phone: 808.531.3017 Fax: 808.531.3177
www.oceanit.com

RECEIVE
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JOSH GREEN, **M.D.**
GOVERNOR I KE KIA"IINA

SYLVIA LUKE
LIEUTENANT GOVERNOR I KA HOPE KIA"AINA

STATE OF HAWAI'I I KA MOKU'AINA 'O HAWAI'I
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA 'OIHANA KUMUWAIWAI 'AINA
Office of Conservation and Coastal Lands
P.O. BOX621
HONOLULU, HAWAII 96809

DAWN N.S. CHANG
CHAIRPERSON

BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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FIRST DEPUTY

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DEPUTY DIRECTOR - WATER

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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

REF:OCCL:MK

COR OA 26-80

Nov 17, 2025

Berna Senelly
Oceanit
828 Fort Street Mall, Suite 600
Honolulu, HI 96813

SUBJECT: Correspondence OA 26-80 Pre-Consultation Draft Environmental Assessment for Proposed REEFrame Coral Nursery Project Located in Waikīkī, Honolulu, Island of O'ahu

Dear Berna Senelly:

The Office of Conservation and Coastal Lands (OCCL) is in receipt of your letter regarding the subject matter. According to the information you have provided, on behalf of Conservation International, Oceanit is preparing a Draft Environmental Assessment (EA) for the construction and installation of an artificial reef offshore of Waikīkī, and as part of the environmental review process pursuant to Hawai'i Revised Statutes (HRS) Chapter 343 and Hawai'i Administrative Rules (HAR) Chapter 11-200.1, is seeking agency comments. The applicant states that the proposed project location is approximately 0.75-1 mile off Waikīkī Beach. It appears the proposed project is located within State submerged unencumbered lands, within the Resource Subzone of the State Land Use Conservation District. See **Exhibit 1.**

The proposed project includes the installation of up to 150, 30 printed, concrete "REEFrame" modules; comprised of five units: four units that form the base, and the fifth unit on top; at a depth of 40-60 feet. The modules are comprised of concrete material with steel hardware, covered in concrete coatings. Each module measures six feet wide and six feet tall, and the total installation footprint will be approximately 12,675 feet2. The design weight is an average of five tons and is structurally designed to be stable in a 50-year southern swell storm event where wave heights may reach or extend 18 feet **(Exhibit 2).**

The construction of the REEFrame will require construction barges with heavy equipment to carefully place the units on the sandy sea floor. GPS will be used to confirm the placement locations of each module, and installation will only proceed during fair weather conditions. Observation divers will assist in this operation, ensuring the accuracy of each placement, and avoiding damage to sensitive species and habitats.

The project is designed to provide a suitable nursery for "corals of opportunity", which are living coral colonies previously dislodged by storms, ship groundings, anchor drags, and other disturbances. These corals will be attached to the REEFrame modules. Additionally, urchins

from the Division of Aquatic Resources' nursery will be added to the modules, and serve as natural grazers. The project aims to create a permanent framework that will serve as coral nurseries and foundations for structurally complex, natural coral reefs.

The applicant notes that Best Management Practices (BMPs) will be established prior to project deployment to help control potential short-term risks of the construction activities on ocean water quality and benthic environment, such as pre-rinsing materials, turbidity curtains, and maintaining a 100-foot buffer from existing reefs, and monitors for cultural and wildlife resources.

It appears the proposed project could be an identified land use, pursuant to HAR §13-5-24, R-2 ARTIFICIAL REEFS, (D-1) *Artificial reefs.* This requires the filing of a Conservation District Use Application for 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 (BLNR). Applications can be found on our website at https://dlnr.hawaii.gov/occl/application-process/.

The Draft EA should answer the following questions:

- Will the reef modules result in ground disturbance?
- How will the corals of opportunity be attached to the modules?
- Is there a long-term management plan for the modules? Will Oceanit be responsible for maintaining the structures and ensuring their success?
- How has the community received the project proposal through community engagement so far?
    - Has there been any concern regarding the project impeding recreational or cultural practices?

The applicant notes that the Division of Aquatic Resources is a state partner in the project. The OCCL strongly recommends that the applicant conduct early consultation with the Department of Army Corps of Engineers, the Department of Health Clean Water Branch, and the Division of Boating and Ocean Recreation regarding potential agency requirements, as well as the Land Division for the proposed use of state submerged unencumbered lands. Our office appreciates the opportunity to provide our comments on the proposal, and anticipates the forthcoming Draft EA.

Should you have any questions, please contact Mari Kurosawa of our Office at mari.i.kurosawa@hawaii.gov or at (808) 587-0381.

Sincerely,

S Michael Cain

S. Michael Cain, Administrator
Office of Conservation and Coastal Lands

CC: Chairperson
DARIDOBOR/Land Division
DOH- Clean Water Branch, USACE

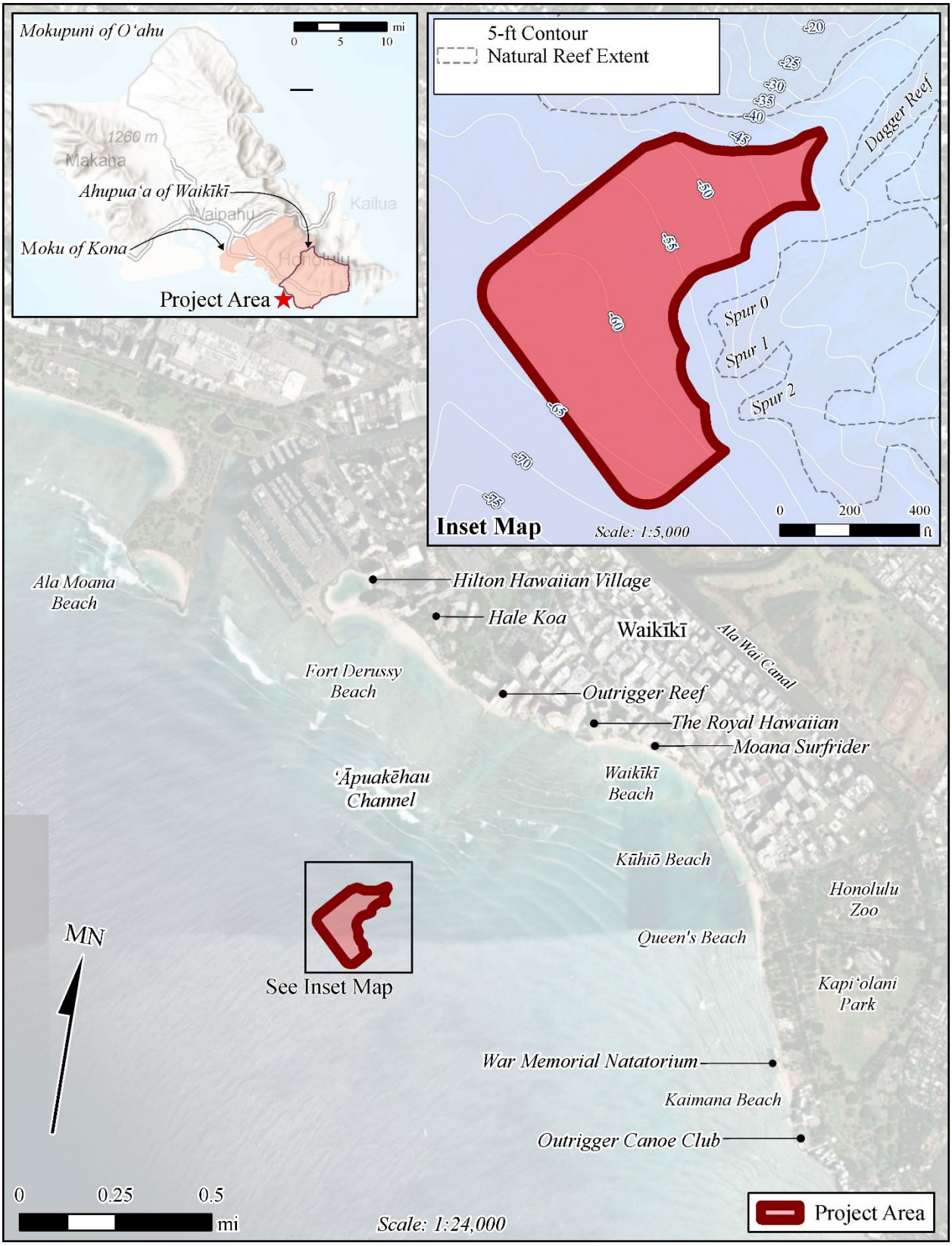


Exhibit 1: Project Area

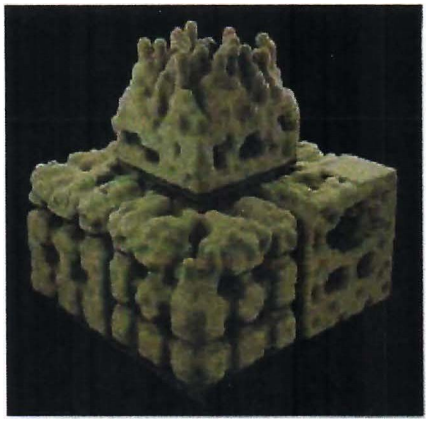


Figure 3: Typical REEFrame Module

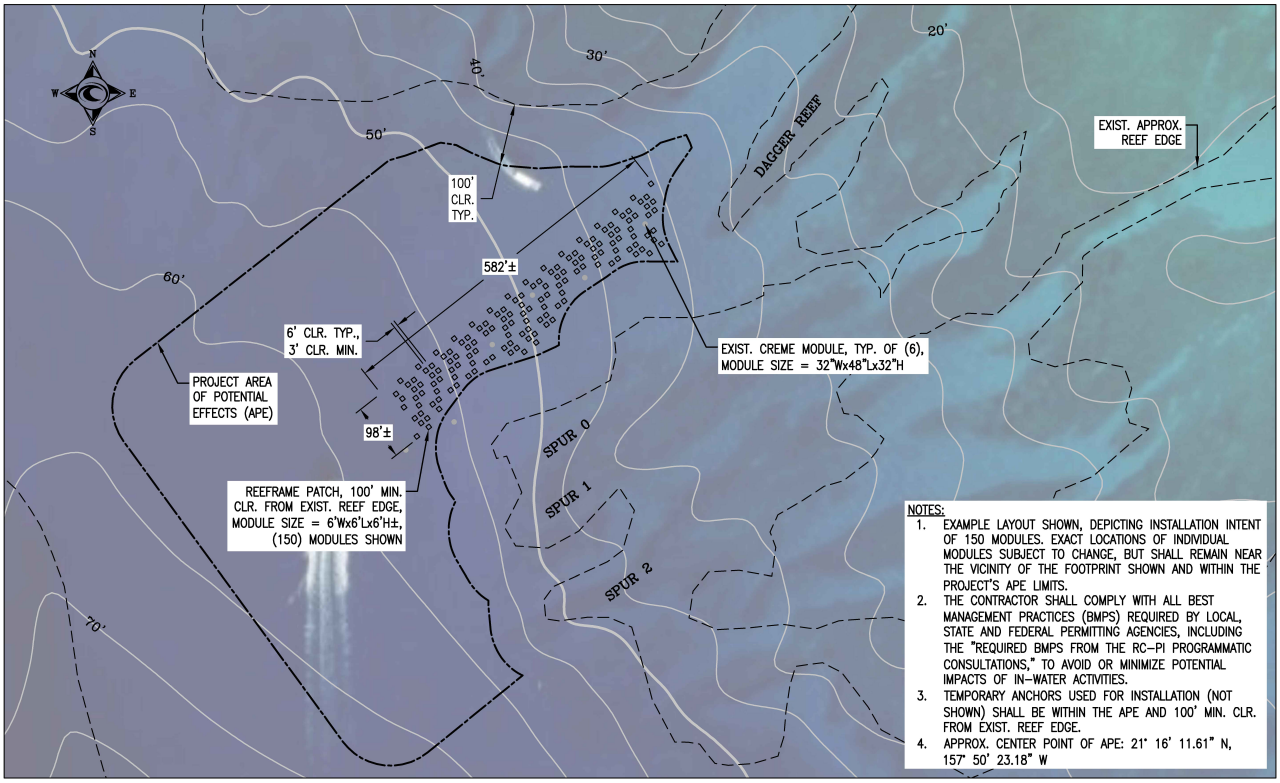


Exhibit 2: Module Design and Potential Site Plan

May 8, 2026

Michael Cain
Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources (DLNR)
1151 Punchbowl St #131, Honolulu, HI 96813

Transmitted via USPS mail and email: michael.cain@hawaii.gov; mari.i.kurosawa@hawaii.gov

Aloha Mr. Cain,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī**
Response to Pre-Consultation Comments

Mahalo for your comment dated November 17, 2025, on the REEFrame Draft Environmental Assessment. We note your comment that the proposed project may qualify as an identified land use under HAR §13-5-24, R-2 Artificial Reefs, (D-1) Artificial Reefs. This would require submitting a Conservation District Use Application (CDUA) for a Board Permit, with the Board of Land and Natural Resources (BLNR) determining whether to allow, modify, or deny the proposed use.

Your recommendation regarding early consultation is noted, and we have included the Department of Health Clean Water Branch and the Division of Boating and Ocean Recreation in pre-consultation for this Draft EA. Further, we have initiated consultation with the U.S. Army Corps of Engineers (USACE), regarding potential agency requirements, as well as consultation with the Land Division for the proposed use of state submerged unencumbered lands.

Our responses to your specific questions are as follows.

1. Will the reef modules result in ground disturbance?

   Response: The total installation footprint will be approximately 11.4 acres, with approximately 150 REEFrame units placed on the sandy seafloor. No ground-disturbing activities will occur. To minimize bottom sediment disturbance, the Project will implement Best Management Practices (BMPs) developed through Programmatic Consultation with NOAA's Office of Habitat Conservation (OHC). These BMPs are listed in Draft EA Section 3.1.4.2, *Potential Impacts and Proposed Mitigation Measures*.

2. How will the corals of opportunity be attached to the modules?

   Response: Corals of Opportunity will be attached using methods appropriate to colony size, type (colony, fragment, or module), and planting location. Larger colonies may be secured using stainless steel rods or pins, Type II portland cement, and/or marine epoxy. A Viscosity Modifying Admixture (VMA), such as xanthan gum, may be added to cement mixes. Module design and fabrication include 1) pre-drilled holes to insert 0.3–0.6 cm diameter steel rods adhered with non-toxic marine epoxy, and 2) one flat corner per module to accommodate affixing DLNR Division of Aquatic Resources (DAR)'s coral pyramids. The quantity of materials required will depend on the size and type of corals collected.

3. Is there a long-term management plan for the modules? Will Oceanit be responsible for maintaining the structures and ensuring their success?

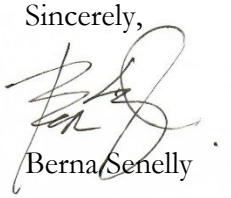
   Response: After deployment is completed, a monitoring contractor will conduct post deployment and restoration monitoring, DAR will conduct long-term monitoring and maintenance. DAR will provide one week of monitoring annually, consisting of five days of surveys by two dive teams (four divers total), completing three dives per day, for a total of 30 dives per year. While this level of effort will only detect broad-scale temporal and spatial changes, it will document trends in species composition, species richness, coral survival, and coral growth. A Before-After Control-Impact (BACI) study design will be used. To evaluate NOAA's recommended performance measures, DAR or a partner organization will conduct subsampling 90 days after each annual monitoring session. It is anticipated that additional research by marine scientists will continue over time, further studying the ecology of the permanent REEFrame structures and associated coral restoration.

4. How has the community received the project proposal through community engagement so far? Has there been any concern regarding the project impeding recreational or cultural practices?

   Response: REEFrame has been conducting ongoing community outreach with a broad range of stakeholders, including resource management agencies, Waikīkī residents, cultural groups and kūpuna, the surfing community, fishers, scuba tour operators, youth and schools, the visitor industry, and the scientific community. Feedback has been and continues to be positive. Regarding recreational and cultural practices, negative concerns have not been raised regarding project effects or impacts. A summary of community outreach efforts can be found in Draft EA Section 5.1.2: Ongoing Community Outreach.

Because the Proposed Action may constitute an identified land use under HAR §13-5-24 (R-2 Artificial Reefs, D-1 Artificial Reefs), a CDUA for a Board Permit will be submitted. Section 401 compliance will be coordinated with USACE and the DOH Clean Water Branch. Pre-consultation letters were sent to the DLNR Land Division and Division of Boating and Ocean Recreation on November 3, 2025, and the Land Division submitted comments.
We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development. Thank you again for your comment.

Sincerely,



Berna Senelly

Regulatory Lead

HONOLULU POLICE DEPARTMENT
KA 'OIHANA MĀKA'I O HONOLULU
CITY AND COUNTY OF HONOLULU
801 SOUTH BERETANIA STREET • HONOLULU, HAWAI'I 96813
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KAHU MĀKA'I KŪIKAWĀ

AARON TAKASAKI-YOUNG
RYAN T. NISHIBUN
INTERIM DEPUTY CHIEFS
NĀ HOPE LUNA NUI MĀKA'I KŪIKAWĀ

OUR REFERENCE EO-SH

December 1, 2025

SENT VIA EMAIL

Ms. Berna Cabacungan Senelly
reeframe@oceanit.com

Dear Ms. Senelly:

This is in response to your email correspondence dated November 3, 2025, requesting input for the Draft Environmental Assessment for the proposed REEFrame Coral Nursery Project in Waikīkī.

Based on the information provided, the Honolulu Police Department (HPD) recommends that all necessary signs, lights, barricades, and other safety equipment be installed and maintained by the contractor during the construction phase of the project. The impact of the ingress/egress of construction vehicles, equipment, and deliveries should be evaluated to ensure the flow of traffic is not adversely affected. Lastly, as this project may affect areas of Waikīkī Beach, the HPD recommends working with the Neighborhood Board, as well as the hotels and businesses in the area regarding possible road and/or beach closures which may affect visitors and residents alike.

If there are any questions, please call Acting Major Dason Toma of District 6 (Waikīkī) at (808) 723-3345.

Sincerely,

CARLENE LAU
Acting Assistant Chief of Police
Support Services Bureau

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innovation through engineering & scientific excellence

May 8, 2026

Carlene Lau
Acting Assistant Chief of Police
Support Services Bureau
Honolulu Police Department
City and County of Honolulu
801 South Beretania St. Honolulu, HI 96813

Transmitted via email: hpdchiefsoffice@honolulu.gov

Aloha Ms. Lau,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī**

Mahalo for your comment dated December 1, 2025 on the REEFrame Draft Environmental Assessment.

We note your comment that the contractor should install and maintain all necessary signs, lights, barricades, and other safety equipment during construction; that the impact of construction on traffic flow be evaluated; and that coordination occur with the Neighborhood Board, hotels, and nearby businesses regarding any potential road or beach closures.

During the construction phase of the REEFrame Project, the contractor will install and maintain all required signs, lights, barricades, and safety equipment. Because construction activities will occur offshore, the project is not anticipated to result in any road or beach closures and will not affect traffic flow. Nevertheless, the project team will maintain communication with the Waikiki Neighborhood Board and nearby businesses to keep them updated on project progress. Further discussion is contained in Draft EA Section 3.4.2, Police, Fire Protection and Ocean Safety. .

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development. Thank you again for your comment.

Sincerely,

Berna Senelly

Regulatory Lead

Oceanit Center 828 Fort Street Mall, Suite 600 Honolulu, Hawaii 96813 Phone: 808.531.3017 Fax: 808.531.3177
www.oceanit.com

STATE OF HAWAIʻI
OFFICE OF PLANNING
& SUSTAINABLE DEVELOPMENT

235 South Beretania Street, 6th Floor, Honolulu, Hawaiʻi 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaiʻi 96804

JOSH GREEN, M.D.
GOVERNOR

SYLVIA LUKE
LT. GOVERNOR

MARY ALICE EVANS
DIRECTOR

Telephone: (808) 587-2846
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Coastal Zone Management Program

Environmental Review Program

Land Use Commission

Land Use Division

Special Plans Branch

State Transit-Oriented Development

Statewide Geographic Information System

Statewide Sustainability Branch

DTS202512021252MO

December 4, 2025

Ms. Berna Cabacungan Senelly
Oceanit
828 Fort Street Mall, Suite 600
Honolulu, HI 96813

Dear Ms. Senelly:

Subject: Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī

The Office of Planning and Sustainable Development (OPSD) is in receipt of your early consultation request via email, received December 1, 2025, for the preparation of a Draft Environmental Assessment (EA) for the proposed REEFrame Coral Nursery Project in Waikīkī, Oʻahu.

Conservation International proposes a REEFrame Project to restore Waikīkī coral reefs by creating and installing permanent coral habitat. The proposed REEFrame Project proposes to construct 3-Dimensional (3D) printed, concrete reef frameworks that will serve as both coral nurseries and foundations for natural coral reefs. The proposed project location is approximately 0.75 to 1 mile off Waikīkī Beach in water depths between 40 to 60 feet.

REEFrame module would comprise five total units, including four units that form the base and the fifth unit on top. Each REEFrame module measures six feet wide and six feet tall. The design weight is an average of five tons and structurally designed to be stable in a 50-year southern swell storm event. Up to 150 REEFrame modules will be deployed in Waikīkī.

The Project will be funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Habitat Conservation.

The OPSD has reviewed the early consultation request and has the following comments to offer:

1. The EA shall discuss the triggers for the preparation of an EA set forth in Hawaiʻi Revised Statutes (HRS) Chapter 343, as well as a list of all required permits and approvals. Furthermore, the EA should contain the project location maps, including the regional location on the Island

of O‘ahu, and provide schematic plans or drawing for the scope of the project.

2. The State of Hawai‘i Coastal Zone Management (CZM) Area encompasses the entire state. The Hawai‘i CZM Law requires all state and county agencies to enforce the CZM objectives and policies. The subject EA should include an assessment with mitigation measures, if needed, as to how the proposed projects conform to each of the CZM objectives and policies set forth in HRS § 205A-2, as amended.

3. Given that other areas across the State of Hawai‘i may be also available for such REEFrame Project, OPSD suggests that the EA specifically discuss why offshore Waikīkī Beach, which is a manmade engineered beach, was selected as the REEFrame Project to restore coral reefs. In addition, the EA may provide specific measures to assess the restoration progress of Waikīkī coral reefs after the Project.

4. Construction of REEFrame will require construction barges with heavy equipment to carefully place the units on the sandy sea floor. The Project will cover an area that measures 1,700 feet by 1,200 feet, or approximately 47 acres. The EA should discuss whether the proposed REEFrame Project will affect any sandy deposit area of Waikīkī Beach, which is crucial to sand supplies for periodically restoration and maintenance of Waikīkī Beach.

5. The National Coastal Zone Management Act (CZMA), section 307, requires federal agency activities and development projects, activities requiring a federal permit or license, and activities conducted with federal financial assistance that affect coastal uses and resources must be conducted in a manner consistent with the state’s CZM program. OPSD is the state agency with the authority to conduct CZMA federal consistency review. Please contact OPSD on the policies and procedures applicable to CZMA federal consistency reviews for the proposed REEFrame Project.

If you respond to this comment letter, please include DTS202512021252MO in the subject line. For any questions regarding this letter, please contact Shichao Li of our office at (808) 587-2841 or by email at shichao.li@hawaii.gov.

Sincerely,

Mary Alice Evans

Mary Alice Evans
Director

May 8, 2026

Mary Alice Evans
Director
State of Hawai‘i Office of Planning & Sustainable Development
235 South Beretania St, 6th floor, Honolulu, Hawai‘i 96813

Transmitted via email: shichao.li@hawaii.gov

Aloha Ms. Evans,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī**
Response to Pre-Consultation Comments DTS202512021252MO

Mahalo for your comment dated December 4, 2025, on the REEFrame Draft Environmental Assessment. Your comments and our responses are as follows:

1. The EA shall discuss the triggers for the preparation of an EA set forth in Hawai‘i Revised Statutes (HRS) Chapter 343, as well as a list of all required permits and approvals. Furthermore, the EA should contain the project location maps, including the regional location on the Island of O‘ahu, and provide schematic plans or drawing for the scope of the project.

   Response: The Draft Environmental Assessment discusses the triggers for an EA under HRS Chapter 343 in Section 1.4 and Section 4.4. lists required permits and approval. The project location maps, including the regional location on O‘ahu, and schematic project plans for the project are presented in Sections 1 and 2, as well as other sections as relevant.

2. The State of Hawai‘i Coastal Zone Management (CZM) Area encompasses the entire state. The Hawai‘i CZM Law requires all state and county agencies to enforce the CZM objectives and policies. The subject EA should include an assessment with mitigation measures, if needed, as to how the proposed projects conform to each of the CZM objectives and policies set forth in HRS § 205A-2, as amended.

   Response: Draft EA Section 4.2.5, Hawai‘i Coastal Zone Management, includes an assessment of how the Proposed Action conforms to all CZM objectives and policies outlined in HRS § 205A-2, as amended.

3. Given that other areas across the State of Hawai'i may be also available for such REEFrame Project, OPSD suggests that the EA specifically discuss why offshore Waikīkī Beach, which is a manmade engineered beach, was selected as the REEFrame Project to restore coral reefs. In addition, the EA may provide specific measures to assess the restoration progress of Waikīkī coral reefs after the Project.

   Response: Waikīkī Beach was selected because its reef ecosystems are among the most degraded in Hawai'i and because it has the lowest herbivorous fish density in the state. REEFrame offers a proactive approach to restoring a resilient coral reef ecosystem in this vulnerable area. Section 2.4.1, Location Alternatives, discusses how the Project Area was selected after an inventory of Waikīkī potential locations.

4. Construction of REEFrame will require construction barges with heavy equipment to carefully place the units on the sandy sea floor. The Project will cover an area that measures 1,700 feet by 1,200 feet, or approximately 47 acres. The EA should discuss whether the proposed REEFrame Project will affect any sandy deposit area of Waikīkī Beach, which is crucial to sand supplies for periodically restoration and maintenance of Waikīkī Beach.

   Response: The Project Area has decreased since the pre-consultation request was disseminated in November 2025. The total installation footprint is approximately 11.4 acres. Because the Project Site is located 0.52-0.75 miles offshore, no impacts to sandy deposit areas supporting Waikīkī Beach nourishment are anticipated. Best Management Practices (BMPs), developed through Programmatic Consultation with NOAA's Office of Habitat Conservation (OHC), will be implemented to minimize bottom-disturbing activities. These BMPs are listed in Section 3.1.4.2, Potential Impacts and Proposed Mitigation Measures.

5. The National Coastal Zone Management Act (CZMA), section 307, requires federal agency activities and development projects, activities requiring a federal permit or license, and activities conducted with federal financial assistance that affect coastal uses and resources must be conducted in a manner consistent with the state's CZM program. OPSD is the state agency with the authority to conduct CZMA federal consistency review. Please contact OPSD on the policies and procedures applicable to CZMA federal consistency reviews for the proposed REEFrame Project.

   Response: An application for CZM federal consistency review/concurrence will be submitted to the State of Hawai'i Office of Planning and Sustainable Development.

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development. Thank you again for your comment.

Sincerely,

Berna Senelly

Regulatory Lead

JOSH GREEN, M.D.
GOVERNOR | KE KIAʻĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIAʻĀINA

STATE OF HAWAIʻI | KA MOKUʻĀINA ʻO HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA ʻOIHANA KUMUWAIWAI ʻĀINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

DAWN N.S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RYAN K.P. KANAKAʻOLE
FIRST DEPUTY

CIARA W.K. KAHAHANE
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

December 15, 2025

Oceanit
Attn: Berna Cabacungan Senelly
828 Fort Street Mall, Ste 600
Honolulu, HI 96813

via email: reeframe@oceanit.com

SUBJECT: Draft Environmental Assessment (DEA) regarding the Proposed Habitat Restoration REEFrame Project, Waikīkī, Island of Oʻahu, Hawaiʻi

Ms. Senelly,

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.

Enclosed are comments from the Engineering Division, the Land Division, and the Office of Conservation and Coastal Lands on the subject matter. Should you have any questions, please feel free to contact Dayna Vierra at (808) 587-0423.

Sincerely,

Ryan K.P. Kanakaʻole
First Deputy

Enclosure(s)

oceanit
innovation through engineering & scientific excellence

May 8, 2026

Ryan K.P. Kanakaʻole, Acting Chair
Land Division
Department of Land and Natural Resources
P.O. Box 620
Honolulu, Hawaiʻi 96804

Transmitted via email: dayna.k.vierra@hawaii.gov

Aloha Mr. Kanakaʻole

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī**
Response to Pre-Consultation Comments

Mahalo for your letter that we received on December 15, 2025 on the REEFrame Draft Environmental Assessment. As you noted, pre-consultation comments were submitted by the Engineering Division, the Land Division, and the Office of Conservation and Coastal Lands. We are responding to their comments directly with the divisions.

We greatly appreciate that the Land Division circulated the request for pre-consultation on the REEFrame project to DLNR separate divisions.

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawaiʻi, Office of Planning and Sustainable Development. Thank you again for your comment.

Sincerely,

Berna Senelly
Regulatory Lead

Oceanit Center 828 Fort Street Mall, Suite 600 Honolulu, Hawaii 96813 Phone: 808.531.3017 Fax: 808.531.3177
www.oceanit.com

JOSH GREEN, M.D.
GOVERNOR | KE KIA'AINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIA'AINA

STATE OF HAWAI'I | KA MOKU'AINA 'O HAWAI'I
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA 'OIHANA KUMUWAIWAI 'AINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

DAWN N.S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RYAN K.P. KANAKA'OLE
FIRST DEPUTY

CIARA W.K. KAHAHANE
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

RUSH

December 2, 2025

MEMORANDUM

FROM: +G:

DLNR Agencies:
X Div. of Aquatic Resources (kendall.l.tucker@hawaii.gov)
X Div. of Boating & Ocean Recreation (richard.t.howard@hawaii.g
X Engineering Division (DLNR.ENGR@hawaii.gov)
X Div. of Forestry & Wildlife (rubyrosa.t.terrago@hawaii.g
X Div. of State Parks (curt.a.cottrell@hawaii.gov
X Commission on Water Resource Management (DLNR.CWRM@hawaii.gov
X Office of Conservation & Coastal Lands (sharleen.k.kuba@hawaii.gov)
X Land Division - O'ahu District (barry.w.cheung@hawaii.gov
X Aha Moku Advisory Committee (leimana.k.damate@hawaii.gov

TO: **FROM:** Ryan K.P. Kanaka'ole, First Deputy
SUBJECT: **Draft Environmental Assessment (EA) regarding the Proposed Habitat Restoration REEFrame Project**
LOCATION: WaikTkT, O'ahu
APPLICANT: Oceanit on behalf of Conservation International

Transmitted for your review and comment is information on the above-referenced subject matter.

Please submit comments by **December 15, 2025.** If no response is received by this date, we will assume your agency has no comments. Should you have any questions about this request, please contact Dayna Vierra at dayna.k.vierra@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: Dina U. Lau, Acting Chief Engineer
Division: Engineering Division
Date: Dec 11, 2025

Attachment(s)

May 8, 2026

Dina U. Lau, Acting Chief Engineer
Engineering Division
Department of Land and Natural Resources
P.O. Box 620
Honolulu, Hawai'i 96804

Transmitted via email: dayna.k.vierra@hawaii.gov

Aloha Ms. Lau,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī Response to Pre-Consultation Comments**

Mahalo for your comment dated December 11, 2025 on the REEFrame Draft Environmental Assessment. You responded that you have no comments.

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development. Thank you again for your comment.

Sincerely,

Berna Senelly
Regulatory Lead

Oceanit Center 828 Fort Street Mall, Suite 600 Honolulu, Hawaii 96813 Phone: 808.531.3017 Fax: 808.531.3177
www.oceanit.com

JOSH GREEN, M.D.
GOVERNOR | KE KIA'ĀINA

SYLVIA LUKE
LIEUTENANT GOVERNOR | KA HOPE KIA'ĀINA

STATE OF HAWAI'I | KA MOKU'ĀINA 'O HAWAI'I
DEPARTMENT OF LAND AND NATURAL RESOURCES
KA 'OIHANA KUMUWAIWAI 'ĀINA
LAND DIVISION

P.O. BOX 621
HONOLULU, HAWAII 96809

DAWN N.S. CHANG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RYAN K.P. KANAKA'OLE
FIRST DEPUTY

CIARA W.K. KAHAHANE
DEPUTY DIRECTOR - WATER

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CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

RUSH

December 2, 2025

MEMORANDUM

TO: **DLNR Agencies:**
X Div. of Aquatic Resources (kendall.l.tucker@hawaii.gov)
X Div. of Boating & Ocean Recreation (richard.t.howard@hawaii.gov)
X Engineering Division (DLNR.ENGR@hawaii.gov)
X Div. of Forestry & Wildlife (rubyrosa.t.terrago@hawaii.gov)
X Div. of State Parks (curt.a.cottrell@hawaii.gov)
X Commission on Water Resource Management (DLNR.CWRM@hawaii.gov)
X Office of Conservation & Coastal Lands (sharleen.k.kuba@hawaii.gov)
X Land Division – O'ahu District (barry.w.cheung@hawaii.gov)
X Aha Moku Advisory Committee (leimana.k.damate@hawaii.gov

FROM: Ryan K.P. Kanaka'ole, First Deputy
SUBJECT: **Draft Environmental Assessment (EA) regarding the Proposed Habitat Restoration REEFrame Project**
LOCATION: Waikīkī, O'ahu
APPLICANT: Oceanit on behalf of Conservation International

Transmitted for your review and comment is information on the above-referenced subject matter.

Please submit comments by **December 15, 2025**. If no response is received by this date, we will assume your agency has no comments. Should you have any questions about this request, please contact Dayna Vierra at dayna.k.vierra@hawaii.gov. Thank you.

BRIEF COMMENTS:

Any improvements on (submerged) lands under the Land Board jurisdiction outside the current set aside area (EO4604 to Division of Boating and Ocean Recreation) needs a land disposition from the Board.

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

Signed: Darlene Bryant-Takamatsu
Print Name: Darlene Bryant-Takamatsu
Division: Land Division
Date: 12/3/2025

Attachment(s)

May 8, 2026

Darlene Bryant-Takamatsu
Land Division
Department of Land and Natural Resources

Transmitted via email: dayna.k.vierra@hawaii.gov

Aloha Ms. Bryant-Takamatsu,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī**
Response to Pre-Consultation Comments

Thank you for your comment dated December 3, 2025 on the REEFrame Draft Environmental Assessment. As you noted, any improvements on (submerged) lands under the Land Board jurisdiction outside the current set aside area (EO4604 to Division of Boating and Ocean Recreation) needs a land disposition from the Board of Land and Natural Resources. We are in consultation with the Land Division, the Office of Conservation and Coastal Lands, and the Division of Aquatic Resources to coordinate required land disposition from the Board.

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development. Thank you again for your comment.

Sincerely,

Berna Senelly
Regulatory Lead

Oceanit Center 828 Fort Street Mall, Suite 600 Honolulu, Hawaii 96813 Phone: 808.531.3017 Fax: 808.531.3177
www.oceanit.com

Berna Senelly

From: Hendrix, Alicia M <alicia_hendrix@fws.gov>
Sent: Monday, December 8, 2025 7:30 PM
To: reeframe
Cc: Kim, Jiny
Subject: [External] Fw: [EXTERNAL] RE: Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī
Attachments: REEFrame Pre-Consultation Package.FINAL.11_3_2025.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

You don't often get email from Alicia_hendrix@fws.gov. Learn why this is important

Aloha,

Thank you for reaching out and sharing information on the REEFrame project with the US Fish and Wildlife Service's Pacific Islands Office. We appreciate the invitation to have provided pre-consultation comments. Though time constraints prevented us from being able to review last week, our Aquatics and Environmental Contaminants Team would like to be involved moving forward. Please keep us in the loop as your project progresses so that we can provide any necessary technical guidance and address any consultation needs (for instance Fish and Wildlife Coordination Act review) in a timely manner.

Mahalo,
Alicia Hendrix

Alicia Hendrix, Ph.D.
Acting Aquatic Ecosystem and Environmental Contaminants Team Manager
Environmental Contaminants Biologist
USFWS Pacific Islands Fish and Wildlife Office
Work cell: 808-347-7524

From: Wolfe, Matthew J <matthew_wolfe@fws.gov> on behalf of PIFWO_Admin, FW1 <pifwo_admin@fws.gov>
Sent: Tuesday, December 2, 2025 9:34 AM
To: Hendrix, Alicia M <alicia_hendrix@fws.gov>
Cc: Kim, Jiny <jiny_kim@fws.gov>
Subject: Fw: [EXTERNAL] RE: Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī

Hi All,

Here is the forwarded message regarding the Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī, Oahu.

Please review and determine if further action is needed.

Very Respectfully,
Matthew J.Y.M. Wolfe

Office Assistant
Pacific Islands Fish & Wildlife Office
U.S. Fish & Wildlife Service
Department of the Interior
300 Ala Moana Blvd, Room 3-122
Honolulu, HI 96850
Office: 808-460-7713
Cell: 808-260-5164
fws.gov

From: reeframe <reeframe@oceanit.com>
Sent: Monday, December 1, 2025 9:47 AM
To: reeframe <reeframe@oceanit.com>
Cc: Bryson Gonzalez <bgonzalez@oceanit.com>
Subject: [EXTERNAL] RE: Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī

This email has been received from outside of DOI - Use caution before clicking on links, opening attachments, or responding.

Aloha kākou~

A friendly reminder. If you have not yet submitted your pre-consultation comments on the REEFrame Coral Nursery Project in Waikīkī, comments are due on Thursday, December 4. Please let us know if you have any questions.

Sincerely,
Berna Cabacungan Senelly

Berna Cabacungan Senelly
Senior Regulatory and Community Lead
Oceanit
828 Fort Street Mall Ste 600 Honolulu, HI 96813
Email: bsenelly@oceanit.com
Office: 808.531.3017 ext. 221
Fax: 808.531.3177
Direct: 808.954.4221
Mobile: 817.422.1372

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From: reeframe
Sent: Monday, November 3, 2025 9:34 AM
To: reeframe <reeframe@oceanit.com>
Cc: Bryson Gonzalez <bgonzalez@oceanit.com>
Subject: Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī

Aloha kākou~

On behalf of Conservation International, Oceanit is preparing a Draft Environmental Assessment (EA) regarding the proposed REEFrame project on the island of Oʻahu. REEFrame is a habitat restoration project intended to restore Waikīkī's coral reefs by creating and installing permanent coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. This $9 million project is funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Habitat Conservation. Urbanization, erosion and climate change have accelerated the decline of Waikīkī's coral reef ecosystem, and today this ecosystem is among the most degraded in Hawaiʻi. REEFrame will help to restore Waikīkī's coral reefs by creating permanent coral habitat that mimic the complex shapes and surface textures of natural coral reef formations. Over time, the complex structure of the REEFrame nurseries will be colonized by naturally settling coral larvae and eventually become coral reefs in their own right.

We are conducting a thorough environmental review pursuant to Chapter 343, Hawaiʻi Revised Statutes, and Hawaiʻi Administrative Rules Chapter 11-200.1, and invite you to submit pre-consultation comments on this project. Attached is a pre-consultation package that provides project information that is the basis for environmental review. Your comments and manaʻo would be very helpful in the preparation of environmental review documents.

Please transmit your comments to reeframe@oceanit.com by ***Thursday, December 4, 2025***. You may also mail your comments via US Postal Service to the address provided below.
Your comments and our responses will be included in the Draft Environmental Assessment that will be published in *The Environmental Notice* issued by the Hawaiʻi State Office of Planning and Sustainable Development Environmental Review Program. Please email me if you have questions.

We look forward to your comments.

Sincerely,

Berna Cabacungan Senelly

Berna Cabacungan Senelly
Senior Regulatory and Community Lead
Oceanit
828 Fort Street Mall Ste 600 Honolulu, HI 96813
Email: bsenelly@oceanit.com
Office: 808.531.3017 ext. 221
Fax: 808.531.3177
Direct: 808.954.4221
Mobile: 817.422.1372

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May 8 2026

Alicia Hendrix
Acting Aquatic Ecosystem and Environmental Contaminants Team Manager
Environmental Contaminants Biologist
USFWS Pacific Islands Fish and Wildlife Office
300 Ala Moana Blvd. Rm 3-122
Honolulu, HI 96850

Transmitted via email: alicia_hendrix@fws.gov

Aloha Ms. Hendrix,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī**
Response to Pre-Consultation Comments

Thank you for your comment on the REEFrame Draft Environmental Assessment dated December 9, 2025, voicing your interest in the project and your request to be involved moving forward. We will keep you informed as the REEFrame project progresses and will reach out for technical guidance or to initiate any required consultations.

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly

Regulatory Lead

Berna Senelly

From: Koskelo, Vera B CIV USARMY CEPOA (USA) <Vera.B.Koskelo@usace.army.mil>
Sent: Wednesday, April 1, 2026 4:17 PM
To: reeframe
Cc: Bryson Gonzalez
Subject: [External] RE: Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī
Attachments: PCN_6082_POH_Apr2024.pdf; PCN_Scanned_6082_POH_Apr2024.pdf; POH Regulatory Program Brochure .pdf; What You Should Know Before You Build Or Fill_Corps info sheet 2025.pdf

Aloha,

Thank you for submitting the request for comments on the subject project.

Regarding the USACE Regulatory process, we regulate activities in Waters of the U.S., specifically work and structures in tidally influenced waters of the U.S. (WOTUS) and the discharge of fill in all WOTUS. Please see the attached literature and our website for more information: https://www.poh.usace.army.mil/Missions/Regulatory/

For a project to receive our review and oficial comments, i.e., on letterhead, the submittal of a completed and signed Pre-construction Notification or request for a Jurisdictional Determination is required. The PCN form (fillable and scanned pdf versions) is attached. The form to request a JD is located on our website here: https://www.poh.usace.army.mil/Missions/Regulatory/Jurisdictional-Determinations/
Whichever form you complete, please submit it to our main ofice email CEPOH-RO@usace.army.mil.

Please bear in mind, as per the Pacific Ocean Division Regulatory Action Prioritization special public notice (https://www.poh.usace.army.mil/Portals/10/docs/Regulatory/2SPN_POA_POH_RegulatoryActionPrioritization_SPN_20241010.pdf?ver=TN0uSpsAjph35WkUNlTfog%3d%3d) review of permits is the top priority for our ofice. Given that our ofice is currently very understafed, review of AJD requests or other pre-application coordination is likely to be substantially delayed.

Thank you,

Ms. Vera Koskelo
Biologist, Project Manager | Regulatory Division |

U.S. Army Corps of Engineers | Honolulu District 230 Otake Street, Fort Shafter, Hawaii 96858-5440 808-835-4310 |
Main Line: 808-835-4303
Vera.B.Koskelo@usace.army.mil
https://www.poh.usace.army.mil/Missions/Regulatory/

From: reeframe <reeframe@oceanit.com>
Sent: Monday, November 3, 2025 5:35 AM
To: reeframe <reeframe@oceanit.com>
Cc: Bryson Gonzalez <bgonzalez@oceanit.com>
Subject: [Non-DoD Source] Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī

Aloha kākou~

On behalf of Conservation International, Oceanit is preparing a Draft Environmental Assessment (EA) regarding the proposed REEFrame project on the island of Oʻahu. REEFrame is a habitat restoration project intended to restore Waikīkī's coral reefs by creating and installing permanent coral habitat. The REEFrame project proposes to construct permanent, structurally resilient, 3D printed, concrete reef frameworks that will serve as both coral nurseries and foundations for structurally complex natural coral reefs. This $9 million project is funded by the National Oceanic and Atmospheric Administration (NOAA) Ofice of Habitat Conservation. Urbanization, erosion and climate change have accelerated the decline of Waikīkī's coral reef ecosystem, and today this ecosystem is among the most degraded in Hawaiʻi. REEFrame will help to restore Waikīkī's coral reefs by creating permanent coral habitat that mimic the complex shapes and surface textures of natural coral reef formations. Over time, the complex structure of the REEFrame nurseries will be colonized by naturally settling coral larvae and eventually become coral reefs in their own right.

We are conducting a thorough environmental review pursuant to Chapter 343, Hawaiʻi Revised Statutes, and Hawaiʻi Administrative Rules Chapter 11-200.1, and invite you to submit pre-consultation comments on this project. Attached is a pre-consultation package that provides project information that is the basis for environmental review. Your comments and manaʻo would be very helpful in the preparation of environmental review documents.

Please transmit your comments to reeframe@oceanit.com by ***Thursday, December 4, 2025***. You may also mail your comments via US Postal Service to the address provided below.

Your comments and our responses will be included in the Draft Environmental Assessment that will be published in *The Environmental Notice* issued by the Hawaiʻi State Ofice of Planning and Sustainable Development Environmental Review Program. Please email me if you have questions.

We look forward to your comments.

Sincerely,

Berna Cabacungan Senelly

Berna Cabacungan Senelly
Senior Regulatory and Community Lead
Oceanit
828 Fort Street Mall Ste 600 Honolulu, HI 96813
Email: bsenelly@oceanit.com
Ofice: 808.531.3017 ext. 221
Fax: 808.531.3177
Direct: 808.954.4221
Mobile: 817.422.1372

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innovation through engineering & scientific excellence

May 8, 2026

Vera Koskelo
Biologist, Project Manager, Regulatory Division
U.S. Army Corps of Engineers, Honolulu District
230 Otake Street
Fort Shafter, Hawaii 96858-5440

Transmitted via email: vera.b.koskelo@usace.army.mil

Aloha Ms. Koskelo,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī Response to Pre-Consultation Comments (POH-2025-00265)**

Thank you for your comment dated April 1, 2026, on the REEFrame Draft Environmental Assessment. We note your comment that the U.S. Army Corps of Engineers (USACE) regulates activities in Waters of the U.S. (WOTUS), including work and structures in tidally influenced waters and the discharge of fill material in all WOTUS. Thank you for attaching the Pre-Construction Notification (PCN), the Regulatory Information Guide, and an information sheet with definitions and instructions.

Pre-consultation with USACE has been initiated with the project number POH-2025-00265. NOAA will submit a Pre-Construction Notification (PCN) for agency review.

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development.

Sincerely,

Berna Senelly
Regulatory Lead

Oceanit Center 828 Fort Street Mall, Suite 600 Honolulu, Hawaii 96813 Phone: 808.531.3017 Fax: 808.531.3177
www.oceanit.com

Berna Senelly

From: Kaweni Ibarra <kawenii@oha.org>
Sent: Friday, November 14, 2025 12:36 PM
To: reeframe
Cc: Kamakana Ferreira
Subject: [External] OHA Comment Re: REEFrame, DEA for Coral Restoration Project, Waikiki, Oahu

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Aloha e REEFrame,

The Office of Hawaiian Affairs (OHA) is in receipt of your letter dated October 2025 regarding the preparation of a Draft Environmental Assessment (DEA) for a coral restoration project in Waikiki, Oahu.

At this time, we would like to request clarification on what kind of consultation is being initiated through this letter? It appears that this might be for Hawaii Revised Statutes (HRS) 343, but that is typically referenced explicitly in consultation letters to clearly demonstrate HAR 11-200.1-18(a) compliance.

Mahalo for your time. We look forward to continuing consultation. If you have any questions, please feel free to contact me.

Mahalo,

Kaweni Ibarra

Kaweni Ibarra

Compliance Advocate

Office of Hawaiian Affairs

OFFICE OF HAWAIIAN AFFAIRS

Berna Senelly

From: reeframe
Sent: Monday, November 17, 2025 7:39 PM
To: Kaweni Ibarra; reeframe
Cc: Kamakana Ferreira; Bryson Gonzalez
Subject: RE: [External] OHA Comment Re: REEFrame, DEA for Coral Restoration Project, Waikiki, Oahu

Aloha Kaweni, and thank you for your request for clarification. In the pre-consultation solicitation email, we reference both Hawaii Revised Statutes (HRS) 343 and the Hawaii Administrative Rules (HAR) 11-200.1. HAR 11-200.1-18(a) is part of the administrative rules that carry out the environmental review process embodied in HRS 343. The solicitation that we sent you is in compliance with "early consultation seeking, at the earliest practicable time, the advice and input of the county agency responsible for implementing the county's general plan for each county in which the proposed action is to occur, and consult with other agencies having jurisdiction or expertise as well as those citizen groups and individuals that the proposing agency or approving agency reasonably believes may be affected," as stated in HAR 11-200.1-18(a).

Please let me know if I can further clarify or if you have questions. We appreciate your interest in this project and look forward to your comments on the Draft EA for the Coral Restoration Project in Waikiki.

Best regards,
Berna Cabacungan Senelly

Berna Cabacungan Senelly
Senior Regulatory and Community Lead
Oceanit
828 Fort Street Mall Ste 600 Honolulu, HI 96813
Email: bsenelly@oceanit.com
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From: Kaweni Ibarra <kawenii@oha.org>
Sent: Friday, November 14, 2025 12:36 PM
To: reeframe <reeframe@oceanit.com>
Cc: Kamakana Ferreira <kamakanaf@oha.org>
Subject: [External] OHA Comment Re: REEFrame, DEA for Coral Restoration Project, Waikiki, Oahu

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Aloha e REEFrame,

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Mahalo for your time. We look forward to continuing consultation. If you have any questions, please feel free to contact me.

Mahalo,

Kaweni Ibarra

Kaweni Ibarra

Compliance Advocate

Office of Hawaiian Affairs

OFFICE OF HAWAIIAN AFFAIRS

oceanit
innovation through engineering & scientific excellence

May 8, 2026

Kaweni Ibarra
Compliance Advocate
Office of Hawaiian Affairs

Transmitted via email: kawenii@oha.org

Aloha Ms. Ibarra,

Subject: **Pre-Consultation for REEFrame Coral Nursery Project in Waikīkī Response to Pre-Consultation Comments (POH-2025-00265)**

Mahalo for your question dated November 14, 2025, on the REEFrame Draft Environmental Assessment. You asked for clarification on what kind of consultation is being initiated through our solicitation. You noted that it appears that this might be for Hawaii Revised Statutes (HRS) 343, but that is typically referenced explicitly in consultation letters to clearly demonstrate HAR 11-200.1-18(a) compliance.

As we responded on November 17, 2026, we reference both Hawaii Revised Statutes (HRS) 343 and the Hawaii Administrative Rules (HAR) 11-200.1. The solicitation that we sent you is in compliance with "early consultation seeking, at the earliest practicable time, the advice and input of the county agency responsible for implementing the county's general plan for each county in which the proposed action is to occur, and consult with other agencies having jurisdiction or expertise as well as those citizen groups and individuals that the proposing agency or approving agency reasonably believes may be affected," as stated in HAR 11-200.1-18(a).

We are including a copy of your comments and our response in the Draft EA which is published in The Environmental Notice published by the State of Hawai'i, Office of Planning and Sustainable Development. .

Sincerely,

Berna Senelly
Regulatory Lead

Oceanit Center 828 Fort Street Mall, Suite 600 Honolulu, Hawaii 96813 Phone: 808.531.3017 Fax: 808.531.3177
www.oceanit.com