



DEPARTMENT OF THE ARMY
HONOLULU DISTRICT, U.S. ARMY CORPS OF ENGINEERS
FORT SHAFTER, HAWAII 96858-5440

October 31, 2017

SUBJECT: Request for Abbreviated Essential Fish Habitat Consultation for the Kapalama Container Terminal Wharf and Dredge Project, Honolulu Harbor, Honolulu, Island of Oahu, Hawaii Department of the Army File No. POH-2012-00081

Mr. Gerald Davis, Assistant Regional Administrator
Habitat Conservation Division
NOAA, National Marine Fisheries Service
Pacific Islands Regional Office
1845 Wasp Boulevard, Building 176
Honolulu, Hawaii 96818

Dear Mr. Davis:

The Honolulu District, U.S. Army Corps of Engineers, Regulatory Branch (Corps) is in receipt of a Department of the Army (DA) permit application requesting authorization for the proposed Kapalama Container Terminal Wharf and Dredge Project in the Honolulu Harbor, Honolulu, Island of Oahu, Hawaii. The State of Hawaii Department of Transportation, Harbors Division (applicant) is requesting authorization from the Corps for the work in, affecting and resulting in the discharge of dredged and fill material into navigable waters pursuant to Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act and Section 103 of the Marine Protection, Research and Sanctuaries Act. The Corps has determined the work may be eligible for authorization under a Standard Permit.

The Corps has completed the enclosed Essential Fish Habitat (EFH) Assessment to document the Corps' evaluation of direct, indirect, and cumulative effects of the proposed action on EFH as defined by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and in support of consultation with the National Oceanic and Atmospheric Administration – National Marine Fisheries Service (NMFS) under Section 305(b)(2) of the MSA for adverse impacts to EFH. The project area contains EFH designated for the following Management Unit Species (MUS): Bottomfish MUS - all life stages for shallow complex, eggs and post-hatch pelagic for intermediate and deep complexes, Crustacean MUS - all life stages, Coral Reef Ecosystem MUS - all life stages and Pelagic MUS - all life stages. The Corps has determined that the proposed action may adversely affect, but does not have the potential to cause substantial adverse effects to the EFH listed above. Accordingly, the Corps is transmitting this letter and enclosed EFH Assessment to NMFS to initiate abbreviated consultation under Section 305(b)(2) of the MSA.

The Corps seeks written concurrence on this determination and requests a response within 30 days after the receipt of this letter to conclude the consultation process. If a written response to this consultation request is not received within 30 days from the date of this letter, the Corps will assume the subject consultation generated no EFH Conservation Recommendations from NMFS and consider the consultation to be complete.

If EFH conservation recommendations are provided within the 30-day time frame, pursuant to Section 305(b)(4)(B) of the MSA, the Corps will provide a detailed response to your recommendations within 30 days of receipt. If the response is inconsistent with any of the EFH conservation recommendations, a detailed response will be provided at least 10 days prior to the final approval of the action unless an alternative time frame is agreed upon between our two agencies.

Should you have any questions, comments or concerns regarding this consultation, please contact me at (808) 835-4107 or via email at jessie.k.paahana@usace.army.mil.

Sincerely,

Jessie Paahana
Regulatory Specialist

Enclosure

cc:
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**THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING
PROJECT**

(H.C. 10498)

Essential Fish Habitat Assessment

State of Hawaii, Department of Transportation

Harbors Division

Honolulu Harbor, Oahu, Hawaii

DEPARTMENT OF THE ARMY FILE NO. POH-2012-00081

Prepared for:
NOAA, National Marine Fisheries Service
Habitat Conservation Division
Pacific Islands Regional Office
Honolulu, Hawai'i

Prepared by:
U.S. Army Corps of Engineers, Honolulu District
Regulatory Office

And

State of Hawaii, Department of Transportation
Harbors Division

March, 2016
(Revised October, 2017)

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Table of Contents

1.0 PURPOSE & BACKGROUND	4
1.1 AUTHORITY.....	4
1.2 PROJECT BACKGROUND (PURPOSE AND NEED FOR THE PROPOSED ACTION).....	4
2.0 DESCRIPTION OF PROPOSED ACTION & “PROJECT AREA”	5
2.1 “PROJECT AREA” DEFINED	6
2.2 PROPOSED ACTION	6
2.3 CONSTRUCTION PHASES OF THE PROPOSED ACTION	8
2.3.1 Waterline Installation beneath Kalihi Channel.....	9
2.3.2 Demolition of Existing Shoreline Facilities	9
2.3.3 Shoreline Bulkhead Construction and Sand Island Bridge Scour Protection	9
2.3.4 Enclosing and Filling Snug Harbor, the Rail Slip, and Pier 40F.....	10
2.3.5 Shoreline Excavation.....	10
2.3.6 Harbor Dredging.....	10
2.3.7 Offshore or Upland Disposal of Excess Dredged Spoils	10
2.3.8 Wharf Infrastructure and Surface Facilities Construction	11
2.4 THE APPLICANT’S PROPOSED AVOIDANCE AND MINIMIZATION MEASURES INCLUDED AS PART OF THE PROPOSED ACTION.....	11
3.0 ENVIRONMENTAL BASELINE CONDITIONS WITHIN THE “PROJECT AREA”	13
3.1 PROJECT SITE EXISTING ENVIRONMENT.....	13
3.2 PROJECT AREA EXISTING ENVIRONMENT	15
3.2.1 Soft Substrate Habitat	15
3.2.2 Hard Substrate Habitat	16
3.2.3 Water Column Estuary Habitat	17
3.3 ESSENTIAL FISH HABITAT OCCURRING WITHIN THE PROJECT AREA.....	18
4.0 MARINE BIOTA OCCURRING WITHIN THE PROJECT AREA	20
4.1 GENERAL	20
4.2 CORAL SPECIES.....	21
4.2.1 Coral Coverage	22
4.2.2 Harbor Control Site – Sector K, Pier 40	28
4.3 MACRO-INVERTEBRATES.....	28
4.4 FISH	29
5.0 POTENTIAL EFFECTS OF THE ACTION ON EFH AND MUS	30
5.1 EFFECTS BY PROJECT PHASE	31
5.1.1 Waterline Installation Beneath Kalihi Channel	31
5.1.2 Demolition of Existing Shoreline Facilities	31
5.1.3 Shoreline Bulkhead Construction and Sand Island Bridge Scour Protection	33
5.1.4 Enclosing and Filling Snug Harbor, the Rail Slip, and Pier 40F.....	33
5.1.5 Shoreline Excavation.....	34
5.1.6 Harbor Dredging.....	35
5.1.7 Offshore or Upland Disposal of Excess Dredged Material	36

5.1.8 Wharf Infrastructure and Surface Facilities Construction	36
5.2 EFFECTS BY TYPE OF IMPACT	37
5.2.1 Loss of Physical Habitat	37
5.2.2 Water Quality Degradation	39
5.3 SUMMARY OF SHORT-TERM AND LONG-TERM / PERMANENT EFFECTS	42
6.0 PROPOSED MINIMIZATION AND OFFSET MEASURES	43
6.1 MINIMIZATION MEASURES INTERNAL TO THE PROJECT.....	43
6.1.1 Best Management Practices.....	44
6.1.2 Coral Transplantation	44
6.2 APPLICANT'S PROPOSED OFFSET MEASURES FOR UNAVOIDABLE IMPACTS	Error! Bookmark not defined.
6.2.1 Offset Considerations	48
6.2.2 Selected Offset Measures	49
6.2.3 Support of DLNR-DAR's sea urchin hatchery	50
6.2.4 Support of DLNR-DAR's invasive algae removal program	51
6.2.5 Support of DLNR-DAR's coral stewardship programs.....	52
7.0 DETERMINATION OF EFFECT	52
8.0 REFERENCES	54

List of Figures

Figure 1 Project Area Boundaries	7
Figure 2. <i>Existing and Proposed New Shoreline and Makai Boundary of Project Area</i>	8
Figure 3. Areas of Habitat Types across the Project Area	18
Figure 4. Survey Sector Areas	21
Figure 5. Coral Colonies by Size Class, Number of Colonies, and Colony Area (AECOS, 2014)	26
Figure 6. Distribution of live coral species across the Existing Project Shoreline	27
Figure 7. Distribution of live corals >40 cm displayed as red lines within Project area	27
Figure 8. Percent of Non-Coral Invertebrates in	29
Figure 9. Fish Transect Data from Project Area Adjusted to Per Hectare Density	30
Figure 10. Candidate Coral Recipient Sites in Honolulu Harbor	47
Figure 11. Area Fronting the Waikiki Aquarium suitable for invasive algae removal.	51

List of Tables

Table 1. Gross Dredge and Fill Estimates for Project	11
Table 2 : Designated EFH within Project Area, Honolulu Harbor	20
Table 3. Project Sectors Surveyed and Extrapolated to Total Habitat Areas	23
Table 4. Coral quantity estimates within the Project area.	24
Table 5. Coral Present within the Project Area	25
Table 6. Summary of Direct Impacts to Essential Fish Habitat Associated with Each Project Phase	41

Appendices

- A. Reduced-Sized Plans Showing Phasing of Wharf and Dredging Project
- B. AECOS 2014 Baseline Assessment for Kapalama Container Terminal Improvements
- C. Coral Transplantation Plan

1.0 PURPOSE & BACKGROUND

1.1 AUTHORITY

Pursuant to the U.S. Army Corps of Engineers' (Corps) authorities to issue a Department of the Army (DA) permit under Section 10 of the Rivers and Harbors Act of 1899 (Section 10; 33 U.S.C 403), Section 404 of the Clean Water Act (Section 404; 33 U.S.C. 1344), and Section 103 of the Marine Protection, Research and Sanctuaries Act, as amended (Section 103; 33 U.S.C. 1413), the Corps is evaluating the environmental effects of the State of Hawaii Department of Transportation, Harbors Division's (DOT-Harbors; Applicant), proposed improvement and expansion of existing harbor facilities located at Piers 40F through 45 within the Honolulu Harbor to support the New Kapalama Container Terminal Wharf and Dredging Project, Honolulu, Island of Oahu, Hawaii. Tax map key (TMK) numbers for the project site includes 1-2-025:009, 011, 012, 016, 017, 040, 046, 071, 076, and 1-5-032:002 and 043.

This document constitutes the Corps' Essential Fish Habitat (EFH) Assessment which evaluates the direct, indirect, and cumulative effects of the proposed action on EFH as defined by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and in support of consultation with the National Oceanic and Atmospheric Administration – National Marine Fisheries Service (NMFS) under Section 305(b)(2) MSA for adverse impacts to EFH.

1.2 PROJECT BACKGROUND (PURPOSE AND NEED FOR THE PROPOSED ACTION)

The main Hawaiian Islands are geographically isolated from the contiguous U.S. and have limited natural resources and industries. As such, a great deal of goods and materials are imported to Hawaii via cargo vessels, which the people of Hawaii rely heavily upon. Honolulu Harbor is the primary commercial port of entry for overseas cargo vessels. The State of Hawaii anticipates a continued increasing demand for shipped goods and materials to Honolulu Harbor based on forecasted projections of Hawaii's future population growth and a steadily improving economic climate since the late 2000s recession. The rising demand for imported shipped goods and materials has led to an increase in container ship traffic in Honolulu Harbor, with a rising trend of larger ships carrying larger cargoes. Similarly, interisland barge companies are responding in kind by placing larger barges into service to accommodate distribution of larger cargo shipments to the outer islands at higher frequency. During the past decade interisland barge calls in Honolulu Harbor have increased and currently vary from 13.2 to 18.5 visits per week.

The existing management and distribution of imported cargo shipments from Honolulu Harbor to the outer islands requires moving and transporting by truck cargo containers from Piers 51-53 on Sand Island over the Sand Island Bridge to the interisland terminals at Piers 39-40 on the main side, prior to barging to neighboring islands. Because there is no alternative large containership dock space in Honolulu Harbor main side to receive and handle large overseas cargo vessels, the interisland distribution of shipped goods remains entirely dependent on existing overseas containership operations on Sand Island with transport over the Sand Island Bridge. As such, Hawaii's food and commodities security remains continually threatened by potential import shortages and risks associated with the vulnerability of the bridge to structural damage and/or attack.

Therefore, the proposed wharf and dredging project to improve and expand existing commercial harbor shipping operations and related facilities at Piers 40F through 45 is necessary to: 1) support anticipated increases in cargo imports due to forecasted increases in population and economic growth; and 2) provide safe, efficient, and alternative berths for large overseas vessels, interisland barges and related cargo container handling for existing and future commercial harbor operations.

2.0 DESCRIPTION OF PROPOSED ACTION & "PROJECT AREA"

The New Kapalama Container Terminal Wharf and Dredging Project ("The Project") is a component of the DOT-Harbor's greater Kapalama Container Terminal (KCT) project. The KCT project complies with and supports the State's long-range development plan for the harbor, "*Oahu Commercial Harbors 2020 Master Plan*" (1997), which includes the wharf and dredging improvements at Piers 40F through 45, development of a new container yard, and other related improvement projects to support tenant relocations at various locations within the harbor.

The scope of the Project is comprised of new wharf construction and dredging within the area water ward of the Wharf and Dredging Project Limit boundary shown on Figures 1 and 2, and consists of approximately 18.8 acres of fast land and 8.13 acres of waters of the U.S. (total area: 26.93 acres). The proposed activities associated with the Project that require a DA permit, are within the Corps' federal control and responsibility to consider, and that constitute the Federal action are described below in Section 2.2 Proposed Action, and in construction details provided in Section 2.3 and accompanying design plans.

2.1 “PROJECT AREA” DEFINED

The scope of the Corps’ “Project area” for the purposes of EFH consultation under Section 305(b)(2) of the MSA consists of the in-water work areas within the Wharf and Dredging Project Limit boundary depicted on Figure 2. The total area of EFH waters and substrate (waters of the U.S.) within the defined project area boundary is 8.13 acres (See also Section 3.3 Essential Fish Habitat).

2.2 PROPOSED ACTION

The proposed improvements include constructing two docks for overseas container ships and two docks for interisland barges along a common wharf with modern infrastructure for container loading, offloading, storage, and transshipment. Specifically, the following proposed activities require a DA permit to achieve the project purpose:

- A total of 972 m (3,190 ft.) of sheet/king pile installed in uplands and waters of the U.S. to armor the shoreline and construct the new bulkhead for the wharf. (Section 10)
- Dredging in waters of the U.S. and excavation in uplands to remove a total of 319,740 cu. m. (417,900 cu. yd.) of material. The total dredging and excavation area is 8.42 acres, which consists of 11,250 sq. m. (2.78 acres) of fast land and 22,832 sq. m. (5.64 acres) of soft benthic substrate in waters of the U.S. (Section 10)
- Permanent discharge of dredged and fill material into 10,077 sq. m. (2.49 acres) of waters of the U.S. to fill in the enclosed Snug Harbor, Rail Slip and Pier 40F. (Section 404)
- A total of 757 cubic meters (cu. m.) (990 cubic yards [cu. yd.]) of rock permanently discharged in shallow water over 409 sq. m. (4,400 sq. ft.) of waters of the U.S. at the west end of Pier 43 near the northern abutment of the Sand Island Bridge for scour protection. (Section 404)
- A total of 151,700 cu. m. (198,400 cu. yd.) of dredged material would be transported for ocean disposal at the South Oahu Offshore Dredged Material Disposal Site (SOODMDS). The remainder of the dredged/excavated material would be disposed of in uplands. Gross dredge and fill estimates are shown in Table 1. (Section 103) New utility lines, including water lines beneath the harbor channel, other appurtenant structures (e.g. bollards, ladders, fenders, etc.), and temporary Best Management Practice (BMP) measures would also be installed in, over or under navigable waters to complete the Project. (Section 10)

A total of 8.13 acres of waters of the U.S. would be directly and permanently impacted by new wharf construction activities, including permanently filling 10,077 sq. m. (2.49 acres) of waters of the U.S. to construct new wharf structures (Figure 2). It is

The New Kapalama Container Terminal Wharf & Dredging
Essential Fish Habitat Assessment



Figure 1 Project Area Boundaries. Landward limit of The Project labelled, “Wharf and Dredging Project Limit (blue dashed line). Seaward limit of the Project demarcated in orange.

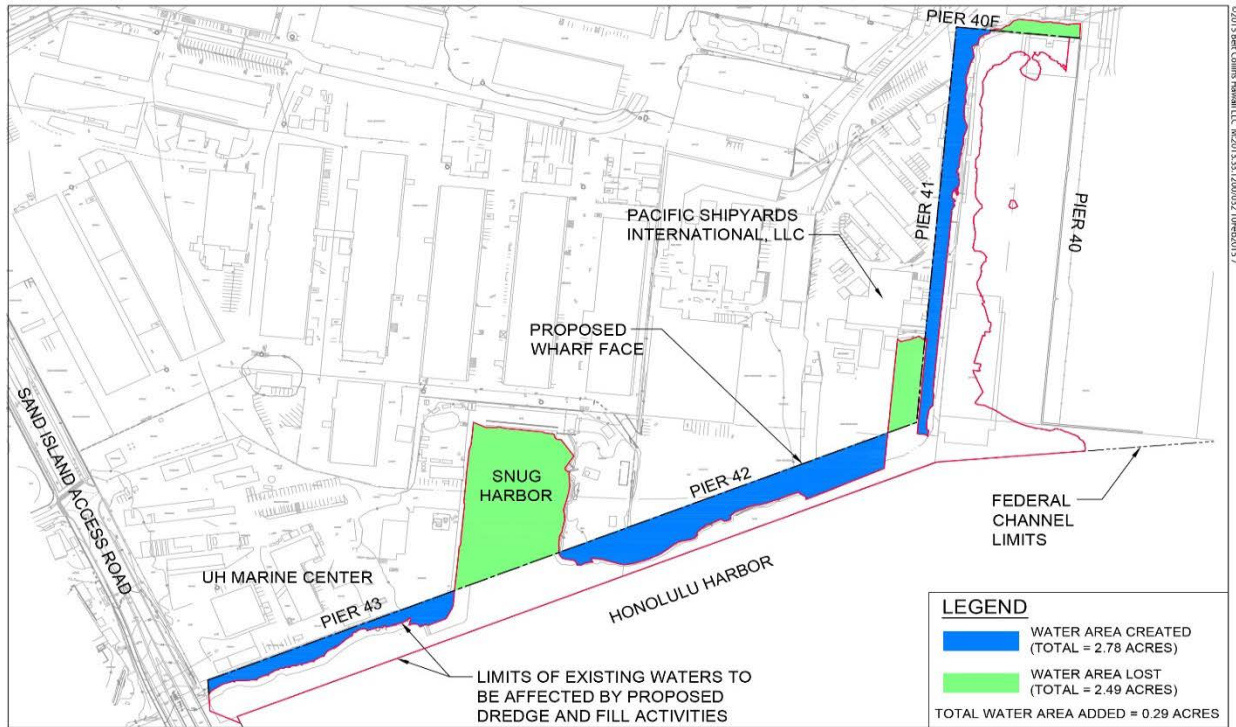


Figure 2. Existing and Proposed New Shoreline and Makai Boundary of Project Area. Green areas would be filled, blue areas would be excavated. The Project Area includes all in-water work areas and is bounded by the solid red line and dashed black line.

presumed that marine waters immediately adjacent to the in-water work area would be indirectly affected by in-water construction activity. To minimize total area of waters of the U.S. filled and converted to uplands to construct the docks, DOT-Harbors has proposed the excavation of uplands to create and expand the area of waters of the U.S. by 11,254 sq. m. (2.78 acres) as shown in Figure 2. Overall, the Project would yield a total net gain of 1,174 sq. m. (0.29 acres) of waters of the U.S. No loss of coral reefs, vegetated shallows, or other special aquatic sites, as defined at 40 CFR 230, Subpart E, would result from the Project.

2.3 CONSTRUCTION PHASES OF THE PROPOSED ACTION

The proposed action is divided into the following eight (8) general construction phases:

1. Waterline Installation beneath Kalihi Channel
2. Demolition of Existing Shoreline Facilities
3. Shoreline Bulkhead Construction and Sand Island Bridge Scour Protection

4. Enclosing and Filling Snug Harbor, the Rail Slip, and Pier 40F
5. Shoreline Excavation
6. Harbor Dredging
7. Dredged Spoils Disposal
8. Wharf Infrastructure and Surface Facilities Construction

Construction is planned to begin in 2018 and would require 36 months to complete the overlapping construction phases. A summary of the activities requiring a DA permit in or affecting waters of the U.S., which comprise each construction phase is described in the following subsections, with additional construction details provided in a partial set of plans at Appendix A. DOT-Harbors has identified appropriate and necessary BMP measures that are considered part of the proposed action. These measures are detailed in Section 2.4, below.

2.3.1 Waterline Installation beneath Kalihi Channel

Two (2) new, 12 to 16-inch diameter High Density Polyethylene (HDPE) water lines would be installed approximately 50 to 70 feet beneath the Kalihi Channel bottom using entry and exit pits located in uplands of both the Project area and Sand Island via Horizontal Directional Drilling (HDD). The new water lines would replace existing 12-inch and 16-inch diameter water lines owned by the Honolulu Board of Water Supply, currently proposed for abandonment in place. The locations of the drill entry and exit pits would be sited in uplands, several hundred feet from waters of the U.S. Return flows of drilling effluent are not proposed. Drill pits would be appropriately sized to prevent overflow and contain all effluent generated by the upland drilling activity.

2.3.2 Demolition of Existing Shoreline Facilities

All existing man-made structures occurring in waters of the U.S. along the shoreline, including 452 concrete piles, sheet-pile bulkheads, in-water concrete debris, rail-slip hardware and foundations, wharf pavement and other deleterious concrete structures would be completely removed from the existing 1,277-m (4,190-ft.) long shoreline. All demolition waste generated on site would be disposed of at an approved upland facility or reused as on-site fill, where appropriate.

2.3.3 Shoreline Bulkhead Construction and Sand Island Bridge Scour Protection

A king pile and sheet pile wall with a total length of 972 m (3,190 ft.) would be driven into the substrate by impact and/or vibratory hammer from the west end of Pier 43 to the junction of Piers 42 and 41 and along the new face of Pier 41 to its junction with Pier 40. Most of the wall would be installed within uplands well inland of the existing shoreline. In-water pile installation would occur across the mouth of Snug Harbor and the Rail Slip and along Pier 40F. To protect against scouring,

the west end of Pier 43 near the Sand Island Bridge would be lined with a 409 sq. m. revetment constructed of a three-foot layer of quarry rock overlain by a 5-ft thick layer of armor stone.

2.3.4 Enclosing and Filling Snug Harbor, the Rail Slip, and Pier 40F

Initially, Snug Harbor would be partially filled with dredged material by direct deposition from hopper barges prior to the installation of the sheet/king pile wall across the harbor mouth. The balance of the fill to Snug Harbor, the Rail Slip and Pier 40F would be dredged spoils and excavated materials placed within the pile walls. Additional dredged material would be added as surcharge to the top of the fill areas to compress the fill. The total area of waters of the U.S. that would be filled and permanently converted to uplands is 2.49 acres.

2.3.5 Shoreline Excavation

A 2.78-acre area of existing fast land would be excavated from the existing shoreline at Piers 41, 42 and 43 back to the new wharf face. The excavation activities would result in the permanent conversion of 2.78 acres of uplands to waters of the U.S., and result in a net gain of 0.29 acres of waters of the U.S. (Figure 2).

2.3.6 Harbor Dredging

Material that cannot be excavated from the shoreline would be dredged from the harbor using barge-mounted equipment to achieve the design depths of -30 and -40-feet MLLW, plus two-foot over-dredge. Dredging would be achieved using mechanical means, specifically, a clamshell dredge with an “environmental bucket” (fitted with a lid) to minimize inadvertent discharges into the water column. Neither cutter-head nor suction dredge is proposed. The total excavated and dredged quantity would be approximately 319,740 cu. m. (417,900 cu. yd.) of uplands and in-water sediments.

2.3.7 Offshore or Upland Disposal of Excess Dredged Spoils

Dredged material that is not reused on-site for construction fill would be disposed of at an approved upland disposal facility or at the SOODMDS. The United States Environmental Protection Agency (USEPA) has issued a suitability determination and conditional concurrence dated July 14, 2015, and correction to this determination and concurrence dated August 13, 2015, approving DOT-Harbors’ proposed disposal of dredged material at SOODMDS. The conditions prescribed by USEPA would become required special conditions of the DA permit, if issued. The total amount of dredged material conditionally approved for disposal at SOODMDS is 198,400 cu. yd.

2.3.8 Wharf Infrastructure and Surface Facilities Construction

Under the greater KCT project, the new wharf would be topped with a 21-inch thick reinforced concrete deck and infrastructure capable of supporting the cranes and other equipment necessary to operate a modern container terminal. The wharf infrastructure would also include on-site drainage facilities equipped with storm water treatment systems designed to treat storm water runoff from the new wharf. To clarify, these activities occurring in uplands are not within the Corps' authority to regulate and are therefore beyond the Corps' federal control and responsibility.

Table 1. Gross Dredge and Fill Estimates for Project

Location	Removal (+) or Fill/Disposal (-) Volume (cubic yards)	Area (acres)
Material to be removed from the site, including dredge material and fast land excavation material	+417,900	8.42
SOODMDS, ocean disposal site	-198,400	Pending results of pre-disposal survey of SOODMDS
Fill in Snug Harbor	-124,200	2.00
Snug Harbor Closure Dike*	- 6,450*	0.50*
Fill in Rail Slip	-13,300	0.35
Fill at Pier 40F	-4,150	0.14
Pier 43 Slope Protection**	- 990**	0.10**
On-site grading/fill material or material to be disposed of at an approved upland facility	-68,460	

*The entire volume of closure dike would be inside the sheet/king piles and is part of the 2.0 acres to be filled within Snug Harbor, therefore the 6,450 cu. yd. quantity does not add toward permanent fill quantity.

**Slope protection armor stone is from quarry, not from dredged material.

2.4 THE APPLICANT'S PROPOSED AVOIDANCE AND MINIMIZATION MEASURES INCLUDED AS PART OF THE PROPOSED ACTION

DOT-Harbors has formulated a Site-Specific BMP Plan identifying all measures that would be implemented before, during and after construction to avoid and/or minimize project-related impacts to the natural and human environment. The following BMPs, as excerpted from the Project BMP Plans, are considered a part of the applicant's proposed action and would be implemented, as applicable, to avoid and/or minimize

adverse impacts, specifically to EFH. Rationale for implementation of each BMP as it relates to EFH is also provided below.

- Prior to initiating any in-water construction or demolition work, coral colonies meeting transplant specifications outlined in the Project's coral transplantation plan, "*The New Kapalama Container Terminal Wharf and Dredging Project, Coral Transplantation Plan*", revised July 2017 (Appendix C), would be transplanted to an accepted recipient site (i.e., Piers 5-6).
 - *Rationale: to minimize direct and avoid indirect impacts to coral colonies.*
- Coral transplantation activities shall be timed to occur outside of peak lobe coral spawning season and preceding (1-month prior) expected reproduction timeframes (July through August).
 - *Rationale: The most prevalent coral found within the harbor, Lobe coral (Porites lobate), spawns from July to August two to three days after the full moon. For corals, the production of gametes is a physically demanding process causing natural stress for corals during spawning season. Avoiding coral transplantation activities the month preceding and during the spawning season would reduce additional Project-related stressors to spawning corals and reproduction efficacy.*
- Restrict turbidity-generating construction activities and remove sediment containment BMPs overnight during specific coral reproduction timeframes (e.g. two to three days, or five days to be conservative, after the full moon in July and August).
 - *Rationale: The majority of larvae are released at night and elevated turbidity has the potential to adversely affect coral spawning activities. Removal of in-water sediment containment BMPs overnight would avoid disruption or restriction of night coral spawning during reproductive months.*
- The use of full length, full-surround silt curtains shall be installed during in-water construction activities (i.e. dredging, shoreline excavation, pile driving, demolition of in-water structures, filling of Snug Harbor, etc.) to isolate and contain construction-generated turbidity, where and when such installation is effective and appropriate.
 - *Rationale: to minimize indirect impacts that have the potential to degrade water quality of surrounding harbor waters and to prevent settling of suspended sediments atop adjacent habitats for coral, macro-invertebrate, and fish communities. Silt curtains are ineffective when deployed in currents, therefore any in-water construction activities dependent upon their use, would be curtailed during significant storm events when flows from streams entering the harbor generate surface currents. The BMP plan*

provides a description of conditions for when silt curtain BMPs are not likely to be effective and accordingly would not be implemented.

- Oil absorbent booms shall be readily available during excavation of the upland shoreline.
 - *Rationale: to protect against potential release of land-based pollutants into the soil at the groundwater interface that could infiltrate harbor waters.*
- Designated areas for dewatering of dredge spoils would be designed and managed to ensure containment of stockpiles and dredged effluent and prevent surface return flow or overflow into harbor waters or other waters of the U.S.
 - *Rationale: to avoid degradation of harbor water quality resulting from return flow or overflow of dredged spoils.*
- An environmental observer would be on-site daily to monitor all in-water work.
 - *Rationale: this BMP is intended to cover a broad range of potential resource concerns from sea turtle and marine mammal observations to documentation of any turbidity plumes or other construction practices that may result in adverse impacts to the harbor environment. The observer would play an active role in addressing and resolving environmental concerns and ensuring corrective measures are implemented in a timely manner.*
- Turbidity-generating, in-water construction activities would be halted during periods of heavy precipitation that have the potential to elevate ambient turbidity levels within the harbor.
 - *Rationale: this BMP is intended to avoid compounding construction-generated turbidity levels atop stormwater-related turbidity within the harbor to minimize adverse impacts to EFH.*

3.0 ENVIRONMENTAL BASELINE CONDITIONS WITHIN THE “PROJECT AREA”

As described in Section 2.1, the “Project area” is defined as the in-water work areas within the dredge and fill footprint as shown on Figure 2. The Project area is a component of the greater KCT “Project site”, which includes, in addition to the Project Area, the adjacent shoreline and uplands that would be impacted to facilitate construction of the KCT Project.

3.1 PROJECT SITE EXISTING ENVIRONMENT

The KCT Project site is located in Hawaii on the Island of Oahu at the western extent of Honolulu Harbor at the base of the Kalihi-Nuuanu Watershed. The project site

occupies 13 parcels of uplands within TMKs 1-2-025, 1-5-032, and 1-5-041 adjacent to the Sand Island Bridge and the Kalihi Channel, and includes the fronting harbor waters. The land is completely urbanized and classified for industrial and commercial land use, with harbor waters restricted to commercial or other use by State-authorized tenants/users.

Over the past century, Honolulu Harbor has undergone dramatic physical changes with gradual development and modifications of the harbor shoreline resulting in the construction of Sand Island on barrier reef islets, and the dredging of the Kalihi Channel and adjacent Keehi Lagoon channels to support both ship traffic and landing seaplanes. Much of the historic coastal wetlands that surrounded the harbor were filled to construct docks and wharves. The estuarine fishponds at the northwest end of Honolulu Harbor were filled to build docks and to construct the former Kapalama Military Reservation that was subsequently returned to the State of Hawaii and leased to various harbor users including the University of Hawaii's Marine Center at Snug Harbor, Pacific Shipyards International, Young Brothers, Atlantis Submarines, Pasha Group, Honolulu Fueling Facilities Corp and Sea-Land Service.

Because of the former development and use of the site, there are no natural or landscaped areas within uplands in the KCT Project site. The existing dry land portions of the Project site and other upland areas identified for construction of the proposed container yard were formerly contained warehouses that supported a wide variety of businesses. Except for a few remaining tenant businesses, most have moved or are in the process of relocating to other piers within the harbor as a result of the KCT Project. Within the project site, only a few buildings and remnant structural features remain that would be removed and improved upon as part of the proposed action.

Water depths in the immediate vicinity of the KCT Project site range from approximately 13 feet below mean lower low water (MLLW) at the waterfront edge to approximately 43 feet below MLLW at the middle of the channel. Water depths within Snug Harbor are in the range of 25 to 31 feet below MLLW (USACE HD 2011).

Honolulu Harbor receives surface runoff via sheet flow and drainage outlets and drainage from Kapalama Canal and Nuuanu Stream which have the potential to convey terrigenous sediments into Honolulu Harbor during precipitation events. During storm events, storm runoff can result in temporary increases in nutrients, pollutants, and sediments in the harbor in addition to a decrease in water clarity. Harbor sediments are continually re-suspended into the water column due to large vessel activity such as ship and tug boat movements i.e. propeller wash within the harbor. Such inputs contribute to the ambient water quality of Honolulu Harbor.

Based on water quality data from 2002 and 2004, the State of Hawaii Department of Health (DOH) designated Honolulu Harbor a Water Quality Limited Segment (WQLS) for exceeding state water quality criteria for nitrates/nitrites, ammonia, total nitrogen, total phosphorus, turbidity, trash, and chlorophyll α . A survey of water quality in the harbor was conducted for 23 stations on April 6, 2012, (MRC, 2012) during mild weather conditions; i.e., no major storm runoff from Kapalama or Nuuanu Streams. The 2012 survey indicated that Honolulu Harbor water met basic water quality criteria at the majority of the stations at the time of this sampling, with the exception of ammonia.

The State DOH Water Quality and Assessment Report (HDOH, 2014) lists Honolulu Harbor as having insufficient data to conclude whether water quality standards are currently being met. However, it does list the ammonia standard as not met in the Aloha Tower Waterfront area of the harbor. Additionally, the State turbidity criterion is also not met from near shore waters to 30-foot depth, from one mile northwest of Honolulu Harbor/Sand Island Channel to Waikiki Beach. Accordingly, the ambient water quality is constantly impacted by landside drainage into and vessel movement within the harbor that adversely affect the chemical characteristics of its waters.

3.2 PROJECT AREA EXISTING ENVIRONMENT

Two benthic habitat types are recognized in the Wharf and Dredging Project area of Honolulu Harbor: the soft bottom substrate of the harbor floor and the hard substrate along the shoreline perimeter. Surveyed hard substrate habitat includes both man-made and naturally occurring substrate that has been substantially modified by man over the past century to construct the operational harbor. The water column in Honolulu Harbor is stratified and provides a variety of micro-habitats defined by light, salinity, nutrient availability and plankton concentrations.

3.2.1 Soft Substrate Habitat

The soft substrate community makes up over 90% of the benthos of the aquatic area that may be impacted by the Project. The Project area was surveyed (AECOS, 2014), and found to consist primarily of dark, very soft silt and fine sand with no evidence of any surface dwelling macro-invertebrates, macro-algae, or seagrass beds. With the exception of numerous small (typically <1 cm) burrow holes, the bottom lacks visible structural features. However, it is known that soft sediment habitats, in general, support a diverse community likely consisting primarily of polychaetes, crustaceans, mollusks, and burrow-dwelling fish just below the mud surface. Species adapted to this habitat structurally alter the habitat through bioturbation, burrow and tube building. These activities result in increased water flow and nutrient cycling through the surface layers of mud. Soft bottom habitats can perform ecological functions in marine communities, by recycling organic matter up into the food web. Many of the organisms that live in this habitat

are adapted to filter feed, increasing the extraction of material from the overlaying water column. Benthic burrowing communities are typically highly resistant to adverse impacts from sedimentation and have a high rate of reproduction and community recovery but would be very susceptible to the wholesale removal of the habitat (i.e. dredging).

The abundance of mobile invertebrate feeding fish noted in the fish survey are at least partially dependent upon these bottom dwelling organisms for their food supply. Members of this community have the most direct link to managed fishery species. The soft bottom community provides food either directly or in the form of eggs and larvae broadcast into the water column.

3.2.2 Hard Substrate Habitat

Most of the 11,844 sq. m. of hard substrate is vertically oriented around the shoreline perimeter and at the edge and side-slopes of dredged navigation channels. The hard substrate is primarily colonized by algae and invertebrates and is either artificially constructed of concrete or metal or occurs as mechanically exposed natural geological formations. Artificial vertical substrate constitutes the bulk of the existing shoreline, installed as part of the construction of Honolulu Harbor pier and wharf structures. These include 5,817 sq. m. of concrete piles and 317 sq. m. of metal sheet piles, with a total combined area of 6,134 sq. m. Natural hard substrate is exposed along steep slopes at the edges of dredged channels and docks often directly below pile footings and has a total estimated area of 5,710 sq. m (Figure 3).

The shoreline below the Sand Island Bridge and along Piers 41–42 consist of steep dredged slopes down to the channel bottom. Debris and boulders littering this slope provide substrate for the growth of individual coral colonies and fouling community organisms. Hard calcareous substrate was described from near the harbor bottom at edges of the dredged channels and existing docks (AECOS, 2014). Corals were distributed between man-made vertical substrate (31%) and natural hard bottom seafloor substrates (69%) at the base of pilings and along steep edges of previously dredged channels.

Fouling community organisms dominated the upper strata of both the natural and artificial hard substrates. This community consists of (in decreasing order) dead bivalves, tunicates, sponges, bryozoans, annelids, and crustaceans with about a third of the 64 taxa identified as introduced species. Macro-algae were not common with only three species observed in the MRC survey and only 29 taxa observed during the AECOS survey. Coral colonies were present within the fouling community, and were also distributed along the entire depth of the hard substrates. A marine fouling community is an assemblage of plants and animals that adheres to, or fouls underwater objects. Most fouling species are able to tolerate certain

changes in environmental parameters such as salinity and temperature. Species having similar environmental tolerances tend to occur together and characterize the fouling community for a given environmental regime. In Hawaii, certain species of fouling community established on new substrate, and grew to 1.5 cm. diameter in 2 months at 50 foot depth. In shallower water the growth rate would be even faster due to greater abundance and availability of planktonic food (Naval Oceanographic Office, 1971).

The man-made, vertically-oriented hard substrate within the Project area provides habitat that supports certain managed fisheries and acts as a de-facto marine protected area for many larger fish due to the regulatory ban on fishing in the harbor. In addition to shelter, the habitat provides food for managed fisheries either directly or in the form of eggs and larvae released into the water column. As such, this artificial, vertical substrate provides features consistent with a typical “coral reef” and that may support managed fisheries or their prey, but does not meet the description of a coral reef habitat composite constituting designated EFH for Coral Reef Ecosystem Management Unit Species, as described in the Final Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region, Chapter 2 (WPRFMC, 2001) and the Fishery Ecosystem Plan for the Hawaii Archipelago, Chapter 3 (WPRFMC, 2009).

3.2.3 Water Column Estuary Habitat

The Honolulu Harbor is an artificially deepened, inshore embayment with strong estuary characteristics influenced by inflow from perennial streams, groundwater, and storm drains from the surrounding urban and light industrial land use areas. With an area in excess of 300 acres and an average depth of 35 feet, the volume of the estuary greatly exceeds the average daily flow volume of all inflowing water sources. These characteristics provide for a relatively long residence time and allow the embayment to function both as a physical sink for land based pollutants and as a biological reaction vessel to transform and incorporate a portion of the land-based nutrients into the marine food web through the production of plankton. The stratified water column provides a variety of micro-habitats defined by light, salinity, nutrient availability, and plankton concentrations. Harbor waters are continually impacted by such terrigenous inputs that adversely affect its water quality.

Benthic Substrate Distribution Across Project Area		
	<u>sq m</u>	<u>Acres</u>
Waters of the US (start of project)	33,200	8.13
Soft Substrate (Harbor Bottom)	22,832	5.64
Hard Substrate	11,844	2.92
Natural Hard Substrate	5,710	1.41
Coral on Natural Substrate	215	
Sand Isl Bridge Revetment	409	0.10
Man-made Hard Substrate	6,134	1.51+
Steel Sheet Piles	317	0.08
Concrete Piles	5,817	1.43
Sheet Piles	317	0.07
Coral on man-made substrate	59	

Figure 3. Areas of Habitat Types across the Project Area

Note that the area of “Hard Substrate” plus “Soft Bottom” is greater than the total area due to the vertical nature of the hard substrate. Dredging and excavation area is 8.42 acres that includes 2.78 acres of fast land and 5.64 acres of harbor bottom soft substrate.

3.3 ESSENTIAL FISH HABITAT OCCURRING WITHIN THE PROJECT AREA

EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). The MSA provisions at 50 CFR 600.10 provide further definition for the purpose of interpreting EFH as follows:

“Waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ full life cycle

Waters and substrate within the harbor are designated as EFH for managed fishery species listed in Table 2 below. Underwater surveys were performed to identify and characterize both the waters and substrates in the project area. Benthic surveys

identified and quantified marine biota to include macro-invertebrate, fish, and coral species populations.

The Project area is located within the boundaries of the Hawaiian Archipelago Fishery Ecosystem Plan (FEP; Western Pacific Regional Fishery Management Council, 2009a). The place-based FEP uses an ecosystem-based approach with “geographically defined ecosystem plans containing identical fishery regulations.” The FEP identifies and categorizes Management Unit Species (MUS) based on the managed fisheries and incorporates all of the management provisions of the former Fishery Management Plans, with updates. MUS known to be present in waters around the Hawaii Archipelago include Bottomfish and Seamount Groundfish MUS (BMUS), Crustaceans MUS (CMUS), Precious Corals MUS (PCMUS), and Coral Reef Ecosystems MUS (CREMUS). Pelagic MUS (PMUS) are managed separately through the Pacific Pelagic FEP. According to the Hawaii Archipelago and Pacific Pelagic FEPs, the following MUS and life history stages are identified as likely present at, near, or dependent on the Project area:

- BMUS: all life stages for shallow complex, eggs and post-hatch pelagic for intermediate and deep complexes.
- CMUS: all life stages.
- CREMUS: all life stages
- PMUS: all life stages.

According to the EFH designations in the Hawaii FEP, Honolulu Harbor is absent of EFH for precious corals, deep-water shrimp, or seamount ground fish. No juveniles or adults for either BMUS or CMUS were recorded from surveys within the harbor.

The Hawaii and Pelagic FEPs further identify ecologically valuable subsets of EFH for the above MUS as “habitat areas of particular concern” (HAPC). These HAPCs are based on the importance of the ecological functions provided, the sensitivity to human or development-induced environmental degradation or stress, and rarity. There are no HAPC within, adjacent to, or near the project area that may be affected by the KCT Wharf and Dredge project.

The following table indicates the EFH designations for each of the MUS that may occur within the Project area:

Table 2: Designated EFH within Project Area, Honolulu Harbor

MUS	Species Complex	Designated EFH
CREMUS ⁺	All currently and potentially harvested coral reef taxa	Water column and all benthic substrate to a depth of 50 fm from the shoreline to the EEZ
BMUS (all stages) ⁺⁺	Bottomfish Shallow Complex	Eggs and post-hatch pelagic: Water column from the surface to 240 meter depth from the shoreline to the EEZ. Post-settlement and Sub-adult/adult: Water column from the surface to 240 meter depth from the shoreline to the EEZ
	Bottomfish Intermediate and Deep complexes	Eggs and post-hatch pelagic: Water column from the surface to 400 meter depth from the shoreline to the EEZ.
CMUS ⁺	Spiny/Slipper Lobster and Kona Crab complexes (all stages)	Eggs and larvae: water column from the surface to 150 meter depth, from the shoreline to the EEZ Juveniles and adults: bottom habitat from the shoreline to 100 meter depth
PMUS ⁺⁺⁺	Temperate/Tropical Species, Sharks and Squid complexes	Eggs and larvae: water column from the surface to 200 meter depth, from the shoreline to the EEZ. Juveniles and adults: water column from the surface to 1,000 meter depth, from the shoreline to the EEZ.

⁺Western Pacific Regional Fishery Management Council, 2009a.

⁺⁺ Western Pacific Regional Fishery Management Council, 2016.

⁺⁺⁺ Western Pacific Regional Fishery Management Council, 2009b.

4.0 MARINE BIOTA OCCURRING WITHIN THE PROJECT AREA

4.1 GENERAL

The types and abundance of marine biota identified within each sector are provided in the Project's two marine surveys conducted by MRC (2012) and AECOS (2014). The second baseline survey was necessitated by a molasses spill into the harbor in September 2013 caused by a cargo loading malfunction unrelated to the Project. The MRC survey report is retained for its general observations concerning the harbor ecosystem, but only the AECOS dataset is used for quantification of the Project's environmental baseline.

AECOS surveyed a total of 1,942 sq. m. of the hard substrate, plus additional randomly selected point surveys across an area of soft substrate in the Project area. Each sector was divided into four segments which were independently surveyed. Designations of sectors surveyed during both efforts are shown in Figure 4. Sectors B (1-3) through J are within the Project area. Sectors A, B (4), K, and L are outside

the Project area and act as control areas. The locations of each segment are shown in the survey documents from AECOS attached as Appendix B to this report.



Figure 4. Survey Sector Areas

4.2 CORAL SPECIES

Porites lobata

Lobe coral (*Porites lobata*) is the most common and widespread coral in Hawaii. The growth form is most commonly massive but can be encrusting in high wave energy environments or plate-forming on steep calm slopes (or concrete pilings). Lobe coral spawns from July to August two to three days after the full moon and has a moderate 11.4 millimeters (mm) per year growth rate. Lobe coral was the most prevalent within the Project area, accounting for 58% of the total colony count and 88% of the total coral area. Of the estimated 167 “larger” coral colonies measuring >40 cm found in the project area, 153 are Lobe coral, representing 92% of this population.

Porites compressa

Finger coral (*Porites compressa*) is often the most common coral in low wave energy environments and has a rapid growth rate (28 mm per year; Minton, 2013) and tends to be very fragile. Finger coral spawns from June through September on the new moon’s 1st quarter from 23:00 to 01:30. Finger coral was not common within the

project area (< 1% of corals, 27 out of 82,324 colonies), but 25% of these colonies were >40 cm in diameter. Of the 167 coral colonies >40 cm. found in the project area, 7 are finger corals (4.2%).

Leptastrea sp.

Crust coral (*Leptastrea sp.*) comes in a variety of relatively common species typically field identified by color and colony morphology in larger specimens, but it can be difficult to identify small individuals of this coral species. *Leptastrea sp.* has a reported radial growth rate of 10.3 mm per year and commonly forms large encrusting colonies on exposed reefs. Within the Project area, crust coral was the second most common coral identified (41%, 34,017 out of 82,324 colonies). But the colonies were <5 cm in diameter, and the total area of this entire species was about 7% of the total coral area.

Pavona varians

Corrugated coral (*Pavona varians*) grows in encrusting brown lumpy masses with curling ridges that make up the edges of the coral calices. This species is relatively common in shallow waters, in areas exposed to moderate to strong wave action in spaces between other corals. Colonies are typically small and rarely larger than 60 cm in diameter. This coral has a reported radial growth rate of 15.1 mm per year (Minton, 2013) and spawns in June during the full moon's third quarter between 19:05 and 20:15 (Kolinski and Cox, 2003). Within the project area, only 54 colonies are estimated to be present, representing less than 1% of the total population. Of the 167 coral colonies >40 cm found in the Project area, 8 are corrugated corals (4.8%).

Cyphastrea ocellina

Oscillated coral (*Cyphastrea ocellina*) typically has an encrusting morphology with small colonies that have large calices. This species spawns on a monthly basis releasing fertilized planulae directly into the water column, with slightly larger spawns during the months of April and June (Gulko, 1998). Only 29 colonies of this coral were found within the project area, 21 of which were less <5 cm in diameter.

4.2.1 Coral Coverage

The extent of the hard substrate within the Project area is not well represented by the 2D mapped area due to the vertical relief of much of the substrate. The area of hard substrate, incorporating its vertical (Z-axis) extent, was calculated from the AECOS (2014) benthic survey data in which counts/characteristics in each transect were used to estimate a larger (un-surveyed) area of each sector. Based upon the AECOS estimate that the transects covered 16.4% of the area, the total of all combined areas represented by the Project area benthic surveys is 11,844 sq. m, or about 2.92 acres (Table 3).

Table 3. Project Sectors Surveyed and Extrapolated to Total Habitat Areas

Sector	Survey Area m	Coral Colonies	Seafloor sq m	Piling sq m	Sheet Pile sq m	Sector Area sq m
B	240	4844	1560			1560
C	160	4602		1184		1184
D	44	526		279		279
E	796	12554	1250	3329		4579
F	60	2706	410			410
G	272	11608	1420	173		1593
H	42	4378			317	317
I	240	37164	1070	368		1438
J	88	3944		484		484
Total	1942	82324	5710	5817	317	11844

An estimated total of 82,324 coral colonies (+/- 1 standard error of mean of 14,632), representing 5 live species with a combined calculated colony area of 275 sq. m. was documented within the Project area (Table 3). About 30% of the corals were attached to artificial structures (concrete piles and sheet piles) and 70% were affixed to hard substrate exposed at the base of piles and edges of dredged slopes. An additional 124,099 corals were documented outside of the Project area, in the following Sectors: A = 8,701; B4 = 493; K = 109,558; and L = 5358). Corals outside of the Project area are of similar species and size range as those inside the Project area. Coral quantity estimates for each sector surveyed within the Project area are shown in Table 4.

Living coral cover within the Project area is 2.3% (275 sq. m. of 11,844 sq. m.). Four additional species of recently deceased corals (*Montipora capitata*, *M. patula*, *Pocillopora damicornis*, and *P. meandrina*) representing 3.5% of the total coral count were identified from their skeletal remains and do not contribute to the Project total coral area. The smallest size class (1–5 cm) made up 79% (64,988 of 82,324) of the live coral colony count within the Project area. Each subsequent larger size class contains only about 20% as many corals.

Coral species were not distributed evenly along the shoreline substrates. The distribution of all live coral species along the Project shoreline is shown in Figure 6. The distribution of corals larger than 40 cm in diameter is displayed in Figure 7. Over 99% of the coral colonies consist of only two common species (*Porites lobata* and *Leptastrea sp.*). The most prevalent species, *P. lobata*, 58% (48,198 of 82,324), ranging in size up to 1.6 meters in diameter accounted for 88% (241 of 275) of the area of all living corals. The least prevalent live species was *P. compressa*, with 27 individuals estimated to be present.

Table 4. Coral quantity estimates, plus and minus one standard error of the mean, for each sector surveyed within the Project area.

	Coral Count	Survey Area m2	Sector Area	# coral per m ²	#Coral Est Mean	- 1 SEM	+ 1 SEM
B1	438	80	480	5.5	2628	843	4413
B2	169	80	600	2.1	1268	821	1714
B3	158	80	480	2.0	948	250	1646
C	624	160	1184	3.9	4602	2700	6504
D	84	44	279	1.9	527		
E-Piles	826	557	3329	1.5	5068	4000	6136
E-Shore	1078	180	1250	6.0	7486	4077	10895
F	396	60	410	6.6	2706	2605	2807
Gshore	1772	220	1420	8.1	11437	8620	14255
Gpiles	51	51.9	173.3	1.0	170	3	338
H	580	42	317	13.8	4378	3907	4848
I-Shore	4940	160	1070	30.9	33036	18237	47836
I-Piles	897	96	368	11.2	4126	3482	4770
J	717	88	484	8.1	3944	2961	4926
TOTAL	12,730	1,899	11,844		82,324	67,692	96,956
			Average ->	7.0			

Larger corals have a higher ecosystem service value than small corals. Their increased size provides greater habitat cover for fish and invertebrates, provides greater wave and current resistance, and produces much more efficient spawning. Corals <40 cm in diameter provide limited structure, which in turn limits the amount of habitat provided to other organisms as well as the capacity of the coral to sustain the surrounding ecosystem or provide significant resilience capacity. Corals in the smallest size class (<5 cm) perform minimal functions in terms of habitat provision, primary or indirect production, or ecosystem resilience capacity. Although corals >40 cm account for less than 1% (167/82,324) of the population count, they provide 25% (69 sq. m./275 sq. m.) of the living coral area.(Table 5, Figure 5).

Table 5. Coral Present within the Project Area
(as extrapolated from AECOS survey findings)

Project Area Only (B1, B2, B3, C1, C2, D, Epile, Eshore, F, Gshore, Gpile, H, Ishore, Ipile, J)									
Size class ->	1-5cm	6-10cm	11-20cm	21-40cm	41-80cm	81-160 cm	>160cm	Total #	Coral m ²
<i>Cyphastrea ocellina</i>	21	0	7	0	0	0	0	29	0
<i>Leptastrea</i>	32444	1560	13	0	0	0	0	34017	23
<i>Pavona varians</i>	23	15	8	0	8	0	0	53	2
<i>Porites compressa</i>	14	0	0	7	0	7	0	27	8
<i>Porites lobata</i>	32486	11064	3778	717	134	19	0	48198	241
Total Count	64988	12639	3806	724	141	26	0	82324	
Area m ²	32	55	67	51	40	29			275
			205		69				

Seafloor (B1, B2, B3, Eshore, Gshore, Ishore)									
Size class ->	1-5cm	6-10cm	11-20cm	21-40cm	41-80cm	81-160 cm	>160cm	Total #	Coral m ²
<i>Cyphastrea ocellina</i>	14	0	7	0	0	0	0	21	0
<i>Leptastrea</i>	13943	1059	13	0	0	0	0	15015	12
<i>Pavona varians</i>	0	0	0	0	0	0	0	0	0
<i>Porites compressa</i>	14	0	0	7	0	7	0	27	8
<i>Porites lobata</i>	28035	9609	3368	621	101	7	0	41741	196
Total Count	42006	10668	3389	628	101	13	0	56804	
Area m ²	20	47	60	44	28	15			216
			171		43				

Piles and Sheetpiles (C1, C2, D, Epile, F, Gpile, H, Ipile, J)									
Size class ->	1-5cm	6-10cm	11-20cm	21-40cm	41-80cm	81-160 cm	>160cm	Total #	Coral m ²
<i>Cyphastrea ocellina</i>	8	0	0	0	0	0	0	8	0
<i>Leptastrea</i>	18501	501	0	0	0	0	0	19002	11
<i>Pavona varians</i>	23	15	8	0	8	0	0	53	2
<i>Porites compressa</i>	0	0	0	0	0	0	0	0	0
<i>Porites lobata</i>	4451	1455	410	96	33	12	0	6457	46
Total Count	22982	1971	417	96	40	12	0	25520	
Area m ²	11	9	7	7	11	14			59
			34		25				

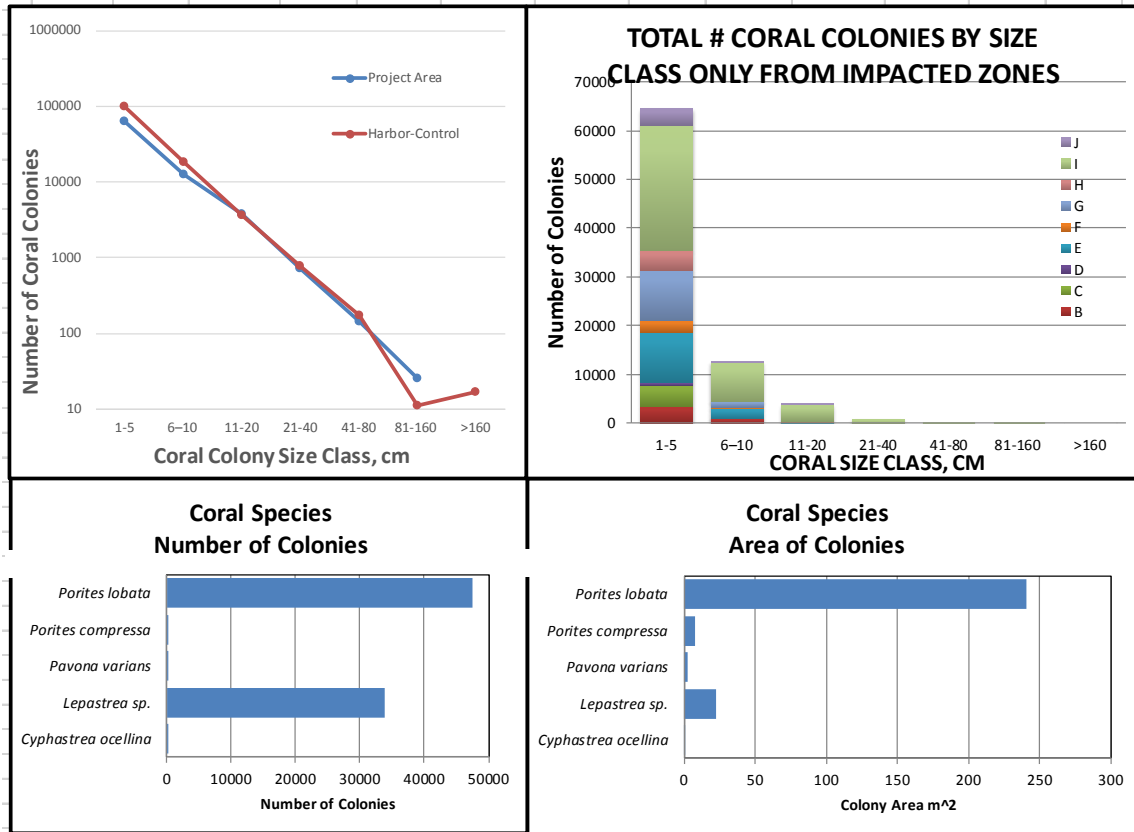


Figure 5. Coral Colonies by Size Class, Number of Colonies, and Colony Area (AECOS, 2014)

Top Left: The number of corals decreases about 80% in each succeeding larger size class. Corals in the surveyed sector K outside the Project area are used as harbor control data.

Top Right: Coral colony counts by sector and size class show that the smaller colonies are much more abundant.

Bottom Left: *Porites lobata* and *Lepastrea sp.* account for 95% of all colonies.

Bottom Right: *Porites lobata* accounts for highest coral area coverage followed by *Lepastrea sp.* Although the corals greater than 20 cm in diameter make up only about 1% of the total coral colony count as shown in top right, they completely dominate the contribution to total coral area.

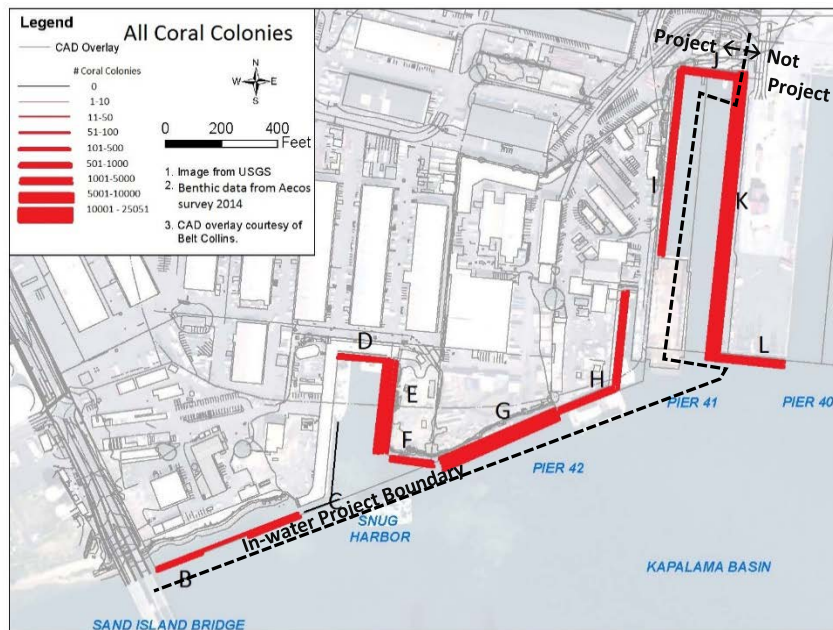


Figure 6. Distribution of live coral species across the Existing Project Shoreline. Sectors K and L are not in the Project area and are not included in the total coral count.



Figure 7. Distribution of live corals >40 cm displayed as red lines within Project area.

4.2.2 Harbor Control Site – Sector K, Pier 40

The face of Pier 40 is outside and immediately adjacent to the Project area. Surveyed as part of both baseline survey efforts, Sector K is comprised of a continuous sheet pile bulkhead pier face with significant (9.8%) coral cover. Sector K contains more coral colonies (109,548) than the rest of the project shoreline combined. Although the bulk of the corals (88,405) are in the smallest size category, the total surface area of corals in Sector K is about 299 sq. m. This area would be used as the control site to assess the efficacy of during-construction BMPs to protect corals and as a comparison for growth rate and survival of corals transplanted from the construction site to other areas (Figure 10). Further discussion on the use of the control site is included in the Coral Transplantation Plan (Appendix C).

4.3 MACRO-INVERTEBRATES

As in most quiescent harbors, much of the hard substrate in the lower tidal and shallow sub-tidal zones is colonized by a diverse fouling community. Many of the sun-lit piles and sheet piles within the Project area are densely colonized by macro-invertebrates. A total of over 64 taxa of macro-invertebrates, 15 of which are not native to Hawaii, were tabulated. The population is dominated by dead bivalves (5 species) and live tunicates (4 species) with sponges (20 species) and bryozoans (5 species) also prevalent (Figure 8). The large majority of these organisms are filter feeders. Although there was typically an abundance of dead mollusk shells covering all vertical substrates, the relative abundance of living mollusks was low.

The initial marine biological survey (MRC, 2012) noted a prevalence both of large dead mollusk habitats and large coral colony skeletons overgrown with fouling organisms and occasional new coral recruits. The molasses spill resulted in a further large die-off of corals of all sizes. Data from the surveys show an 80 % reduction in coral specimen numbers for each increase in the size class.

The above factors indicate that the harbor is a challenging environment for both bivalve and coral survival. The abundance of mollusk shells and coral skeletons (even prior to the molasses spill) suggest periodic severe water quality stressors that may dominate the long-term development of biological structures within the harbor. The general fouling community was more abundant upon the artificial vertical substrates than upon the deeper, natural shelf substrates at the channel edges. In contrast, corals were more abundant upon the deeper natural shelf substrates. High density of burrow holes within the soft mud substrate of the harbor floor within the Project area was noted in both surveys. The percentages of non-coral invertebrates are shown in Figure 8.

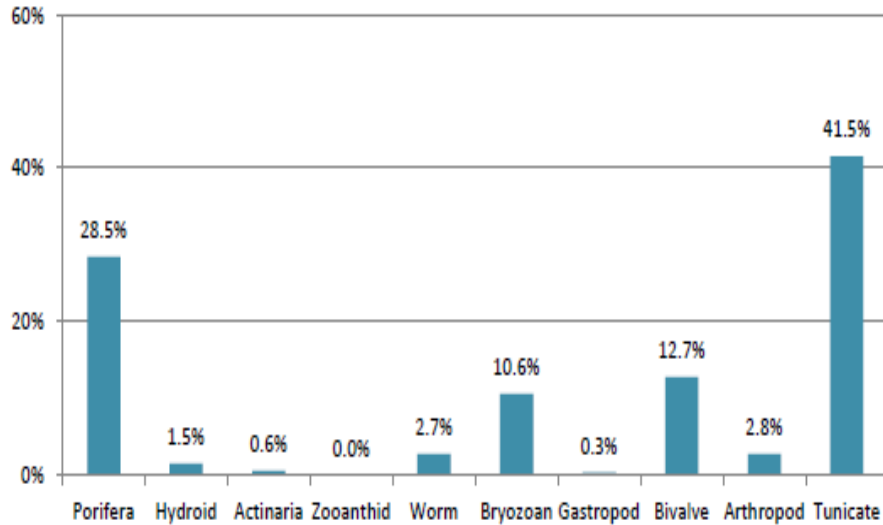


Figure 8. Percent of Non-Coral Invertebrates in Major Groups, All Sectors Combined (AECOS, 2014)

4.4 FISH

Two types of surveys were conducted: 25-meter long belt transects, and 5-minute single point counts, each providing an independent estimate of the fish species and population levels present in the Project area. Traditionally, belt transects are assumed to quantify more cryptic sedentary species as one moves over the surface, whereas stationary point count surveys (SPC) are assumed to count more large species as they swim into view. The area of the harbor comprised of hard substrate edge habitats (i.e. excluding the mud habitat of the harbor bottom), as calculated from the fish surveys, is estimated to be 10,594 sq. m (2.5 acres). The 3,085 individual fish counted and identified within the transect areas are extrapolated to this total area. Note that this is about an 11% lower estimate than the edge habitat hard substrate area as calculated from the coral surveys (11,844 sq. m).

All fish were identified to species, where possible, and lengths were estimated, yielding a calculated estimate of the weight of each fish. In the analysis provided in Figure 9, the fish have been allocated to a number of trophic levels, depending primarily on their dietary habits. The total number and weight of fish are estimated from both the SPC and Belt transect methods and scaled against NOAA baseline average reef data to represent the average fish mass by trophic level per hectare (Ha; Figure 9).

The fish community at the Project area is well represented with 68 species (AECOS) (56 by MRC) identified. A total estimated 5,701 to 7758 individual fish (by belt transect and SPC transect, respectively), with an average of 9 to 17 different species represented in each sector, are estimated to exist within the Project area with a total

mass of 311 kg to 642 kg (294 kg/Ha and 606 kg/Ha). These calculated mass densities include a school of goldspot sardines estimated at 1,200 fish (31.5 kg). Other than the sardines, the most frequently observed fish were the ring-tailed surgeonfish, convict surgeonfish and yellow tang. Also common were the white-spotted toby, domino damselfish, threadfin butterflyfish, yellowfin surgeonfish, blacktail snapper, coronet fish, papio and raccoon butterflyfish. Barracuda were seen in several sectors, but may be more prevalent than indicated by the data, due to poor underwater visibility and this fish's tendency to avoid divers. Fish that feed on invertebrates or upon plankton tended to be more common in the Project area. Sectors E, B, and C yielded the highest fish counts, with sectors D and J yielding the lowest fish counts.

The transect at sector B encountered a large school of sardines, which may bias the average fish counts. Note that the tiger shark encountered in the Harbor Bottom sector is outside of the direct project impact area and that data is not included here.

AECOS DATA" --> INCREASING TROPHIC LEVEL -->									
KAPALAMA HARBOR	Sessile			Mobile		Planktivore	Omnivore	Piscivore	TOTAL
	Detritivore	Herbivore	Coralivore	invert feeder	Invert Feeder				
Average B	1.2	125.5	0.9	61.8	114.9	28.5	0.0	37.0	369.8
Standard	0.3	58.1	0.2	36.8	35.5	17.8	na	15.1	126.5
SPC Biom	0.8	207.2	0.0	156.4	147.3	37.9	0.0	56.0	605.6
Standard	0.5	50.5	0.0	52.4	34.1	26.8	na	22.3	134.4
Belt Biom	1.4	99.3	1.1	31.4	104.5	25.4	0.0	30.9	294.1
Standard	0.3	96.9	0.4	42.6	57.2	19.4	na	16.2	194.6
Average D	128.3	2595.3	3.4	574.8	724.8	868.9	0.0	549.3	5444.9
Standard	65.9	848.1	-	337.5	273.4	555.4	na	224.6	0.0
SPECIES RICHNESS (/ 15m Diam			3,085	TOTAL FISH COUNTED IN ALL PROJECT AREA TRANSECTS IN HARBOR					
mean	2.67			5,788	TOTAL FISH ESTIMATED PRESENT IN PROJECT AREA OF HARBOR				
SEM	2.67			392	Kg of FISH ESTIMATED PRESENT IN PROJECT AREA OF HARBOR				

Figure 9. Fish Transect Data from Project Area Adjusted to Per Hectare Density

5.0 POTENTIAL EFFECTS OF THE ACTION ON EFH AND MUS

Because of the magnitude and range of activities represented by the Project, this section analyzes the potential impacts first, by each individual Project phase, and second, by type of Project impact. Each phase varies by construction method and

likewise, potential vectors for impact to EFH. Project phasing or sequencing is illustrated in plans attached as Appendix A.

5.1 EFFECTS BY PROJECT PHASE

The action, anticipated to begin in 2018, would incorporate 8 construction phases lasting approximately 36 months, followed by operation of the facility. Impacts from turbidity plumes stirred by prop wash of work vessels would be present during all in water work phases and contained within the work areas to the greatest extent practicable through implementation of in-water BMPs. Activities occurring within the following construction phases are discussed in greater detail below: above waterline installation beneath Kalihi Channel, demolition of existing shoreline facilities, shoreline bulkhead construction and Sand Island Bridge scour protection, enclosing and filling of Snug Harbor, the Rail Slip, and Pier 40F, shoreline excavation, harbor dredging, offshore or upland disposal of excess dredged material, and wharf infrastructure and surface facilities construction. Indirect impacts from each Project phase are discussed in each of the following sections and summarized in Section 5.3.

5.1.1 Waterline Installation beneath Kalihi Channel

Two waterlines would be installed under the Kalihi Channel using horizontal directional drilling with entry and exit pits located in uplands adjacent to the Project area and on Sand Island, located several hundred feet from harbor waters to prevent inadvertent discharges. Appropriate BMPs would be implemented at the drilling and receiving pits to prevent storm water runoff and drill effluent from leaving both sites.

Directional drilling a pipeline 50 to 70 feet beneath the seafloor of the Kalihi Channel in Honolulu Harbor eliminates water column and substrate disturbances or alteration. At depths of 50 feet or more, the pipe would be protected from the action of waves and preclude indirect disturbance of EFH. Placed at this depth, permanent embedment in marine mud would reduce the likelihood of any releases or possible spills of the drill hole ("frac-out").

The activities proposed under this phase would not reduce the quantity or quality of EFH. Accordingly, the Corps has determined the waterline installation beneath the Kalihi Channel would neither adversely affect nor have the potential to cause effect to any MUS or its designated EFH.

5.1.2 Demolition of Existing Shoreline Facilities

Potential vectors for impact to MUS and their designated EFH include impacts to water quality resulting from demolition of the existing shoreline, associated facilities and the physical removal of natural, hard substrate that constitutes EFH and artificial, vertical structures that provide substrate that supports habitat for

MUS species and their prey. All hard substrate, natural and artificial, including the associated biological communities for which it supports, would be lost. Demolition activities occurring from land and in marine waters have the potential to suspend sediments and elevate turbidity as well as generate petroleum-based pollutant plumes associated with the operation of heavy machinery atop work barges and shore-side areas, or release terrigenous constituents from buried soils.

To minimize impacts to surrounding EFH, appropriate sediment containment BMPs would be implemented throughout construction to isolate turbidity within the work area. The degree of indirect impacts from these pollutants depends on the success of BMPs. Suspended materials can directly or indirectly impact MUS and EFH including potential impacts such as health detriment to swimming MUS or plankton blooms of unknown potential impact.

The proposed demolition activities would cause the following impacts to MUS within the harbor, at the work area:

- Short-term loss of benthic fouling community habitat that supports eggs, larvae, or prey species of MUS' on the 11,844 sq. m. (2.9 acres) of hard substrate.
- Permanent loss of 82,157 corals <40 cm diameter over an area of 275 sq. m. and all sessile invertebrate communities (tunicates, sponges, hydroids, annelids, mollusks, etc.) currently colonizing hard substrate that is proposed for removal. Loss of the biological community would result in the loss of forage area provided by the existing fouling community to herbivorous and invertebrate-feeding fish in the community.

The activities proposed under this phase would reduce the quantity and quality of EFH and accordingly, would result in the following adverse effects to EFH in the work area:

- Permanent, physical removal of approximately 11,844 sq. m. (2.9 acres) of existing hard substrate and associated biological communities. The loss of natural substrate (dredged channel slopes) results in the reduction in quantity of EFH, and the loss of man-made vertical structures (concrete piles, bulkheads, etc.) results in the reduction in quantity of habitat that supports MUS and other prey species.
- Temporary elevated turbidity levels resulting from resuspension of sediments in the water column would cause disruption of natural reproductive processes involving eggs and larvae for MUS and their prey species, resulting in reduction of the quality of EFH.

5.1.3 Shoreline Bulkhead Construction and Sand Island Bridge Scour Protection

The pier face of the new shoreline would consist of a driven king pile and sheet pile wall. Most of the wall would be installed in uplands located well inland of the existing shoreline. In-water pile installation would occur across the mouth of Snug Harbor and the Rail Slip and along Pier 40F. To protect against scouring, the west end of Pier 43 near the Sand Island Bridge would be lined with a rock revetment. This would result in a permanent loss of 409 sq. m. of existing, natural hard substrate to be replaced with armor stone.

The proposed construction activities would cause the following impacts to MUS within the harbor, at the work area:

- The in-water construction of the rock revetment at the west end of Pier 43 would permanently replace the existing natural substrate and associated biological community resulting in the permanent loss of all sessile invertebrates and 494 colonies of corals measuring less than 20 cm. in diameter. Loss of the biological community would result in the loss of forage area provided by the existing fouling community to herbivorous and invertebrate-feed fish in the community.

The proposed bulkhead construction in and across marine waters would reduce the quantity of EFH and accordingly, would result in the following adverse effect to EFH in the work area:

- Pile installation would permanently sever open marine water and benthic substrate at Snug Harbor and at the Rail Slip, to facilitate filling waters of the U.S. to be converted to uplands and resulting in a reduction in the quantity of designated EFH.

5.1.4 Enclosing and Filling Snug Harbor, the Rail Slip, and Pier 40F

Snug Harbor, the Rail Slip, and Pier 40F would be filled with dredged material. Fill would be placed by barge- or shore-mounted equipment. The total proposed fill area is 10,170 sq. m. (2.49 acres) of marine waters. Filling activities would be expected to generate elevated turbidity levels in the immediate work area and potentially surrounding harbor waters. To the greatest extent practical, implementation of appropriate BMPs would confine any turbidity plumes to the work area and minimize disbursement of construction-generated turbidity to surrounding waters.

Enclosing and filling of Snug Harbor, the Rail Slip, and Pier 40F would reduce the quantity and quality of EFH and accordingly would result in the following adverse effects on MUS and designated EFH in these areas:

- Permanent loss of 10,170 sq. m. (2.49 acres) of water column and substrate EFH, including associated biological community consisting of corals and other sessile biota, with permanent conversion to uplands at Snug Harbor, Rail Slip and Pier 40F bulkhead, resulting in a reduction of quantity of designated EFH
- Elevated turbidity levels resulting from filling activities would temporarily impair water quality and result in the reduction of quality of EFH immediately adjacent to the filling activity.

5.1.5 Shoreline Excavation

The excavation of uplands to facilitate construction of the wharf face inland of the existing shoreline would create a total of 2.78 acres of water column and benthic substrate, thereby permanently increasing the total quantity of EFH. A total of 319,740 cu. m. (417,900 cu. yd.) of material would be excavated and dredged to achieve design depths of -30 and -40 feet mean lower low water (MLLW) plus two-foot over-dredge. Shoreline excavation activities would likely result in impacts similar to that of dredging, except that the terrigenous sediments may have the potential to contain and release land-based pollutants.

Potential adverse impacts would be avoided or minimized through implementation of appropriate construction BMPs and water quality monitoring. All measures such as full surround silt curtains and strict maintenance of excavating equipment would be implemented to comply with Section 404 and Section 401 permit conditions during shoreline excavation. This would ensure adequate control of silt plumes and prevent adverse impacts on the benthic community immediately adjacent the excavation area.

Excavation of the shoreline and dredging to the design depth would reduce the quantity and quality of EFH and accordingly would result in the following adverse effect to designated EFH within and adjacent to the dredge area in the Harbor:

- Permanent loss of existing vertical shoreline hard substrate and associated biological communities would result from shoreline excavation. The loss of natural hard substrate results in the reduction in quantity of EFH and the loss of man-made vertical structures such as sheetpiles and concrete pilings results in the reduction in quantity of habitat that supports MUS and other prey species.

Excavation induced elevated turbidity levels would temporarily impair water quality, resulting in a reduction of quality of EFH. Such a stressor could affect immediate and adjacent communities including the potential to stimulate plankton blooms as a result of increased levels of sediment-borne nutrients dissolved into the water column.

5.1.6 Harbor Dredging

Material that can't be excavated from the shoreline would be mechanically dredged from the harbor using barge-mounted equipment to achieve the design depths of -30 and -40 feet MLLW, plus two-foot over-dredge. The total proposed volume of removed materials through excavation and dredging is approximately 319,740 cu. m. (417,900 cu. yd.).

Dredging would remove both hard substrate and soft sediments and other habitats that support MUS and their prey. Biological communities supported by the substrate would also be lost. In-water dredging operations would elevate turbidity levels by disturbing and re-suspending benthic sediments into the water column that could affect water quality in both immediate and adjacent areas.

Dredging-induced inadvertent discharges would be minimized to the greatest extent practical through use of an "environmental bucket" clamshell dredge. Impairments to water quality stemming from dredging operations would be contained to the greatest extent practical to minimize adverse effects to EFH through implementation of appropriate sediment containment devices such as full-depth silt curtains to encircle dredging operations. Due to the lack of surface currents in the embayment, it is anticipated that the suspended sediments would naturally settle rather quickly upon completion of the dredging operations. In addition, removal of accumulated sediments from the seafloor would reduce sediments available for resuspension by prop wash or other disturbances typical of a harbor environment. Water quality monitoring before, during and after dredging operations would be required to ensure return to pre-dredge, ambient levels.

Dredging hard substrate and soft sediments would reduce the quantity and quality of EFH and accordingly would result in the following adverse effects to designated EFH within and adjacent to the dredge area:

- Permanent loss of hard substrate and soft sediment resulting in reduction in quantity of designated EFH for CRE-MUS, all life stages and CMUS, juveniles and adults and habitat that supports MUS and their prey.
- Permanent loss of associated biological communities including soft bottom infauna invertebrate species resulting in reduction of quality of EFH for MUS, especially prey species.
- Generation of elevated turbidity levels from suspension of sediments causing temporary degradation of water quality in the immediate vicinity of the dredging operation to include de minimis discharges and disturbance of the benthos and also any dredged material transport from

and within the silt curtains resulting in reduction of quality of water column EFH for all MUS occurring within the Project area.

•
5.1.7 Offshore or Upland Disposal of Excess Dredged Material

The disposition of dredged material from the Project would be dependent upon the sediment characteristics and origin. Uncontaminated materials permissible for re-use include discharge in waters of the U.S. to fill Snug Harbor, the Rail Slip and Pier 40F and upland disposal atop filled areas. Material not fit for nearshore or upland re-use would be transported, upon approval from USEPA, to the SOODMDS for disposal. Dredged material unfit for ocean disposal or beneficial reuse would be disposed of at an approved upland disposal site. Upland disposal areas are absent of designated EFH.

The proposed disposition of dredge material on site or as land fill within a properly contained upland area would not reduce the quantity or quality of EFH and, therefore would not adversely affect EFH.

All barges used to transport dredged material for ocean disposal would be water tight to prevent any leaks or other discharges of dredged effluent that are not regulated under Section 404 of the Clean Water Act. The effect discharge of dredged material to fill Snug Harbor, the Rail Slip and Pier 40F would have on EFH is previously discussed in Section 5.1.4, above.

The proposed transport of dredged material to the SOODMDS for ocean disposal would not reduce the quantity or quality of EFH and, therefore would not adversely affect EFH. Ocean disposal of dredged material is authorized by USEPA and is beyond the Corps' federal control and responsibility to regulate.

5.1.8 Wharf Infrastructure and Surface Facilities Construction

Under the greater KCT Project, the constructed wharf would be reinforced with a deck, consisting of a 21-inch thick concrete pad and would include installation of necessary infrastructure utilities. The construction of these facilities would be on fast land and within the sheet pile bulkhead constructed in preceding phases. To reiterate, such activities occurring entirely in uplands are not within the Corps' authority to regulate and are therefore beyond the Corps' federal control and responsibility to evaluate. However, such activities occurring in an area absent of EFH are discussed herein, as they have the potential to affect adjacent EFH. Appropriate use of BMPs to isolate the work areas would be implemented to the greatest extent practical to avoid and/or minimize adverse impact to EFH, including covering stockpiles and exposed erodible areas, and following accepted precautions when equipment would be used or moved to prevent contaminants from land based construction reaching harbor waters.

The proposed construction has the potential to adversely affect EFH as a land-based source of sediments that could, if discharged into the harbor, degrade water quality and thereby reduce the quality of water column EFH for all MUS that may occur within the harbor.

All construction activities would follow the NPDES permit requirements to prevent water pollution. Strict adherence to the permit would eliminate the potential for adverse effects to EFH.

5.2 EFFECTS BY TYPE OF IMPACT

Substrate and water column EFH loss and water quality degradation are common between construction phases. In this section, potential adverse impacts upon EFH and MUS by type of impact are discussed. Due to the extensive classification of thousands of managed fishery species collectively considered under several MUS', the following discussions would be generalized to the impact upon each specific fishery type.

Project-related impacts to substrate EFH include physical loss of substrate (soft and hard) that would reduce the quantity of EFH. Impacts to water column EFH include water quality degradation that would reduce the quality of EFH during construction. MUS impacts may include physical loss of biota and loss and degradation of habitat that supports MUS' and their prey and that has the potential to reduce the quality of designated EFH.

5.2.1 Loss of Physical Habitat

The loss of hard substrate habitat would be limited to four habitat types, each of which has been either constructed or significantly altered by previous navigation enhancement projects.

- Man-made harbor structures (loss to excavation, demolition, and dredging) 452 concrete piles & sheet pile along existing 4,190 ft. shoreline 6,134 sq. m. (1.51 acres)
- Channel edge and miscellaneous hard litter 5,710 sq. m. (1.41 acres)
- Shallow intertidal substrate near abutment of Sand Island Bridge (loss by cover with armor stone and quarry rock) 409 sq. m. (0.10 acre)
- Harbor floor soft-bottom substrate (loss by dredging) 22,832 sq. m. (5.64 acres)

The total loss of existing hard substrate (concrete, sheet piles and dredged channel slope) is estimated at approximately 11,844 sq. m. (2.9 acres), located

along the 1,277 m (4,190 ft.) of existing shoreline, all of which is either man-made or man-modified. However, the Corps considers this loss temporary, as it would be immediately replaced by similar sheet pile habitat along the entire 972 m (3,190 ft.) of new shoreline. The resulting shoreline would have a larger vertical area, as it would be deeper than the present shoreline, and a smaller lateral extent, measuring about 305 m (1,000 ft.) shorter in length due to the loss of Snug Harbor and the Rail Slip.

Loss of hard substrate would include loss of the associated biological community, including the majority of fouling community organisms such as algae, corals, sponges, mollusks, hydroids, and other invertebrates. A total of 82,157 live corals <40 cm in diameter are expected within the proposed construction site, with 56,691 of these corals associated with seafloor natural hard substrate. An assessment of the data obtained during the benthic survey (AECOS, 2014) indicates that there are approximately 171 sq. m. of small (<40cm diameter) corals on the harbor seafloor and 34 sq. m. of small coral colonies on piles and sheet piles. These corals would be lost as part of the demolition and dredging phases of the Project.

Assuming average coral growth rates for Hawaiian corals (Minton, 2013), it would take about 7 years for corals growing on the new sheet-pile substrate to recover the loss of all corals less than 40 cm in diameter.

Corals growing on vertical man-made structures (e.g. pilings, bulkhead, etc.) do not constitute a coral reef habitat composite (EFH for CREMUS). Coral reefs are described in the CREMUS FMP as “patchworks of hard and sediment bottoms” and in the Hawaii FEP as “carbonate rock structures at or near sea level that support viable populations of scleractinian or reef-building corals”. Furthermore, the Western Pacific Region Fishery Management Council, in designating EFH for CREMUS, considered designating individual reef building corals as EFH, but rejected that specific alternative in favor of a habitat composite approach. While coral reefs are considered EFH, individual corals are not. The Corps interprets coral reef/hard substrate habitat composite designated EFH for CREMUS to mean, naturally occurring, hard bottom and not individual coral colonies or artificial vertical structures such as pilings or bulkheads that support coral growth.

DOT-Harbors is proposing to avoid direct physical impact to individual coral colonies within the direct project footprint that may provide habitat and ecological support to MUS and prey species. A total of 167 corals >40 cm in diameter measuring 69 sq. m. in cumulative area would be transplanted to another suitable area within the harbor. Because some corals >40 cm in diameter may not be appropriate for transplantation due to physical formation or other challenge, corals as small as 21 cm in diameter may be transplanted to achieve the 69 sq. m. areal transplant goal.

The existing soft substrate, debris-littered habitat loss totaling about 410 sq. m. (4,400 sq. ft.) at the abutment of the Sand Island Bridge would similarly be permanent, however considered temporary as it would be immediately replaced with rock and armor stone that would provide vertical relief and substrate for marine growth. The Corps expects the replacement substrate to provide opportunity for ecologically greater value and function in comparison to the existing shoreline.

The temporary unavoidable loss of physical habitat that could either be used by or provide forage for MUS totals 11,844 sq. m. (2.9 acres) of hard substrate and 22,834 sq. m. (5.6 acres) of soft sediment substrate.

5.2.2 Water Quality Degradation

In-water construction activities have the potential to generate turbidity through disturbance of the existing substrate causing resuspension of sediments into the water column, thereby raising ambient turbidity levels. Such elevated turbidity levels would degrade ambient water quality within the work area and immediately surrounding area. Elevated turbidity levels would be discrete, temporary and would be expected to naturally dissipate, restoring water quality to ambient levels with no anticipated permanent impact to water quality. Suspended sediments, mostly sand, would be expected to settle rather quickly upon completion of any in-water disturbances. Adverse impacts to the water column, primarily due to construction related turbidity, would likely be very limited in both physical and temporal extent due to the lack of currents in the harbor and use of BMPs. The harbor is enclosed and usually subject to low velocity tidal currents which naturally and considerably limit the potential for turbidity plumes to be carried into adjacent habitats.

Given that the existing harbor is subject to regular bouts of high turbidity during periods of storm water runoff (Namba, 2004) and constant activity by large container ships, cruise liners and barges, it is not likely that temporary increases in turbidity from dredging would have any measurable impact upon mobile marine species. Corals and other marine biota in the harbor are continuously and frequently subjected to high turbidity plumes whenever the prop-wash from large vessels suspends sediments from the bottom. The biota colonizing this environment appears to be resilient to turbidity stress, as observed by their survivorship in such an active harbor environment.

As described in Section 2.4, the applicant has proposed BMPs (e.g., silt curtains) to contain re-suspended sediments in the immediate in-water work area during pile driving, dredging, excavation and other in-water construction activities to avoid spreading project-related, degraded water quality impacts to surrounding waters. In addition, the contractor would not conduct in-water construction activities that

would compound upon adverse water quality impacts resulting from periods of heavy rainfall when flow from the adjacent Kapalama Channel would likely introduce very high turbidity levels. .

Additionally, DOT-Harbors is seeking a water quality certification under Section 401 of the Clean Water Act from the State of Hawaii Department of Health, Clean Water Branch (DOH-CWB). In order to obtain such certification, all proposed actions would comply with State water quality standards and must implement necessary and appropriate monitoring and BMPs to curtail water quality impacts, as documented in the DOT-Harbors Applicable Monitoring and Assessment Plan that would be submitted to the DOH-CWB for approval.

Table 6 presents a summary of direct impacts to EFH with each Project phase.

<p>SUMMARY OF POTENTIAL ADVERSE AFFECTS ON EFH AND MUS FROM PLANNED ACTIVITIES ASSOCIATED WITH THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING PROJECT HONOLULU, OAHU, HAWAII</p> <p>ADVERSE EFFECT</p>	Project Phase							
		1	2	3	4	5	6	7
	Type of Impact	Waterline Installation	Demo Shoreline Facilities	Shoreline Bulkhead & Sand Island Bridge Scour Protection	Enclosing & Filling Snug Harbor, Rail Slip, & Pier 40F	Shoreline Excavation	Harbor Dredging	Offshore or Upland Disposal of Excess Dredged Material
Loss of man-made hard substrate habitat	Loss of Physical Habitat and MUS	N/A	P	P	P	N/A	N/A	N/A
Loss of natural hard substrate		N/A	P	P	N/A	P	N	N
Loss of natural soft substrate		N/A	N	N	P	N	P	N
Loss of biological assemblages colonizing hard substrate		N/A	S	S	S	S	N	N
Loss of biological assemblages colonizing soft substrate		N/A	N	S	P	N	S	N
Degraded water quality from phytoplankton blooms resulting from sediment plumes	Water Quality Degradation	N/A	N	N	N	N	N	N
Degraded water quality by generation of sediment plumes from in-water construction activities and construction vessel propeller wash		N/A	N	N	N	N	N	N
Decreased water quality from influx of petroleum products or toxic pollutants in groundwater		N/A	N	N	N	N	N	N
Decreased water quality from inadvertent construction wastes and discharges		N/A	N	N	N	N	N	N

Table 6. Summary of Direct Impacts to Essential Fish Habitat Associated with Each Project Phase

- 1) Partially replaced loss by installation of 3,190 linear feet of vertical sheet/king pile
- 2) Replace loss by excavation and dredging of 11,254 m² (2.78 acres) of EFH

P = Permanent or long-term adverse effects
S = Short-term adverse effects
N = No effects due to adequate design or BMP implementation
N/A = Not applicable

5.3 SUMMARY OF SHORT-TERM AND LONG-TERM / PERMANENT EFFECTS

Summary of potential adverse impacts of the proposed project on EFH and MUS are discussed in this section.

The extent of temporal impacts to EFH would be dependent upon the following factors:

- The intensity of the impact at the specific site being affected.
- The spatial extent of the impact relative to the availability of the habitat type affected.
- The sensitivity/vulnerability of the habitat to the impact.
- The habitat functions that may be altered by the impact (i.e. shelter from predators).
- The timing of the impact relative to when the species or life stage needs the habitat.
- The degree to which the adverse impacts would be avoided or minimized through BMP use.

Some impacts would be avoided or controlled through Project design modification, BMP implementation, or regulatory oversight and are considered negligible. Such impacts are described below.

- Turbidity would be controlled through the use of silt curtains during construction. The low energy environment within the harbor reduces the spread and movement of plumes by current or wave action. Water quality monitoring would measure effectiveness of silt curtains (turbidity control), required as part of the State Water Quality Certification, in accordance with Section 401 of the Clean Water Act.
- The existing Project area is suspected to harbor subgrade pollutants likely to include petroleum hydrocarbons or other potentially toxic substances. During excavation of the shoreline, when these pollutants would most likely be unearthed, absorbent booms (in addition to silt curtains) would be available for deployment to capture any floating hydrocarbons released during the process. The use of sealed-joint sheet/king piles should minimize the pollution threat from contaminants remaining inland of the new shoreline.

Short-Term Effects on EFH

Short-term effects result from actions that would cause temporary adverse impact to EFH or associated MUS, but that would be expected to substantially and naturally restore to pre-construction conditions within one year.

- Removal of the shoreline hard substrate (itself a permanent impact) would have a short-term effect on the fouling community inhabiting this shoreline. The fouling community would rapidly recolonize on the new substrate. The nature of the fouling community would develop and evolve to emulate the pre disturbance conditions.

- Removal of soft substrate would have a short-term effect on the infauna community inhabiting the substrate. Infauna communities are well-adapted to radical changes in substrate and would rapidly recolonize the dredged substrate.
- Mobile MUS (i.e. fish and crustaceans) trapped behind the constructed sheet/king pile walls would be lost. Most fish in the vicinity would swim away from areas of higher turbidity. Although unlikely, any lost individual MUS would be negligible to the managed fishery and would be expected to quickly recover.
- Impacts on water quality from the addition of nutrients or other growth factors would have temporary biological effects. Unlike particulate turbidity which settles out quickly, nutrients that leach from the sediment particles stay in the water column and would quickly be taken up by phytoplankton in the water. Because the harbor has a low rate of water turnover, an increase in nutrients has the capacity to result in a plankton bloom with possible indirect impacts. Such impacts would restore to equilibrium naturally.

Long-Term Effects on EFH

- A portion of the existing hard substrate, both natural shoreline and man-made structures would be replaced with the new KCT wharf face construction, however the final design would result in a net permanent loss of about 1,000 ft. of shoreline. Additionally, the shoreline would be replaced with nearly homogenous vertical relief and would remove all vertical diversity currently provided by existing pilings, deleterious concrete debris and other miscellaneous structures presently lining the Project area shoreline.
- Improvements in water quality due to the removal of polluted sediments presently on-site, the enhanced settling characteristics of the deepened harbor, and decreased pollutant inflow due to the enhanced storm water control features designed into the new wharf infrastructure would be expected.
- Loss of 205 sq. m. of small (<40 cm in diameter) corals that support MUS' within the Project area (171 sq. m on. natural substrate and 34 sq. m. on man-made vertical substrate). Corals would be expected to naturally recruit to replacement hard substrate.

6.0 PROPOSED MINIMIZATION AND OFFSET MEASURES

6.1 MINIMIZATION MEASURES INTERNAL TO THE PROJECT

It is DOT-Harbor's intent that a large majority of potential adverse impacts to EFH would be avoided or minimized through implementation of Project-specific BMPs before, during and post-construction. In addition, impact minimization measures incorporated into the Project design are intended to provide both immediate and long-term benefit to EFH in the harbor. Such benefits include:

- Use of lidded clamshell dredge buckets (“environmental buckets”) that ensure containment of dredged material to minimize potential for incidental fallback of dredged spoils and minimize degradation of water quality during dredging activities;
- Increasing the water depth and removing accumulated sediments resulting from dredging activities that would improve water clarity and reduce opportunity for resuspension of fine, potentially contaminated sediments; and
- Replacing the existing pier face with a sheet pile wall with sealed edge joints to eliminate permeability and reduce groundwater infiltration and pollution of harbor waters, and construction of stormwater treatment facilities atop the newly constructed KCT to control and manage stormwater discharges before entering the harbor.

6.1.1 Best Management Practices

A summary of the construction BMPS to be implemented to avoid and/or minimize adverse impacts to EFH are discussed in Section 2.4.

6.1.2 Coral Transplantation

Removing corals from the Project area and transplanting them to another site would be incorporated into the proposed action as an impact minimization measure. Two sites within the harbor have been provisionally selected as potential recipient sites. The transplantation plan (Appendix C) outlines the process for removal of 167 corals >40 cm diameter from the Project area that represents an area of 69 sq. m. In the event that some of the >40 cm corals cannot be transplanted, then the 69 sq. m. live coral transplantation goal may be met by transplanting corals from 21 to 40 cm size classes. The corals would be removed from the Project area prior to the start of in-water construction.

In early coordination meetings between DLNR-Division of Aquatic Resources (DLNR-DAR) and DOT-Harbors, DLNR-DAR supports a small scale effort to further Hawaii’s knowledge of transplantation efficacy using corals that DLNR-DAR expects to provide the greatest ecological value, fits DLNR-DAR’s criteria for transplantation, and has the greatest potential for survival. DLNR-DAR is in favor of supporting actions that offer high potential value and chance of success for long-term ecological gain. For this reason, DLNR-DAR believes that coral transplantation combined with offset measure efforts would provide greater ecological benefits to marine resources in Hawaii than only translocation. In addition, relocating all coral colonies in all size classes in the Project area to another site within the harbor would not meet such offset criteria. Accordingly, DLNR-DAR biologists recommended focusing transplanting efforts on those larger corals measuring >40 cm only, as opposed to smaller corals, for the following reasons:

- Ecological value of larger corals: The larger size class (>40 cm) is selected because theoretically and historically, larger coral colonies have been assigned more ecological value in terms of habitat, rugosity, shelter and volume of food they may provide. Larger colonies have been found to be more fecund, and thereby, capable of producing more gametes and contributing more reproductively to the ecosystem than smaller colonies (Hall and Hughes, 1996; Babcock, 1991).
- Reduce Risk of Alien Invasive Species (AIS) Introduction: Biologists from DLNR-DAR have expressed concern that the corals within the Project Area could be contaminated with non-native, invasive species and/or chemical pollutants due to their source from within the commercial harbor and based on prior surveys. The more colonies that are transplanted from this site (smaller colony size = more colonies transplanted), the higher the probability of introducing AIS to the recipient site. Therefore, limiting the number of coral colonies transplanted would reduce risk of introducing AIS to the recipient site. Divers can more accurately identify larger corals by their morphology and also more extensively assess presence of AIS attached to 167 large (>40 cm) colonies as opposed to >800 small (<40 cm) colonies.
- Long-Term Ecological Benefit: In addition to focusing transplantation efforts on the larger colonies, with low AIS risk, DLNR-DAR biologists recommend combining this minimization measure with additional offset measures such as out-planting corals produced by DLNR-DAR's coral nursery and invasive algae control via urchin biocontrol to achieve long term ecological benefits for Hawaii's resources.

The transplantation quota is based both upon the total area and the coral size class of coral that could be directly affected within the Wharf and Dredge project footprint. All corals provide functional value to the ecosystem, but larger corals provide greater value, as discussed above. This value is often related to the area of the individual coral colony. Only the largest dimension (or dimension bin category) was recorded for each coral during the aquatic survey. Using this diameter to calculate the area as a circle provides a conservative over-estimate of true coral area. For small corals, this method likely results in reasonable estimates. However, as corals grow larger, their shape often deviates from that of a circle, and the calculated area can be larger than the actual coral area. To avoid this as much as possible, loss of coral coverage area within the Project Area, as well as the area covered at the transplantation sites were calculated using the dimension given in the survey reports.

Coral recipient site selection criteria:

- Sites closer to the Project area are preferred to those more distant. Recipient sites within 1-mile of an impact site are generally considered to constitute “on-site” mitigation. More distant sites require more logistics in transportation and may result in greater mortality.
- The site selected to receive corals should remain undisturbed by development activity into the foreseeable future to promote growth and stabilization. It does not make sense to transplant corals to a site that might not be left intact for the future.
- Coral colonies in Honolulu Harbor likely support alien flora and fauna (AECOS, 2014). Minimizing contamination from source to any recipient site should be an important factor in recipient site selection.
- The water dynamics at the recipient site should be similar to the low surge, low energy regime under which the corals grew in the Project area.
- The water quality at the recipient site should equal or exceed the water quality at the Project area.
- The depth of water available at the recipient site should allow for a similar depth range as that of the Project area.
- Sufficient space should be available to provide an optimum separation between transplanted specimens to avoid detrimental interactions.
- Acceptable to controlling government agency (USACE, DOH , DOT-Airports, DLNR)
- Availability of site to DOT-Harbors (e.g. land ownership, permissions, etc.)

The invasive species requirement limits the potential transplantation sites to those within the harbor. The sites discussed below generally meet the above criteria. Further biological evaluation is needed to determine whether the sites have appropriate water quality, acceptable levels of wave action, and have sufficient space. Other than a general knowledge of site conditions and casual underwater observations, the sites have not been analyzed for substrate suitability, stability or invasive species characterization. Potential candidate coral recipient sites (see Figure 10) within the harbor meeting the criteria listed above include:

- **AFRC Revetment**
The AFRC recipient site consists of approximately 1,000 feet of shoreline, extending from the AFRC to the shoreline observation deck located in the Sand Island State Recreation Area (Figure 6). This revetment is outside of the Federal project line and might not be impacted by future dredging activities. The revetment is a USACE designed structure and would therefore require a Section 408 permit to authorize the addition of coral to the structure. The smooth surface and basaltic nature of these boulders are not conducive to larval settlement, but once established, corals along this

shoreline appear to grow well. The proximity of the recipient site to the State's coral culture laboratory at the AFRC should simplify the post-transplantation monitoring at this site. A marine biota census and detailed investigation of this 1,000-foot shoreline will need to be conducted prior to transplanting any corals. USACE Section 408 permitting process will have to be completed before transplanting is implemented. In addition, input from the USACE (civil) branch should be obtained for use of this site for coral transplanting.

- Pier 5-6 Area

The Pier 5-6 area is similarly located within Honolulu Harbor and outside the Federal project line (Figure 6). The sizes of revetment rocks along the slope are smaller than those located along the Anuenue revetment, but do support the growth of corals as observed during casual in-water observation. No preliminary survey has yet been conducted at this site. A marine biota census and detailed investigation of this shoreline will need to be conducted prior to transplanting any corals.

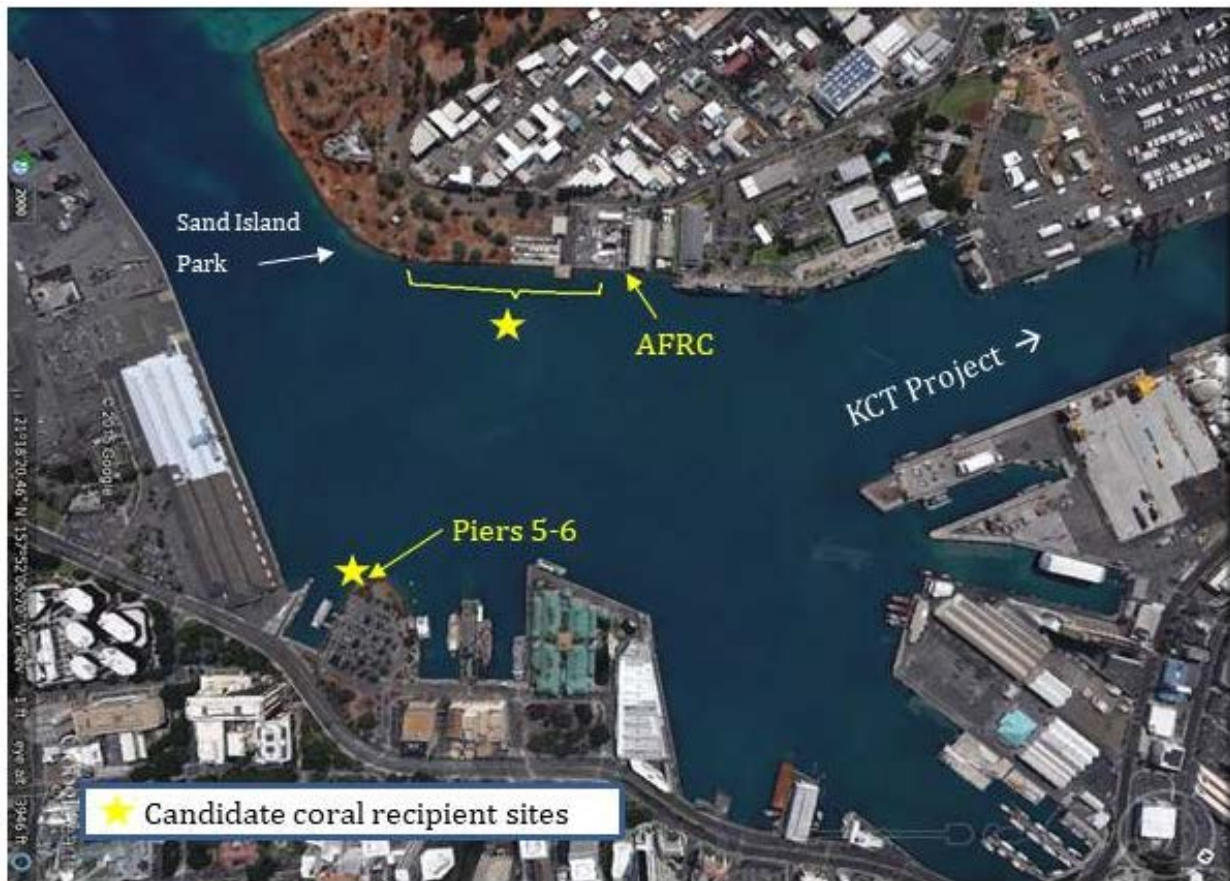


Figure 10. Candidate Coral Recipient Sites in Honolulu Harbor

6.2 APPLICANT'S PROPOSED OFFSET MEASURES FOR UNAVOIDABLE IMPACTS

This section of the report discusses the potential types and quantities of measures to offset adverse effects to EFH. The specific offset measures selected would be further defined through discussion with the USACE and Federal and State Resource Agencies. Offset measures for habitats, water column and MUS are addressed in this section.

6.2.1 Offset Considerations

The EFH coral reef FMP (WESTPAC, 2009) suggests the following opportunities to offset unavoidable adverse effects that would conserve or enhance EFH to increase yields of MUS by:

- Restoration or enhancement of river, stream, or coastal area watersheds
- Improvements in water quality or quantity to ensure that water quality standards are met, such as:
 - Improved sewage treatment
 - Proper disposal of waste material
 - Maintenance of sufficient in-stream flow to estuaries
- Restoration or creation of habitat

The United States Coral Reef Task Force (USCRTF) was established in 1998 by Presidential Executive Order 13089 to lead U.S. efforts to preserve and protect coral reef ecosystems. USCRTF identified a portfolio of compensatory mitigation and restoration options (Draft Handbook on Coral Reef Impacts) and a list of BMPs that could be implemented to offset adverse impacts on coral reef communities from development projects.

The USCRTF list was reviewed and screened for appropriateness to the anticipated project impacts, ability to successfully implement, and impacts already minimized by project specific BMPs. Offsets proposed for further consideration for this project are listed below.

- Water quality improvements
 - Storm water BMPs
- Coral response and rescue team
 - Movement of at-risk corals from a project area
- Offsite placement of structures to enhance substrate
 - Placement of material that mimics natural coral reef structure
 - Deposition of boulders or other artificial material
 - Placement of artificial reef modules
 - Deposition of coarse dredge spoil

- Nuisance species removal
 - Removal of nuisance or invasive algae species
 - Super sucker removal of invasive algae
- Active coral population enhancement, propagation, and out-planting
 - Land based propagation – aquaria

To offset adverse impacts resulting from the proposed action DOT-Harbors is proposing such measures occur either on-site, within 1-mile of the Project Area or within the same watershed. Offset measures proposed within the harbor are not preferred as the marine environment, by nature, is comparatively degraded as a result of the high commercial activity within and adjacent to the harbor that is compounded by surrounding urban development. Offset opportunities located in nearby areas beyond the influence of the harbor environment are assumed to yield a greater ecological return on investment.

6.2.2 Selected Offset Measures

Based on a review and consideration of the possible offset measures presented in the CREMUS FMP (2009) and identified by the USCRTF, DOT-Harbors determined the following measures would be appropriate (reasonable and practicable) to offset for unavoidable adverse impacts to EFH resulting from the Project:

I. Financial support for the sea urchin hatchery program at the State of Hawaii DLNR-DAR AFRC.

To offset for the permanent loss of 305 m. (1,000 ft.) of shoreline and consequential loss of 5,710 sq. m. (1.4 acres) of natural hard substrate EFH, DOT-Harbors proposes to enhance nearby, naturally occurring hard substrate by providing financial support to the sea urchin hatchery at the State of Hawaii DLNR-DAR AFRC. DOT-Harbors would dictate that such financial assistance would be used specifically to fund outplanting urchins to a reef of an equivalent area (1.4 acres) to remove nuisance and invasive algae and expose natural substrate. A possible candidate site includes the Waikiki MLCD and other sites determined to be appropriate for urchin outplanting that are sufficiently protected to ensure long-term efficacy of the offset. This effort would require program coordination development with others (e.g. DLNR and the private sector). The amount of funding necessary to offset the loss would be determined in coordination with DLNR-DAR.

II. Financial support for the invasive algae removal program at the State of Hawaii DLNR-DAR AFRC.

To offset for the short-term loss of the 11,844 sq. m. (2.9 acres) of biological assemblages associated with the loss of hard substrate, DOT-Harbors

proposes to facilitate recruitment of such a biological assemblage to nearby, naturally occurring hard substrate by providing financial support to the State of Hawaii DLNR-DAR invasive algae removal program. DOT-Harbors would dictate that such financial assistance would be used specifically to fund a one-year algae removal project over an equivalent area (2.9 acres) of shallow back-reef areas. A possible candidate site includes the Waikiki MLCD, and other sites determined to be appropriate for urchin outplanting that are sufficiently protected to ensure long-term efficacy of the offset. This effort would require program coordination development by others (e.g. DLNR and the private sector). The amount of funding necessary to offset the loss would be determined in coordination with DLNR-DAR.

III. Financial support for the coral reef hatchery program at the State of Hawaii DLNR-DAR AFRC.

To offset long-term (estimated 7 years) loss of 171 sq. m. of smaller (<40 cm) corals that provide habitat that supports MUS in the harbor associated with the loss of natural substrate (not on piles or sheet piles), DOT-Harbors proposes to provide financial support for the coral reef hatchery at the State of Hawaii DLNR-DAR AFRC. The amount of funding necessary to offset the loss would be determined in coordination with DLNR-DAR.

6.2.3 Support of DLNR-DAR's sea urchin hatchery (offset for long-term loss of hard substrate)

The key to maintaining low levels of invasive algae is the presence of native herbivores. Therefore, native Hawaiian collector urchins (*Tripneustes gratilla*) are spawned and raised in captivity at the DLNR-DAR's Anuenue Fisheries Research Center. They are propagated as a biological tool to fight invasive alien seaweeds from reef areas throughout Hawaii.

Urchin out-planting works in conjunction with manual removal. Manual removal is an effective means of reducing invasive algae over short periods, but the use of sea urchin biocontrol provides long term results to control and limit algae re-growth. Invasive seaweed may be removed from the coral reef initially by hand or mechanical means. To ensure the seaweed does not grow back, urchins are introduced to the cleared area to eat any re-growth. A strong population of native herbivores is necessary to counteract the invasive seaweed to ensure success of the removal. Removal of algae from benthic substrate creates available substrate for recruitment and/or coral colonization.

To offset the long-term permanent loss of EFH hard substrate in the Project area (5,710 sq. m., 1.4 acres, associated with the loss of 305 m of shoreline), a negotiated amount of financial support would be provided to DLNR-DAR Sea Urchin Hatchery for urchin reproduction and outplanting efforts over an equivalent

area. Support for this program would be balanced with any efforts associated with offsets for the long-term loss of hard substrate.

6.2.4 Removal of invasive algae from reefs (offset for short-term loss of biological assemblage)

Shallow back-reef areas do not support large quantities of corals, but do support a wide diversity of organisms. The MLCD off Waikiki Aquarium would be a suitable site for this action (Figure 11). To offset the short-term loss of the fouling community biological assemblage within the Project area associated with the loss of 2.9 acres of hard substrate, an equivalent area would be financially supported in an established invasive algae removal program. To accomplish this objective, shallow reef areas would be suitable.

This reef restoration effort would remove invasive algae from an important shallow reef habitat thereby allowing an increase in diversity as native algae and invertebrates recolonize the reef. Algae removal could be accomplished by sea urchins, which could perform the same function as other removal methods (physical/mechanical). Urchins are produced at the DAR Anuenue Sea Urchin hatchery and can be outplanted at the Waikiki MLCD and/or other sites determined to be appropriate for urchin outplanting.

This measure would support the efforts of researchers to document the subsequent changes to this ecosystem for a one-year period. One or two years including researcher's efforts would span the time anticipated for recovery of fouling community (MUS) in the Project area.



Figure 11 Area Fronting the Waikiki Aquarium suitable for invasive algae removal (offset for short-term loss of biological assemblage).

6.2.5 Support of DLNR-DAR's coral stewardship programs (offset for long-term loss of 56,691 corals <40 cm in diameter [171 sq. m.]

Of the 82,324 corals to be impacted by the project, 82,157 (205 sq. m.) are <40 cm in diameter and are not likely to be transplanted. Of these, 25,467 (34 sq. m.) are affixed to man-made substrates, and 56,691 (171 sq. m.) are affixed to natural substrates (not on piles or sheet piles), and would be lost. Corals growing opportunistically on vertical, non-carbonate, man-made structures do not constitute a coral reef or other designated EFH and accordingly would not be offset.

To offset the unavoidable loss of 56,691 (171 sq. m.) <40 cm corals colonizing the Project Area seafloor, a negotiated amount of financial support would be provided to DLNR-DAR Coral Stewardship Program at the AAFRC for coral reproductive and restoration research. The coral nursery aims to use professional-level coral husbandry techniques to grow small fragments of a coral colony, recombine them into large colonies, and then transplant them into the field in a fraction of the time it would take these corals to grow naturally. The nursery primarily uses corals for transplantation from harbors. The Coral Restoration Nursery provides coral colonies for multiple restoration projects, which primarily focus on near-shore coral reef resources. Support for this program would offset long term losses of <40 cm corals from the Project area by replacing such resources throughout Hawaii.

7.0 DETERMINATION OF EFFECT

The Project would involve discharges of dredged and fill material into waters of the U.S. and permanently converting 2.49 acres of waters of the U.S. to uplands and the discharge of fill material into waters of the U.S. to construct a rock revetment in 0.10 acres of waters of the U.S. (Section 404). The Project would include upland excavation and dredging over 8.13 acres of waters of the U.S. and permanently converting 2.78 acres of uplands to waters of the U.S. (Section 10). Finally, the Project would involve the transport of dredged material for the purpose of ocean disposal at the SOODMDS (Section 103).

Substrate would be permanently lost resulting in a reduction in quantity of EFH. Water quality within the Project Area would be temporarily degraded resulting in a reduction in quality of EFH. The direct adverse effect to EFH from dredge and fill-related loss of substrate would be partially offset by introducing alternate soft and hard substrate through construction of the new KCT wharf face. Colonization of the new substrate is expected to take up to one year for the fouling community and up to seven years for corals growing on the new sheet-pile substrate to recover the loss of all corals <40 cm in diameter. The indirect adverse effect to EFH from

project related degradation of water quality would be minimized through implementation of appropriate silt-containment BMPs.

Direct beneficial effect to EFH from dredge activities includes removal of accumulated fine sediments that could be re-suspended by normal harbor activity (i.e. prop wash) and increasing the resident time in the Project area by increasing depths and water volume. The sealed pile wall construction would indirectly benefit EFH by restricting groundwater infiltration and improving water quality. Installation and implementation of stormwater treatment systems at KCT would indirectly benefit EFH by improving water quality.

Unavoidable impacts to habitat that supports MUS' would be minimized through implementation of the proposed coral transplantation plan. Unavoidable impacts to substrate and associated biological assemblages would be offset through financial support of substrate and coral reef enhancement programs facilitated by the DLNR-DAR.

The Corps has determined that these activities and their resulting impacts, as described in the preceding sections, would reduce the quantity and quality of EFH, and accordingly would adversely affect EFH for BMUS, CMUS, CREMUS and PMUS within Honolulu Harbor. However, due to the containment of impacts to the Honolulu Harbor, the comparatively low quality of the EFH within the harbor, the size and scale of the impacts in comparison to the seemingly infinite expanse of EFH throughout the Pacific, the expected beneficial offsets resulting from the project design, implementation of temporary and permanent avoidance and minimization measures built into the project and a combination of coral transplantation and proposed offset measures, the Corps has determined that the anticipated adverse effects do not have the potential to cause substantial adverse effects to EFH.

8.0 REFERENCES

- AECOS. 2011. Lahaina Small Boat Harbor Ferry Terminal Improvements Compensatory Mitigation Plan for Impacts to Waters of the U.S. AECOS Report No. 1045F.
- _____. 2012. Kaunakakai Ferry System Improvements Coral Transplantation Plan AECOS Report No. 1211B.
- _____. 2013. Kawaihae Small Boat Harbor Phase I Improvements Coral Transplantation Implementation Plan AECOS Report No. 1182D.
- _____. 2013. Maalaea Small Boat Harbor Ferry Pier Coral Transplantation Plan AECOS Report No. 1080D.
- _____. 2013. Manele Small Boat Harbor Coral Transplantation Plan AECOS report No. 1353.
- _____. 2014. Baseline Assessment for Kapalama Container Terminal Improvements. Report No. 1354B.
- Andrea, D. Shulker, 2003. State of Hawaii Aquatic Invasive Species Management Plan; Final Version. Hawaii Division of Aquatic Resources.
- Babcock, R. C. 1991. Comparative Demography of Three Species of Scleractinian Corals Using Age- and Size-Dependent Classifications. *Ecological Monographs*, 61: 225–244.
- Bentivoglio, A. 2003. Compensatory mitigation for Coral Reef Impacts in the Pacific Islands. U.S. Fish and Wildlife Service, Honolulu, Hawaii. URL: <http://www.coralreef.gov/mitigation/pacmit.pdf> .
- Birkeland, C., Randall, R.H., and Grimm, G., 1979. Three Methods of Coral Transplantation for the Purpose of Reestablishing a Coral Community in the Thermal Effluent Area at the Tanguisson Power Plant. University of Guam Marine Lab Technical Report 60.
- Calfo, A. 2007. Book of Coral Propagation. Reef Gardening for Aquarists. (6th edition) 400pp Reading Trees Publication.
- Carlson, B. 1978. Director of Waikiki Aquarium. Personal Communication. First culture of corals in Public Aquaria occurred at Waikiki Aquarium in 1978.
- Coral Reef Magazine 1999 (in German), 2006. (First edition in English,) The Reef Marine Aquarium Magazine. <http://www.coralmagazine.com/about-us.html>.
- Edwards, A.J., and S. Clark, 1999. Coral Transplantation: A Useful Management Tool or Misguided Meddling? *Mar. Pol. Bull.* 1999, 474.

- Edwards, A.J. (ed.) 2010. Reef Rehabilitation Manual. Coral Reef Targeted Research & Capacity Building for Management Program: St. Lucia, Australia.
- Gorman, John. Personal communication. Curator at the Maui Ocean Aquarium. Responsible for implementation of coral transplantation for DOBOR Lahaina, Maalaea, Manele Bay, coral transplantation projects.
- Gulf of Mexico Fishery Management Council 2013. "Fixed Petroleum Platforms and Artificial Reefs as Essential Fish Habitat". Options Paper Generic Amendment Number 4 to Fishery Management Plans in the Gulf of Mexico.
- Hall, V. R. and Hughes, T. P. 1996. Reproductive Strategies of Modular Organisms: Comparative Studies of Reef- Building Corals. *Ecology*, 77: 950–963.
- Hawaii Department of Health. 2014. State of Hawaii Water Quality Monitoring and Assessment Report: Integrated Report to the U.S. Environmental Protection Agency and the U.S. Congress Pursuant to §303(d) and §305(b), Clean Water Act (P.L. 97-117). 123 pp.
- Kai Tak, 2009. Site formation for Kai Tak Cruise Terminal Development Detailed Coral Translocation Plan. Available at: <http://www.epd.gov.hk/eia/register/english/permit/ep3282009/documents/ctp/pdf/ctp.pdf>.
- Maragos, J.E., 1974. Coral transplantation, a method to create, preserve and manage coral reefs. University of Hawaii Sea Grant Publication UNIH SEAGRANT AR-74-03.
- Marine Research Consultants, Inc. (MRC). 2012. Water quality results for Honolulu Harbor.
- Minton, D., 2013. Growth rate of Hawaiian corals, a review. NOAA Technical Report.
- MRC, 2012. (Marine Research Consultants) Essential Fish Habitat Consultation: Waterfront Operations Facility Boat Ramp Replacement Marine Corps Base, Hawaii. In: USACE Public Notice January 17, 2013. File No. POH-2013-00138 URL: <http://www.poh.usace.army.mil/Portals/10/docs/publicnotices/POH-2013-00138.pdf>.
- _____. 2015. Preconstruction Monitoring Report Applicable Monitoring and Assessment Plan (AMAP) Water Quality for Honolulu Harbor Pier 12 & 15 Improvements. April 2015 report prepared for Hawaii Harbors Constructors JV.
- Namba, 2004. NPDES Water Quality Monitoring Report for construction at Pier-39. DOT-Harbors.
- Neilsen, A. J., and S. A. Fossa 1991. Korallenriff Aquarium Book 1.

- NOAA; Vargas-Angel, personal communication 2015, Dr. Vargas-Angel provided data summaries of the NOAA Main Hawaiian Islands hard bottom benthic survey results.
- Precht, W.F. (ed) 2006. Coral Reef Restoration Handbook. CRC Press, Boca Raton 363 pp.
- Ulrich, A.B. 2015. How to Frag Corals. A simple guide to coral propagation and coral fragging. ASIN BOOROD4OUW 211pp.
- U.S. Army Corps of Engineers, Honolulu District (USACE HD). May 6-7, 2011. FY11 Hydrosurveys, Honolulu Harbor Hydrographic Survey, Oahu, Hawaii. Depths taken from hydrographic survey completed by U.S. Army Corps of Engineers, Portland District, on 6 May 2011.
- United States Congress: *Sustainable Fisheries Act*. 104th Cong. Cong 104-297.. Print.
- Western Pacific Regional Fishery Management Council, 2001. *Final Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region*. Available online at URL: <http://www.wpcouncil.org/wp-content/uploads/2013/03/COMPLETE-CRE-FMP-CD.pdf>
- _____. 2009a. *Fishery Ecosystem Plan for the Hawaii Archipelago*. Honolulu, HI: N.P., 2009. Available online at URL: [http://www.wpcouncil.org/fep/WPRFMC%20Hawaii%20FEP%20\(2009-09-21\).pdf](http://www.wpcouncil.org/fep/WPRFMC%20Hawaii%20FEP%20(2009-09-21).pdf).
- _____. 2009b. *Fishery Ecosystem Plan fo the Pacific Pelagic Fisheries of the Pacific Region*. Available online at URL: [http://www.wpcouncil.org/fep/WPRFMC%20Pelagic%20FEP%20\(2009-09-21\).pdf](http://www.wpcouncil.org/fep/WPRFMC%20Pelagic%20FEP%20(2009-09-21).pdf).
- _____. 2016. *Amendment 4 to the Fishery Ecosystem Plan for the Hawaii Archipelago*. Revised Descriptions and Identification of Essential Fish Habitat and Habitat Areas of Particular Concern for Bottomfish and Seamount Groundfish of the Hawaiian Archipelago. Available online at URL: http://www.fpir.noaa.gov/SFD/pdfs/feps/Hawaii_Amendment_4.pdf.

APPENDIX A

Reduced-Sized Plans Showing Phasing of Wharf and Dredging Project

APPENDIX B

**AECOS 2014 Baseline Assessment for Kapalama Container Terminal
Improvements**

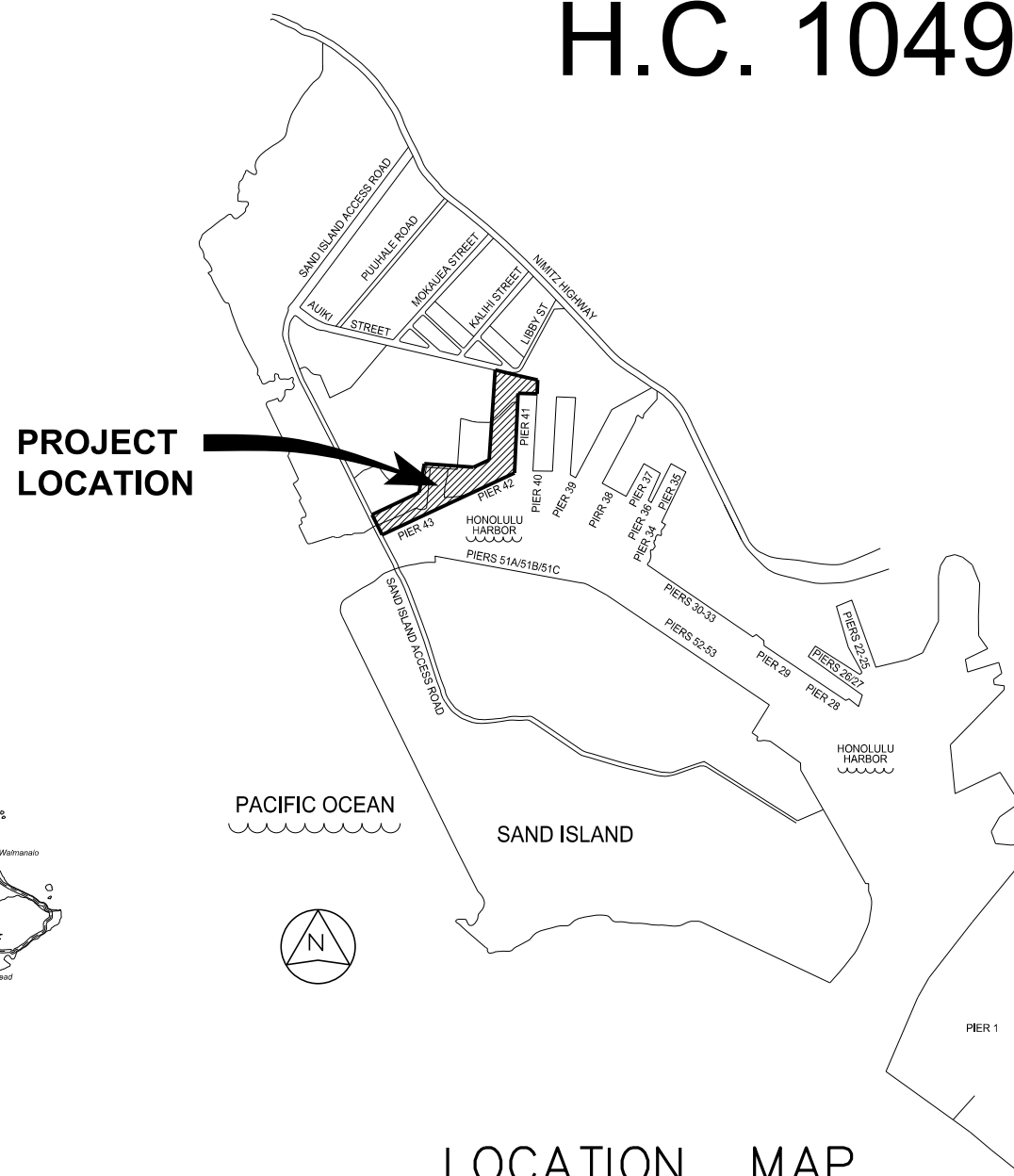
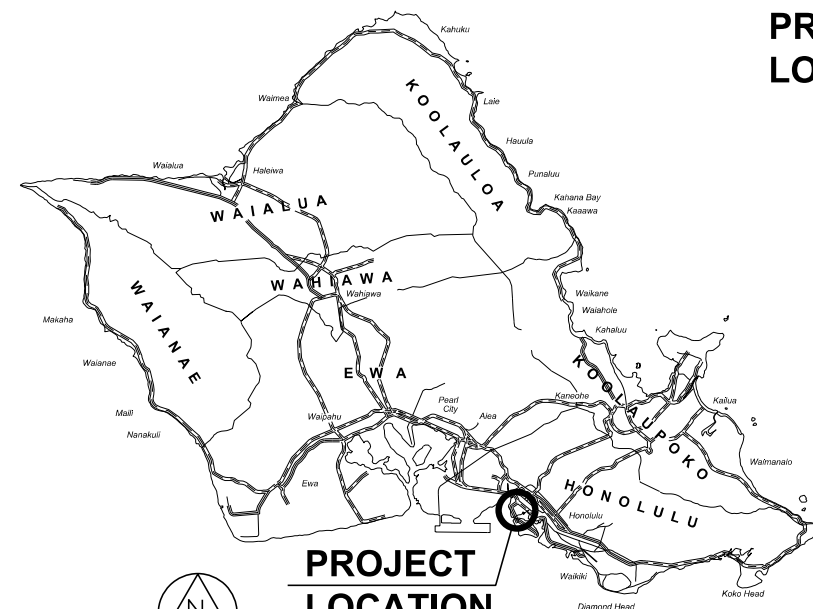
APPENDIX C
Coral Transplantation Plan

THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING

HONOLULU HARBOR, OAHU, HAWAII

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION

H.C. 10498



CONSULTANTS:

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808-533-7000

SEA ENGINEERING, INC.
MAKAI RESEARCH PIER
41-305 KALANIANA'OLE HIGHWAY
WAIMANALO, HAWAII 96795

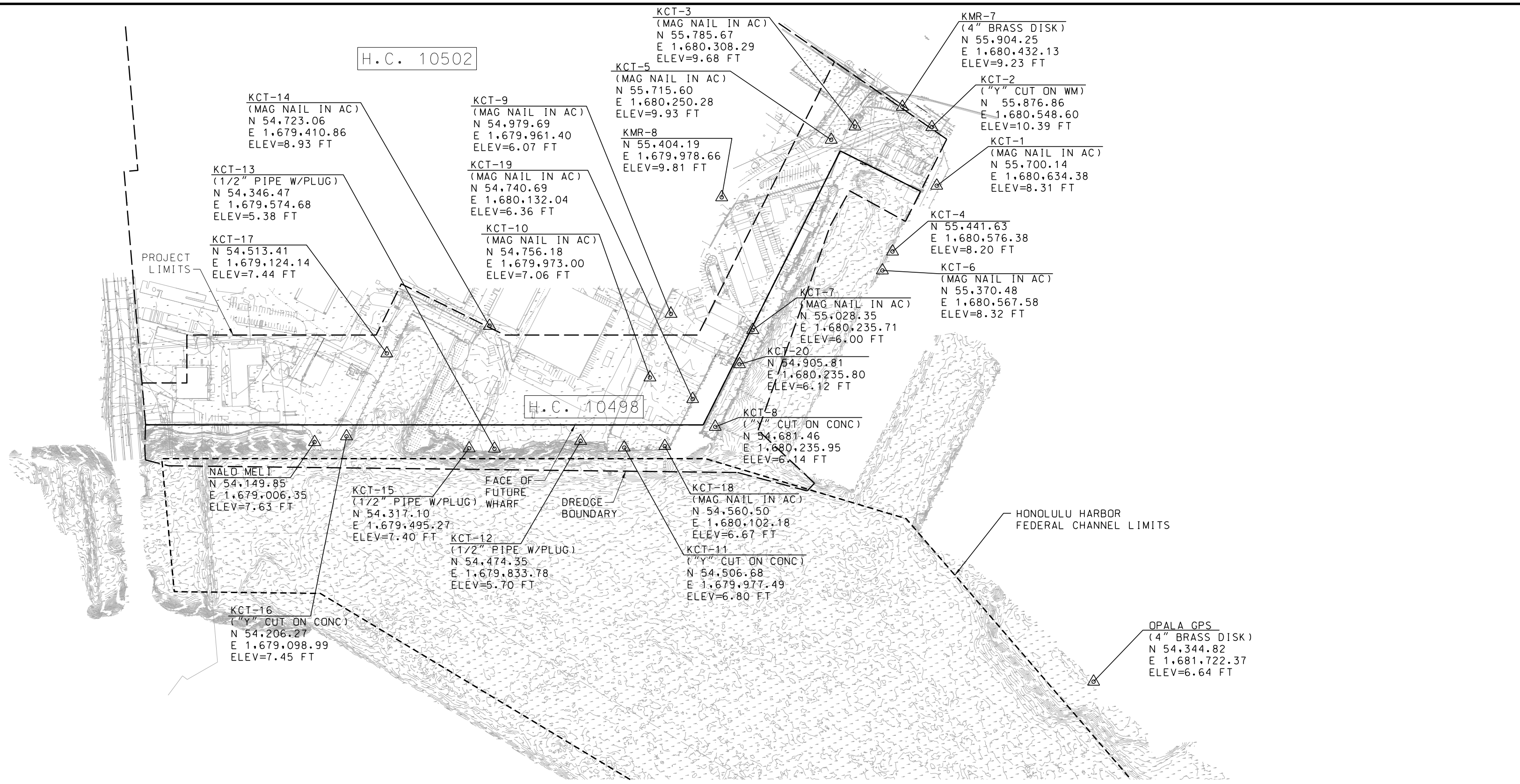
SAM O. HIROTA, INC.
864 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96813

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering
17800 NEWHOPE STREET, SUITE B
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GEOLABS, INC.
2006 KALIHI STREET
HONOLULU, HAWAII 96819

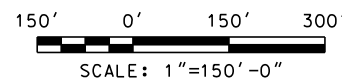
MK ENGINEERS, LTD.
286 KALIHI STREET
HONOLULU, HAWAII 96819

DEPARTMENT OF TRANSPORTATION STATE OF HAWAII	
APPROVED BY:	
_____ DIRECTOR OF TRANSPORTATION	_____ DATE
CITY AND COUNTY OF HONOLULU	
APPROVED BY:	
_____ DIRECTOR, DEPARTMENT OF PLANNING AND PERMITTING (FOR WORK WITHIN THE CITY R/W AND EASEMENTS ONLY)	_____ DATE
_____ MANAGER AND CHIEF ENGINEER, BOARD OF WATER SUPPLY (FOR WORK AFFECTING BWS FACILITIES IN CITY/STATE R/W AND BWS EASEMENTS ONLY)	_____ DATE
POH-2012-00081	



SURVEYOR'S NOTES

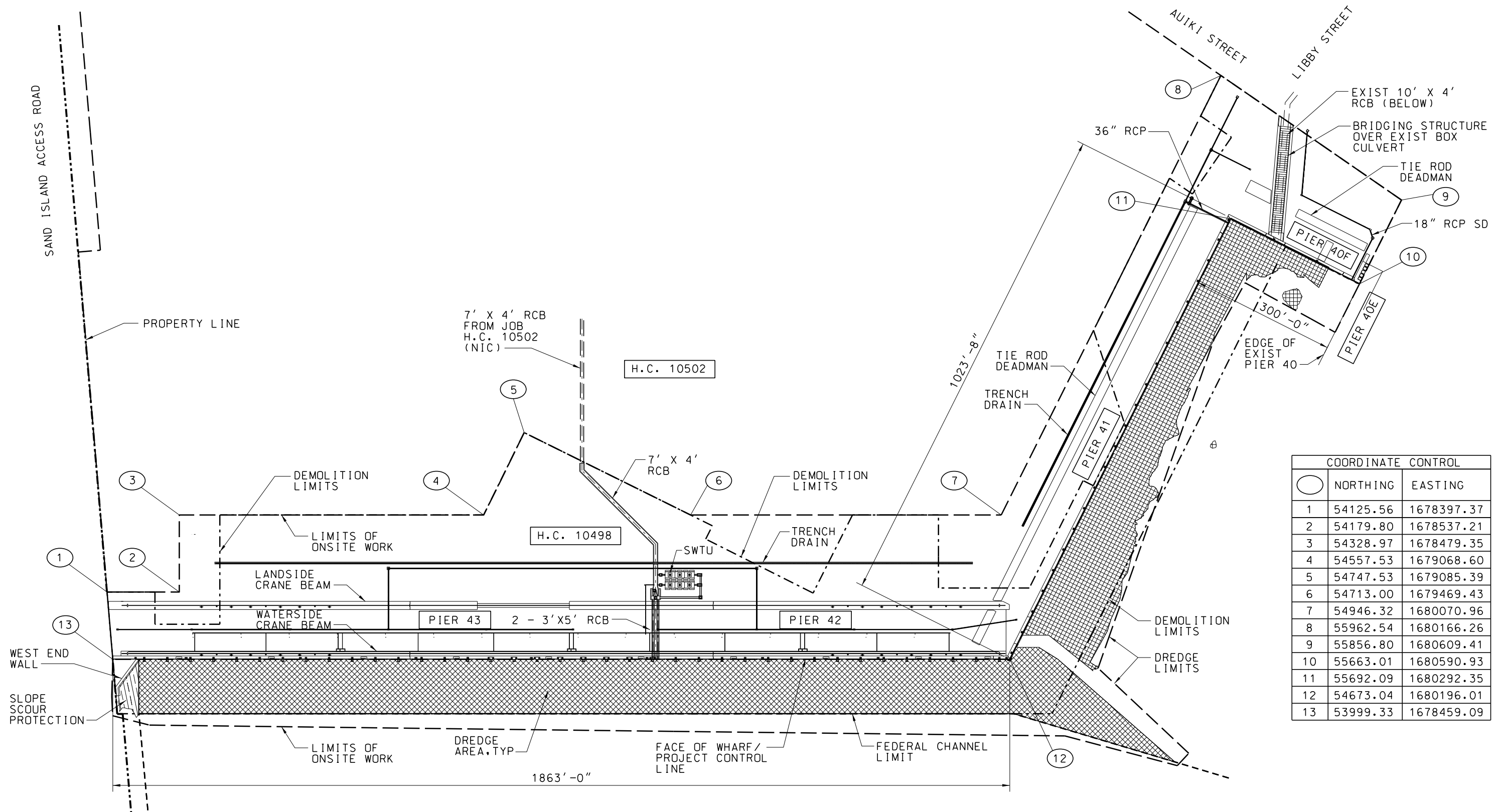
- COORDINATES AND AZIMUTHS ARE REFERRED TO HAWAII STATE PLANE, ZONE 3, NAD 83.
- ELEVATIONS ARE REFERRED TO BENCHMARK "OPALA", ELEVATION = 6.64 FT MEAN LOWER LOW WATER, LOCAL DATUM.
- TOPOGRAPHIC SURVEY WORK HAS BEEN CONDUCTED BY SAM O. HIROTA, INC. ON MARCH 9, 2013 THROUGH APRIL 30, 2013. FIELD BOOKS 1650:02, 1656:01, 1662:02.
- TOPOGRAPHIC SURVEY CONSISTS OF GROUND SURVEY CONDUCTED BY SAM O. HIROTA, INC. AND AERIAL SURVEY PROVIDED BY R.M. TOWILL, CORP. PORTIONS WITHIN "LIMITS OF RM TOWILL SURVEY" ARE SUPPLEMENTED WITH SAM O. HIROTA, INC. GROUND SURVEY.
- BATHYMETRY DATA HAS BEEN PROVIDED BY SEA ENGINEERING, INC. ON FEBRUARY 22-24, OF 2013 AND ON MARCH 5, 7, 15, OF 2013.
- EXISTING UNDERGROUND UTILITIES SHOWN ON ALL PLANS HAVE BEEN OBTAINED FROM AVAILABLE SOURCES AND HAVE BEEN SHOWN FOR GENERAL INFORMATION. THE ACCURACY AND COMPLETENESS OF THIS INFORMATION ARE NOT GUARANTEED. IT IS THE CONTRACTOR'S RESPONSIBILITY TO IDENTIFY ALL UTILITIES.



Appendix A: Reduced-Sized Plans Showing Phasing of Wharf and Dredging Project

LICENSE EXPIRATION DATE: THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.		<table border="1"> <thead> <tr> <th>REVISION</th> <th>DATE</th> <th>DESCRIPTION</th> <th>BY</th> <th>APPROVED</th> </tr> </thead> <tbody> <tr> <td colspan="5" style="text-align: center;"> STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION </td> </tr> <tr> <td colspan="5" style="text-align: center;"> JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU </td> </tr> <tr> <td colspan="5" style="text-align: center;"> SHEET TITLE SURVEY CONTROL AND BENCHMARK </td> </tr> <tr> <td colspan="2">SUBMITTED BY:</td> <td colspan="3">RECOMMENDED BY:</td> </tr> <tr> <td colspan="2">DESIGNED BY: VS</td> <td colspan="2">APPROVED BY:</td> <td>SHEET</td> </tr> <tr> <td colspan="2">DRAWN BY: WS</td> <td colspan="2">HARBORS ADMINISTRATOR</td> <td rowspan="3" style="text-align: center; vertical-align: middle;"> G-101 12 OF 259 SHEETS </td> </tr> <tr> <td colspan="2">CHECKED BY: DC</td> <td colspan="2">JOB NUMBER</td> </tr> <tr> <td colspan="2">DATE: 1/9/2015</td> <td colspan="2"> H.C. 10498-00081 </td> </tr> <tr> <td colspan="2">SCALE: AS SHOWN</td> <td colspan="3"></td> </tr> </tbody> </table>		REVISION	DATE	DESCRIPTION	BY	APPROVED	STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					SHEET TITLE SURVEY CONTROL AND BENCHMARK					SUBMITTED BY:		RECOMMENDED BY:			DESIGNED BY: VS		APPROVED BY:		SHEET	DRAWN BY: WS		HARBORS ADMINISTRATOR		G-101 12 OF 259 SHEETS	CHECKED BY: DC		JOB NUMBER		DATE: 1/9/2015		H.C. 10498-00081		SCALE: AS SHOWN				
REVISION	DATE	DESCRIPTION	BY	APPROVED																																															
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION																																																			
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DRAWN BY: WS		HARBORS ADMINISTRATOR		G-101 12 OF 259 SHEETS																																															
CHECKED BY: DC		JOB NUMBER																																																	
DATE: 1/9/2015		H.C. 10498-00081																																																	
SCALE: AS SHOWN																																																			

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COORDINATE CONTROL		
	NORTHING	EASTING
1	54125.56	1678397.37
2	54179.80	1678537.21
3	54328.97	1678479.35
4	54557.53	1679068.60
5	54747.53	1679085.39
6	54713.00	1679469.43
7	54946.32	1680070.96
8	55962.54	1680166.26
9	55856.80	1680609.41
10	55663.01	1680590.93
11	55692.09	1680292.35
12	54673.04	1680196.01
13	53999.33	1678459.09

PROJECT PLAN
SCALE: 1"=100'-0"

SCOPE OF WORK:

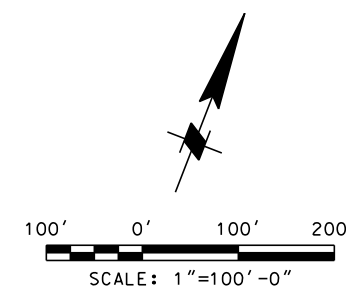
PROJECT INCLUDES DEMOLITION OF ABOVE AND BELOW GROUND STRUCTURES AND FACILITIES, FILLING AND DREDGING, AND CONSTRUCTION OF WHARF AREA OF PIER 40F, 41, 42 AND 43, AS SPECIFIED IN THE SPECIFICATIONS AND AS SHOWN IN THIS SET OF DRAWINGS.

NOTE:

FOR COORDINATES OF DEMOLITION LIMITS SEE SHEET CD101.

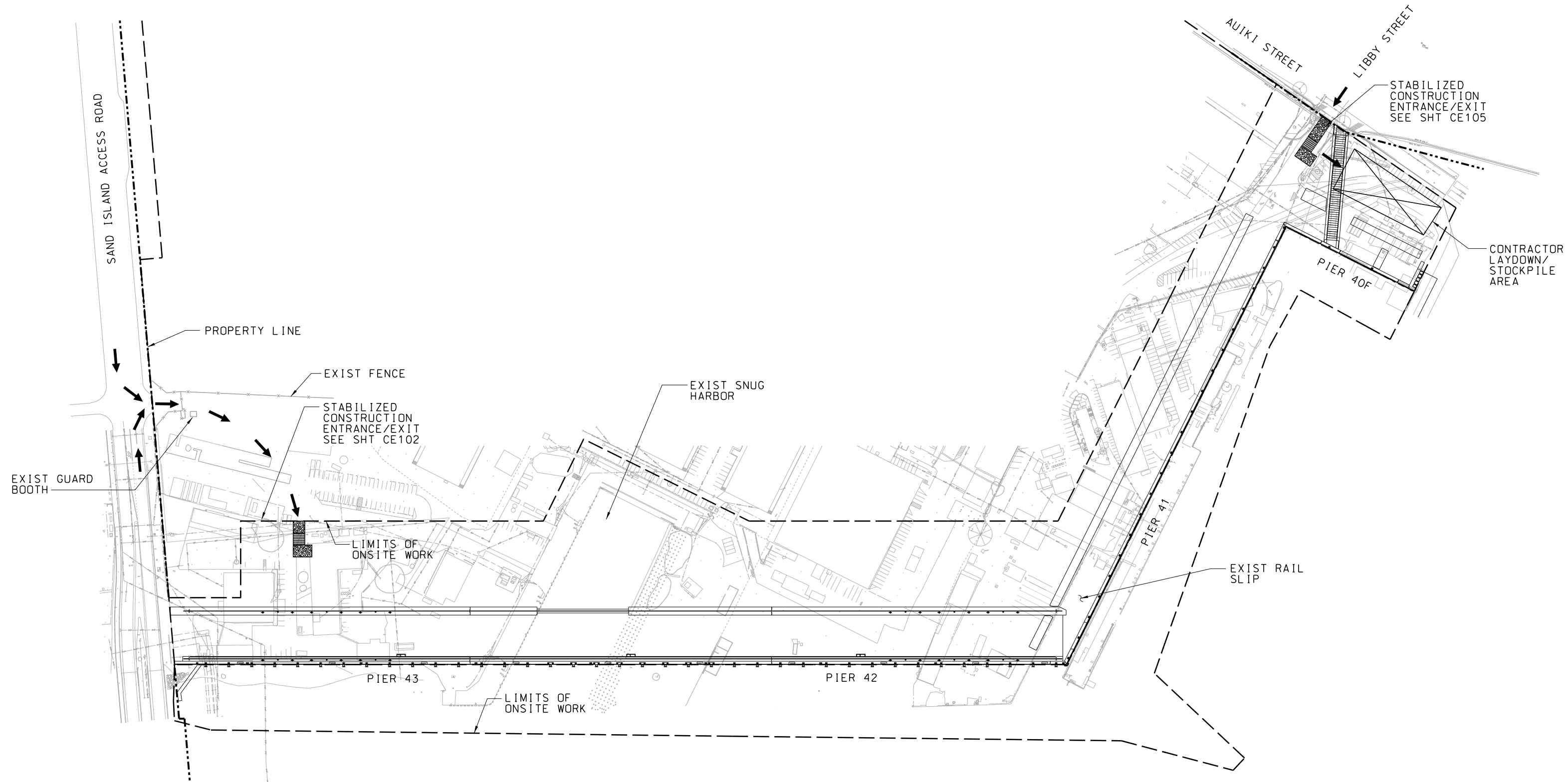
NOTE:

JOB H.C. 10502, REFERENCED THROUGHOUT THE CONTRACT DOCUMENTS, REFERS TO "THE NEW KAPALAMA CONTAINER TERMINAL YARD DESIGN AT HONOLULU HARBOR, HAWAII, JOB H.C. 10502", A SEPARATE PROJECT BY THE STATE OF HAWAII, DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION. THE H.C. 10498 CONTRACTOR SHALL COORDINATE ALL WORK THAT WILL OR COULD AFFECT JOB H.C. 10502 WITH THE H.C. 10502 CONTRACTOR AND THE HARBORS DIVISION.



REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE: THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE: PROJECT PLAN				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: RA		APPROVED BY:		
DRAWN BY: FS		HARBORS ADMINISTRATOR		
CHECKED BY: DC		JOB NUMBER: H.C. 10498-00081		
DATE: 1/9/2015		SHEET: G-102		
SCALE: AS SHOWN		13 OF 259 SHEETS		

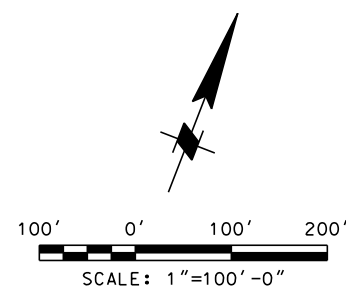
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SITE ACCESS PLAN
SCALE: 1"=100'-0"

LEGEND:

→ ACCESS TO SITE



Appendix A: Reduced-Sized Plans Showing Phasing of Wharf and Dredging Project

REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE: THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE: SITE ACCESS PLAN				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: RK		SECTION HEAD		APPROVED BY:
DRAWN BY: FS		ENGINEERING PROGRAM MANAGER		HARBORS ADMINISTRATOR
CHECKED BY: DC		JOB NUMBER		SHEET
DATE: 1/9/2015		H.C. 10498-00081		G-103
SCALE: AS SHOWN		14 OF 259 SHEETS		

LICENSE EXPIRATION DATE:
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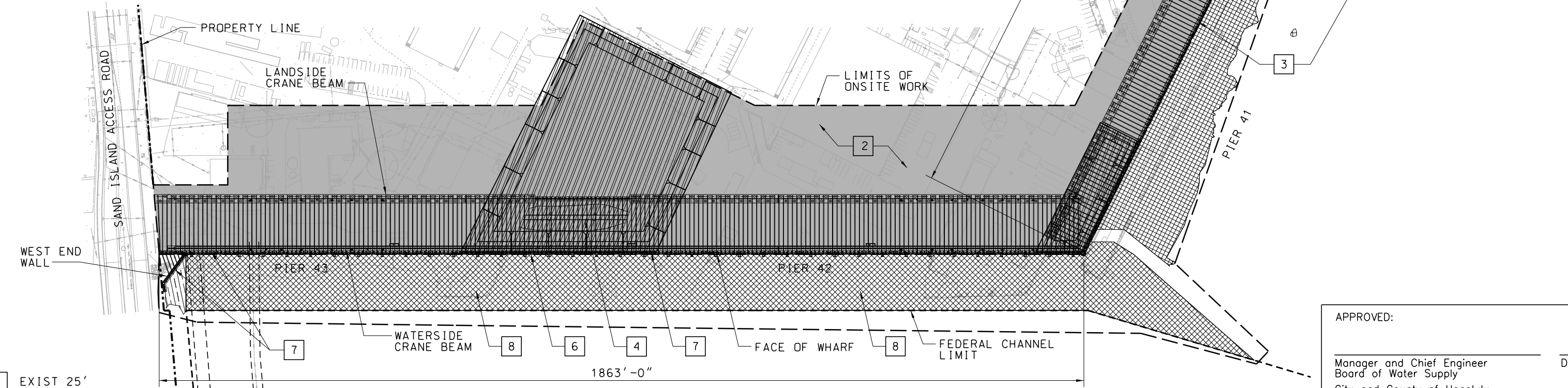
GENERAL CONSTRUCTION SEQUENCE:

NOTE:

DUE TO INTERDEPENDENCIES, THE CONSTRUCTION SEQUENCE ON THIS SHEET MUST BE FOLLOWED. ALL STEPS, BMPS, MEANS AND METHODS REQUIRED TO COMPLETE THE CONSTRUCTION OF THIS PROJECT ARE NOT LISTED IN THIS CONSTRUCTION SEQUENCE. ANY ITEM THAT IS NOT INDICATED ON THIS SHEET SHALL BE COMPLETED PER THE DRAWINGS AND SPECIFICATIONS.

- 1 NEW SUBMARINE WATER LINES INSTALLATION (SEE CU7## SHEETS), AND HECO SUBMARINE POWER CABLES RELOCATION (BY HECO), CAN OCCUR SIMULTANEOUSLY WITH OTHER TASKS IF POSSIBLE
- 2 DEMOLITION WORK (SEE DEMOLITION PLANS, SHEETS CD), CAN OCCUR SIMULTANEOUSLY WITH OTHER TASKS IF POSSIBLE
- 3 CONSTRUCT PIER 41 & 40F KING PILE/SHEET PILE BULKHEAD WALL SYSTEM (INCLUDING PILES, TIE BACKS, DEAD MAN, ETC.)
- 4 CONSTRUCT TEMPORARY CLOSURE DIKE AT SNUG HARBOR (SEE SHT CN304) NOTE: TASKS 1-4 MAY OCCUR SIMULTANEOUSLY AT CONTRACTOR'S OPTION.
- 5 DREDGE PIERS 41 AND 40F:
 - A. DREDGE NON-CORALLINE MATERIALS AT PIER 41 & 40F, PLACE DREDGE MATERIALS AT SNUG HARBOR
 - B. DREDGE, PROCESS CORALLINE MATERIALS AT PIERS 41 & 40F AND PLACE THEM AT SNUG HARBOR
- 6 CONSTRUCT SNUG HARBOR KING PILE/SHEET PILE BULKHEAD WALL SYSTEM
- 7 CONSTRUCT PIERS 42-43 AND WEST END WALL KING PILE/SHEET PILE BULKHEAD WALL SYSTEM

- 8 DREDGE PIERS 42 AND 43:
 - A. DREDGE NON-CORALLINE MATERIALS AT PIERS 42-43 AND PLACE OFFSHORE AT SOODMDS
 - B. DREDGE & PROCESS CORALLINE MATERIALS AT PIERS 42-43, PLACE:
 - FOR SITE GRADING
 - AT SNUG HARBOR
 - AT RAIL SLIP
 - AT PIER 40F
 - FOR SURCHARGE OF SNUG HARBOR, RAIL SLIP, PIER 40F
 - OFFSHORE AT SOODMDS



- 1 EXIST 25' HECO EASEMENT (CONTAINING EXIST POWER CABLES TO BE RELOCATED)
- 1 NEW BWS EASEMENT FOR NEW BWS SUBMARINE WATERLINES

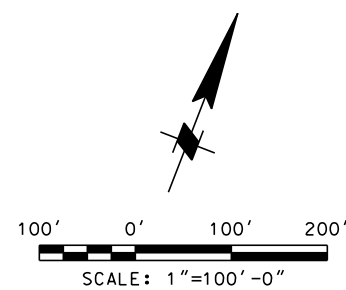
PROJECT CONSTRUCTION SEQUENCE PLAN

SCALE: 1"=100'-0"

LEGEND:

- PROJECT LIMIT
- BOLLARD
- FENDER
- SHEET PILE

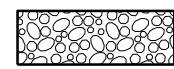

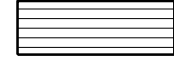
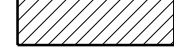
NOTE:
SEE G-3## SHEETS FOR STAGE CONSTRUCTION AT SNUG HARBOR, RAIL SLIP AREA AND PIER 40F



APPROVED: _____ Date _____
 Manager and Chief Engineer
 Board of Water Supply
 City and County of Honolulu
 (FOR WORK AFFECTING BWS FACILITIES IN CITY/STATE R/W AND BWS EASEMENTS ONLY)

REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE PROJECT CONSTRUCTION SEQUENCE PLAN				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: RA		APPROVED BY:		SHEET
DRAWN BY: FS		HARBORS ADMINISTRATOR		G-104 15 of 259 SHTS
CHECKED BY: DC		JOB NUMBER H.C. 10498-00081		
DATE: 1/9/2015		SCALE: AS SHOWN		

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-  STONE COLUMN GROUND IMPROVEMENT
-  SNUG HARBOR SURCHARGE, SEE SHEET CN106.
-  RAIL SLIP FILL SURCHARGE, SEE SHEET CN107.
-  FILL THICKNESS LESS THAN 3 FEET

- STEP 1 - COMPLETE DEMOLITION AND REMOVE WORK.
- STEP 2 - PREPARE SUBGRADE (FINISH SUBGRADE FOR CUT CONDITION, EXISTING GROUND FOR FILL CONDITION).
- STEP 3 - PROOF-ROLL SUBGRADE WITH 20 TON ROLLER AS SPECIFIED.
- STEP 4 - PLACE COMPACTED FILL MATERIAL, AS SPECIFIED.
- STEP 5 - MONITOR SETTLEMENT GAUGES FOR A MINIMUM OF 3 MONTHS.
- STEP 6 - PLACE ADDITIONAL COMPACTED FILL AS REQUIRED TO ACCOUNT FOR SETTLEMENT.

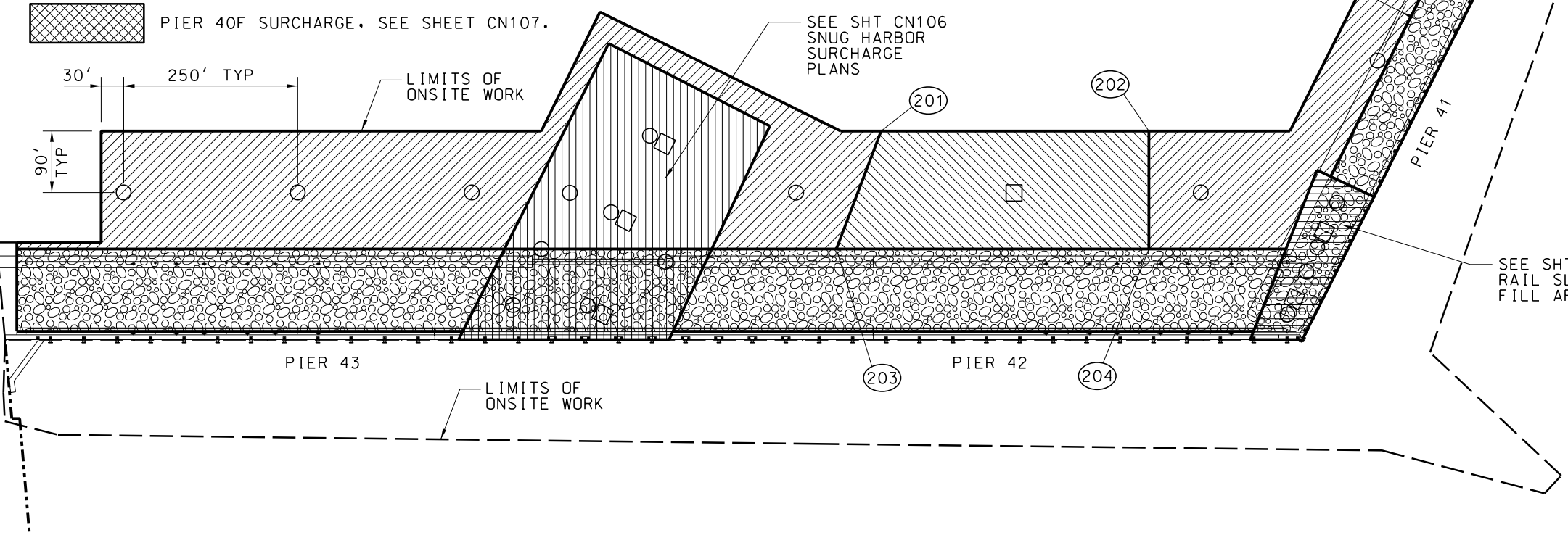
-  SURCHARGE AREA (FILL THICKNESS GREATER THAN 3 FEET)

- STEP 1 - COMPLETE DEMOLITION AND REMOVE WORK.
- STEP 2 - PREPARE SUBGRADE (FINISH SUBGRADE FOR CUT CONDITION, EXISTING GROUND FOR FILL CONDITION).
- STEP 3 - PROOF-ROLL SUBGRADE WITH 20 TON ROLLER AS SPECIFIED.
- STEP 4 - SURCHARGE AREA WITH MIN 4 FEET OF SELECT FILL MATERIAL TO ELEVATION +13.0
- STEP 5 - MONITOR SETTLEMENT GAUGES FOR A MINIMUM OF 3 MONTHS.
- STEP 6 - REMOVE SURCHARGE MATERIAL.

-  PIER 40F SURCHARGE, SEE SHEET CN107.

SAND ISLAND ACCESS ROAD



PROPERTY LINE

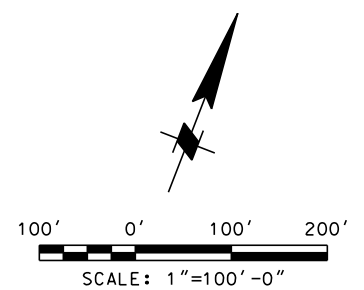


COORDINATE CONTROL		
	NORTHING	EASTING
201	54733.95	1679523.46
202	54873.08	1679882.15
203	54552.77	1679525.05
204	54715.05	1679943.45

GENERAL SURCHARGE PLAN
SCALE: 1"=100'-0"

LEGEND:

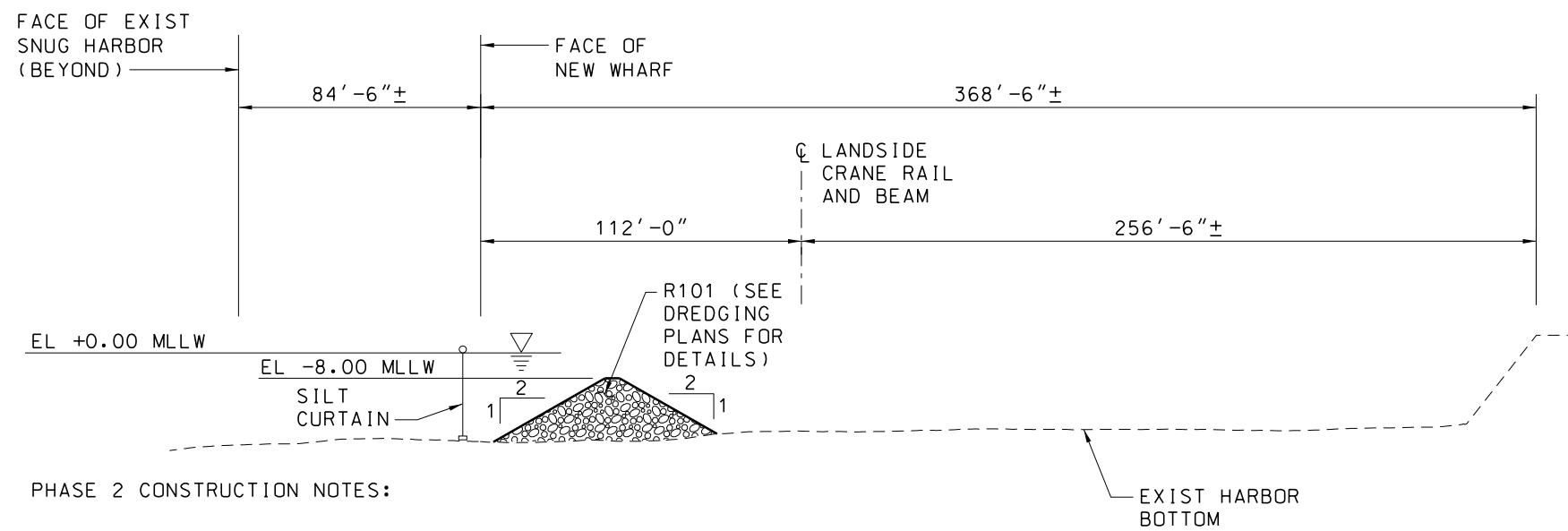
-  SETTLEMENT PLATE, SEE DETAIL 2 ON SHEET CN106
-  SETTLEMENT MONUMENT, SEE DETAIL 3 ON SHEET CN106



REVISION		DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					
SHEET TITLE GENERAL SURCHARGE PLAN					
SUBMITTED BY:			RECOMMENDED BY:		
DESIGNED BY: CL			APPROVED BY:		
DRAWN BY: FS			HARBORS ADMINISTRATOR		
CHECKED BY: RK			JOB NUMBER		
DATE: 1/9/2015			H.C. 10498		
SCALE: AS SHOWN			16 OF 259 SHEETS		

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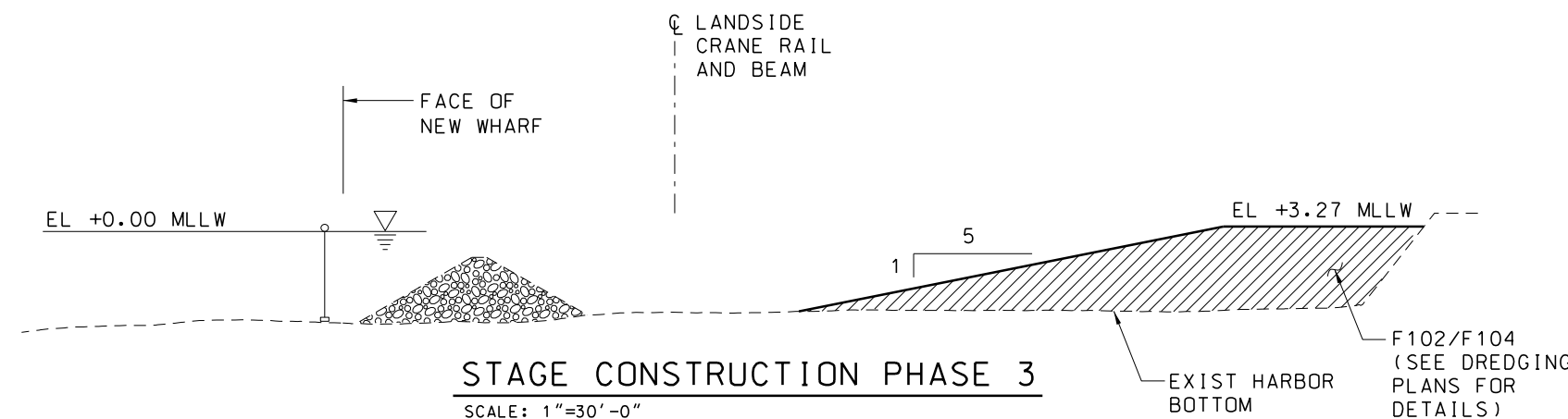


PHASE 2 CONSTRUCTION NOTES:

BUILD GRAVEL OR PROCESSED CONCRETE RUBBLE DIKE AS SHOWN. SEE DREDGING DRAWINGS FOR DETAILS. TOP OF DIKE SHALL BE SET AT EL -8.00 MLLW ALONG THE WIDTH OF SNUG HARBOR, EXCEPT THE LOWER SECTION NEAR MIDDLE OF DIKE AS REQUIRED FOR BARGE ACCESS.

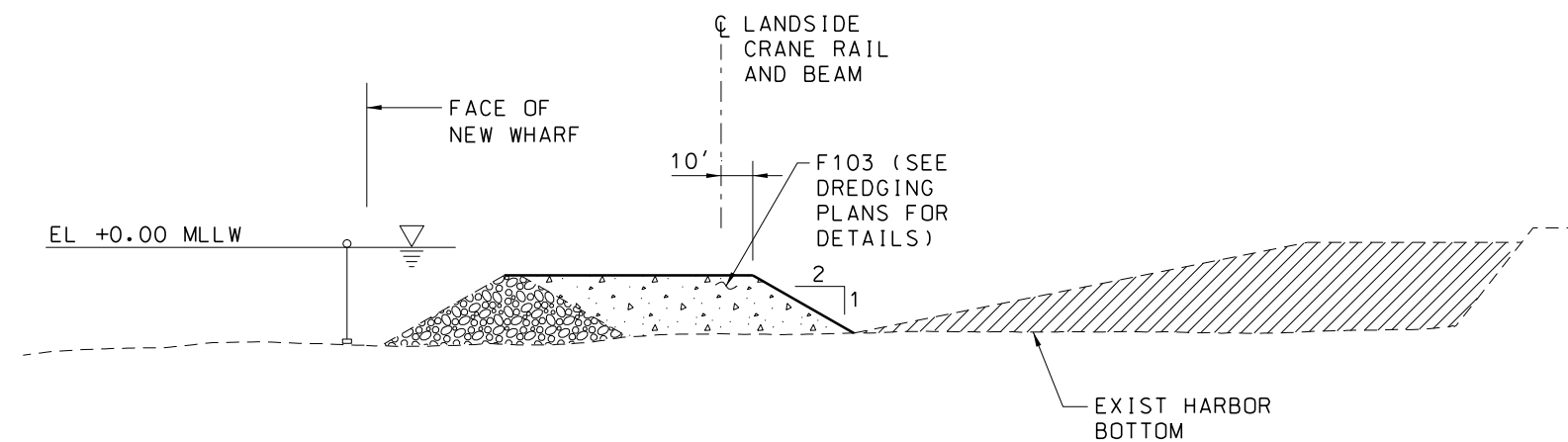
STAGE CONSTRUCTION PHASE 2

SCALE: 1"=30'-0"



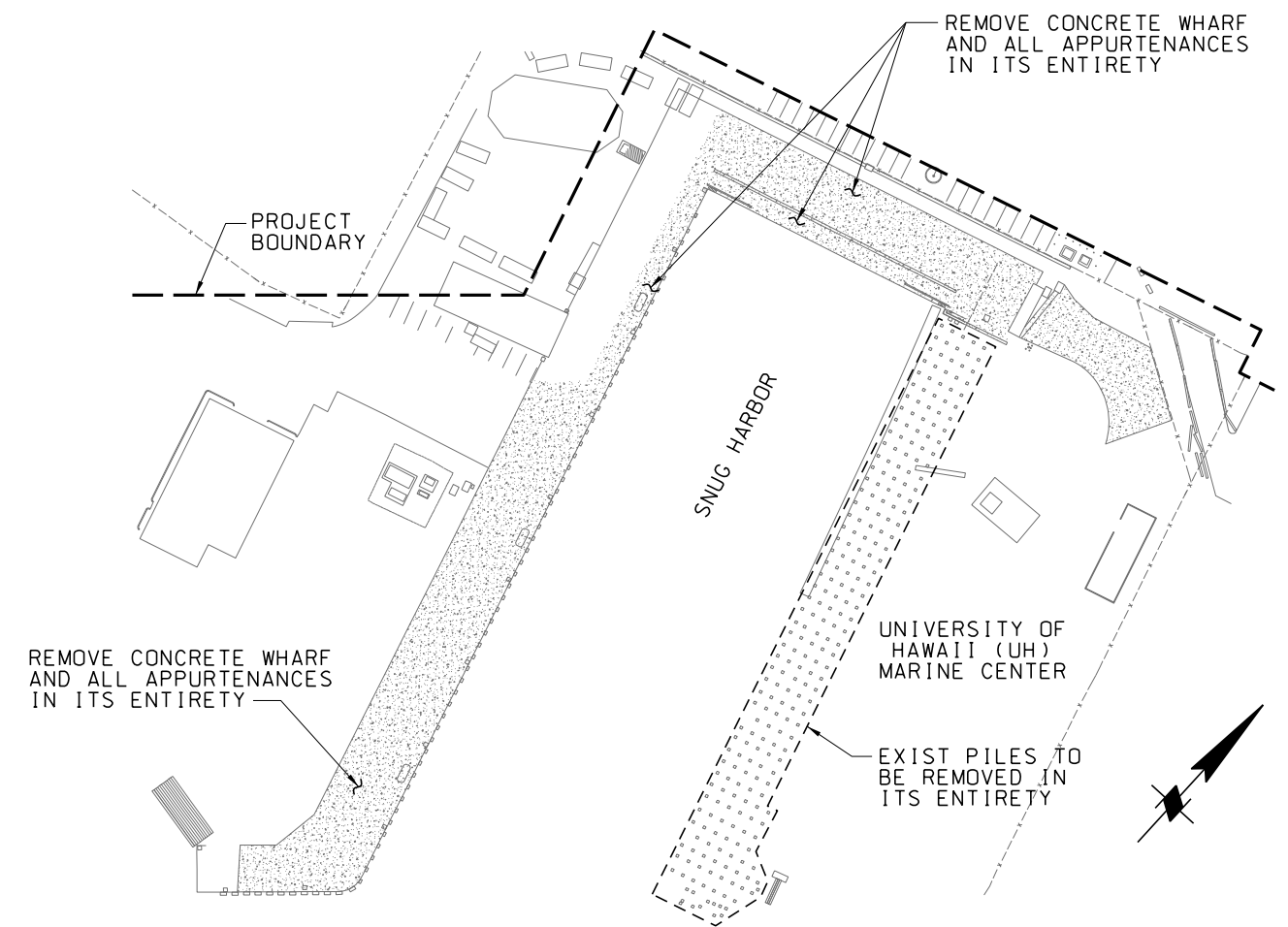
STAGE CONSTRUCTION PHASE 3

SCALE: 1"=30'-0"



STAGE CONSTRUCTION PHASE 4

SCALE: 1"=30'-0"

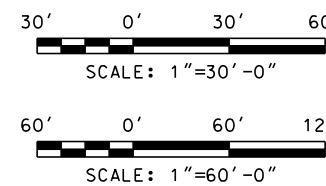


PHASE 1 CONSTRUCTION NOTES:

DEMOLISH EXISTING CONCRETE WHARF AND ALL APPURTENANCES IN ITS ENTIRETY.

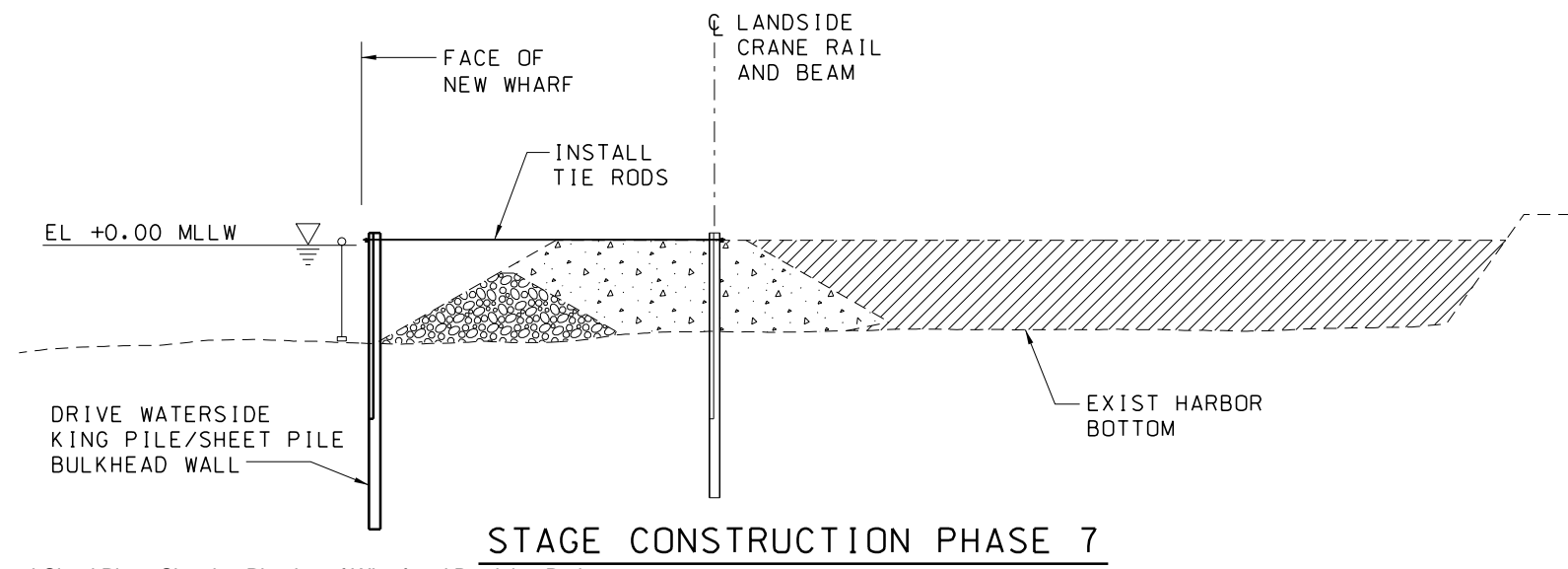
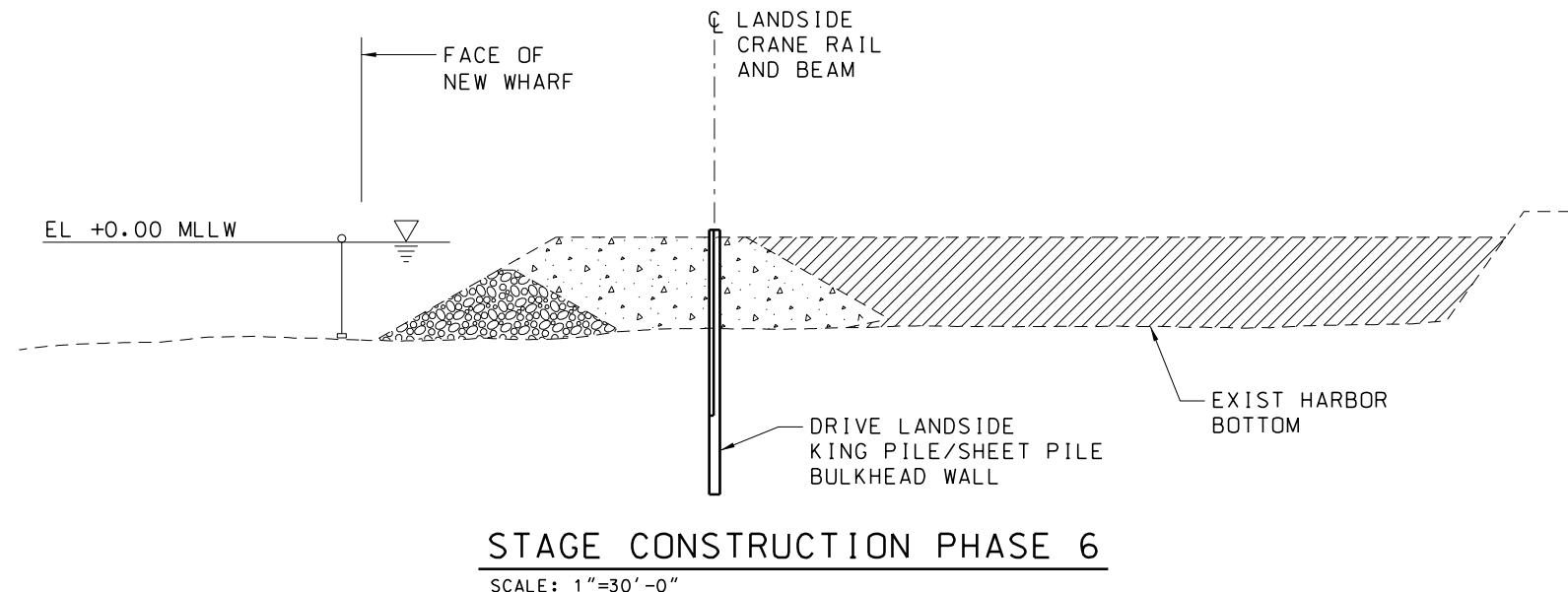
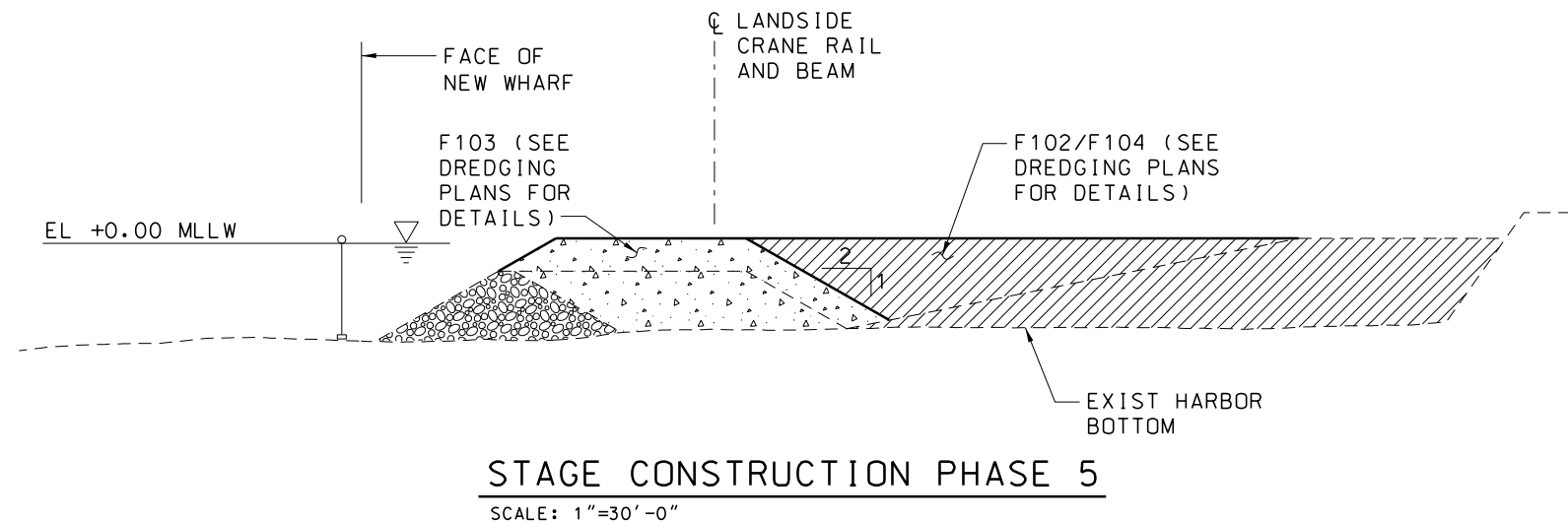
STAGE CONSTRUCTION PHASE 1

SCALE: 1"=60'-0"

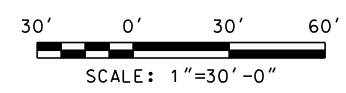


REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE: THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE: STAGE CONSTRUCTION AT SNUG HARBOR - 1				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: RA		APPROVED BY:		SHEET
DRAWN BY: FS		HARBORS ADMINISTRATOR		G-301
CHECKED BY: DC/AA		JOB NUMBER: H.C. 10498-00081		
DATE: 1/9/2015		SCALE: AS SHOWN		
LICENSE EXPIRATION DATE: THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.				
17 of 259 SHETS				

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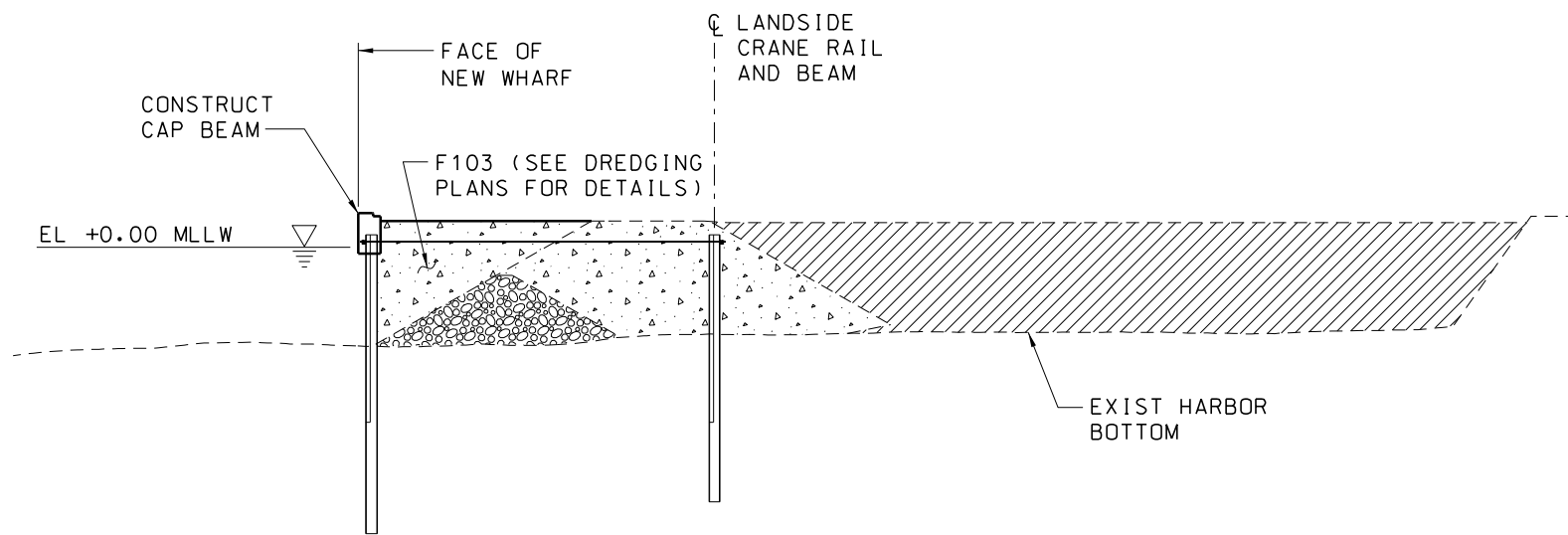


Appendix A: Reduced-Sized Plans Showing Phasing of Wharf and Dredging Project



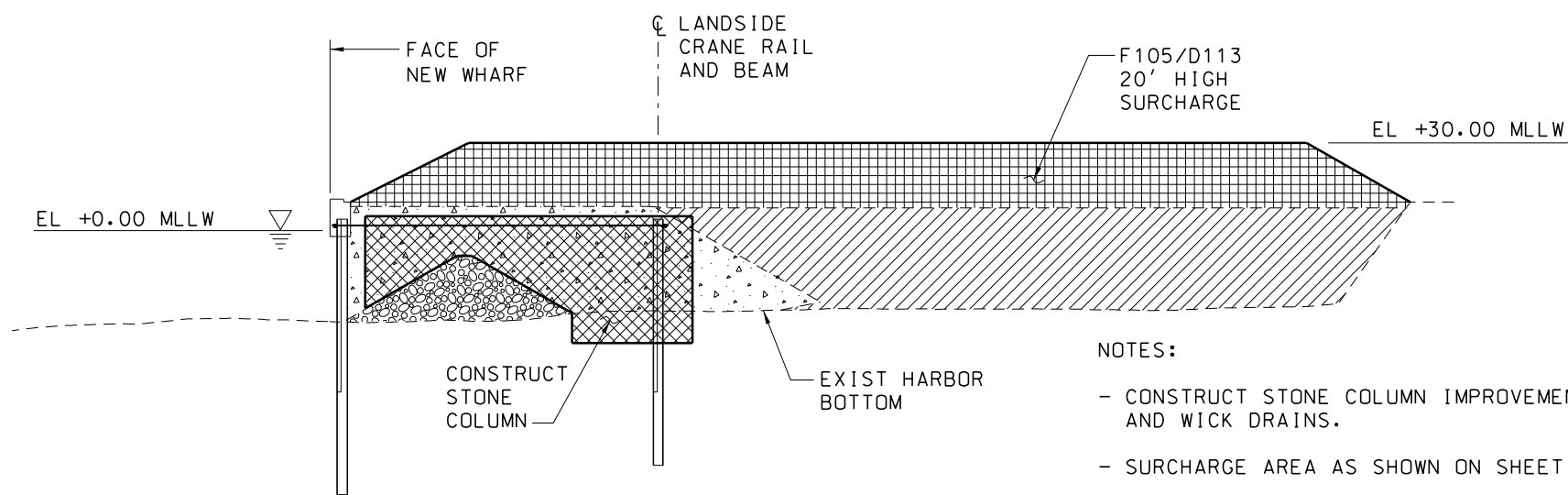
LICENSE EXPIRATION DATE:		THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.	
REVISION	DATE	DESCRIPTION	BY
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION			
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU			
SHEET TITLE STAGE CONSTRUCTION AT SNUG HARBOR - 2			
SUBMITTED BY:		RECOMMENDED BY:	
SECTION HEAD		ENGINEERING PROGRAM MANAGER	
DESIGNED BY: RA	APPROVED BY:	HARBORS ADMINISTRATOR	
DRAWN BY: FS	CHECKED BY: DC/AA	JOB NUMBER	
DATE: 1/9/2015	H.C. 10498-00081		
SCALE: AS SHOWN	G-302		
			18 of 259 SHEETS

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STAGE CONSTRUCTION PHASE 8

SCALE: 1"=30'-0"

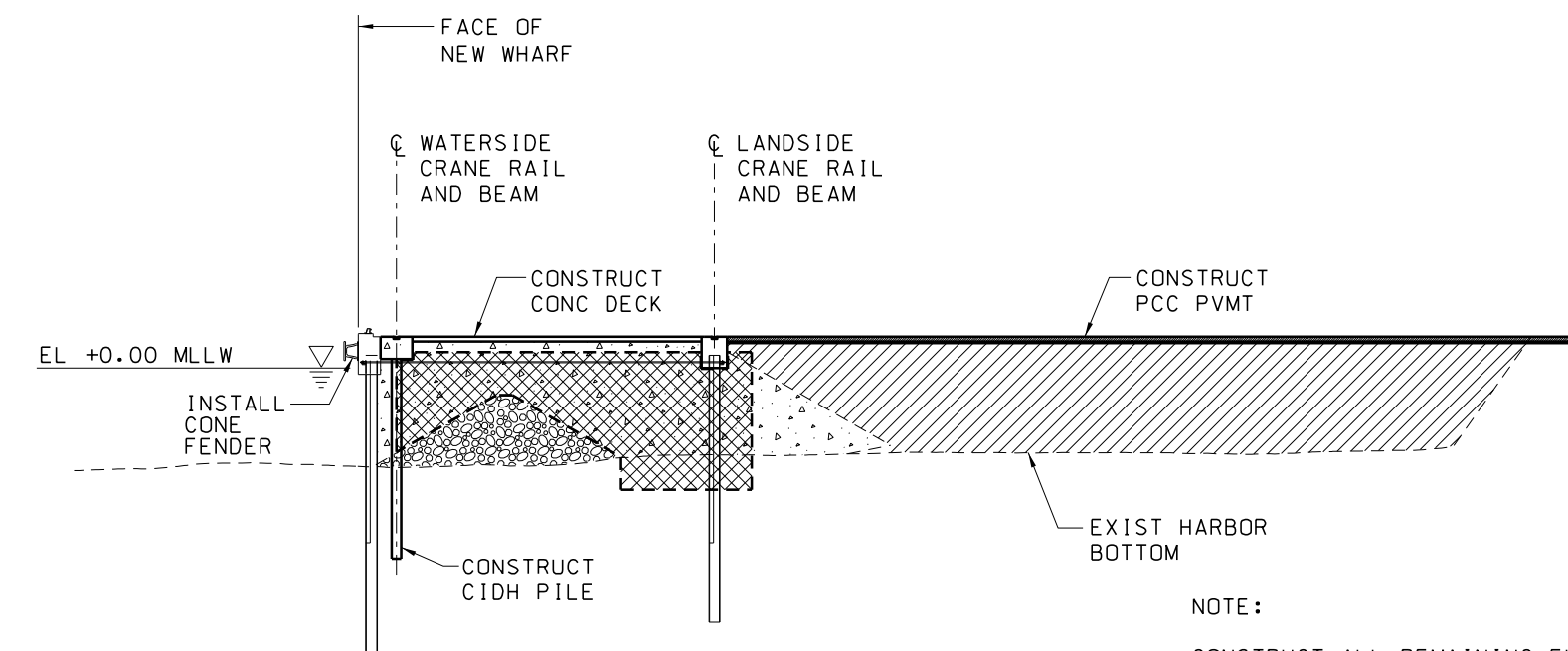


STAGE CONSTRUCTION PHASE 9

SCALE: 1"=30'-0"

NOTES:

- CONSTRUCT STONE COLUMN IMPROVEMENTS AND WICK DRAINS.
- SURCHARGE AREA AS SHOWN ON SHEET CN106.
- STONE COLUMN CAN BE CONSTRUCTED BEFORE OR AFTER SURCHARGE.

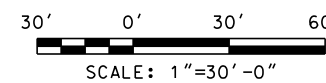


STAGE CONSTRUCTION PHASE 10

SCALE: 1"=30'-0"

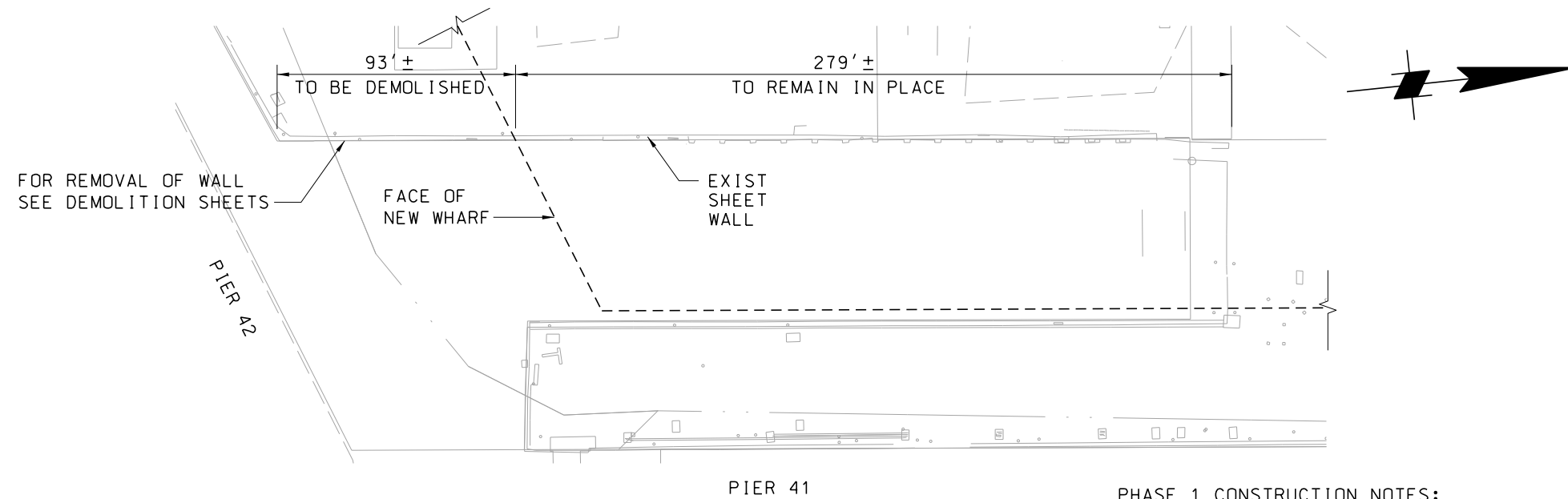
NOTE:

CONSTRUCT ALL REMAINING ELEMENTS.



REVISION		DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					
SHEET TITLE STAGE CONSTRUCTION AT SNUG HARBOR - 3					
SUBMITTED BY:			RECOMMENDED BY:		
DESIGNED BY: RA			APPROVED BY:		
DRAWN BY: FS			SECTION HEAD		
CHECKED BY: DC/AA			ENGINEERING PROGRAM MANAGER		
DATE: 1/9/2015			HARBORS ADMINISTRATOR		
SCALE: AS SHOWN			JOB NUMBER		
			H.C. 10498-00081		
					SHEET G-303 19 of 259 SHIS

LICENSE EXPIRATION DATE:
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OR UNDER MY SUPERVISION.

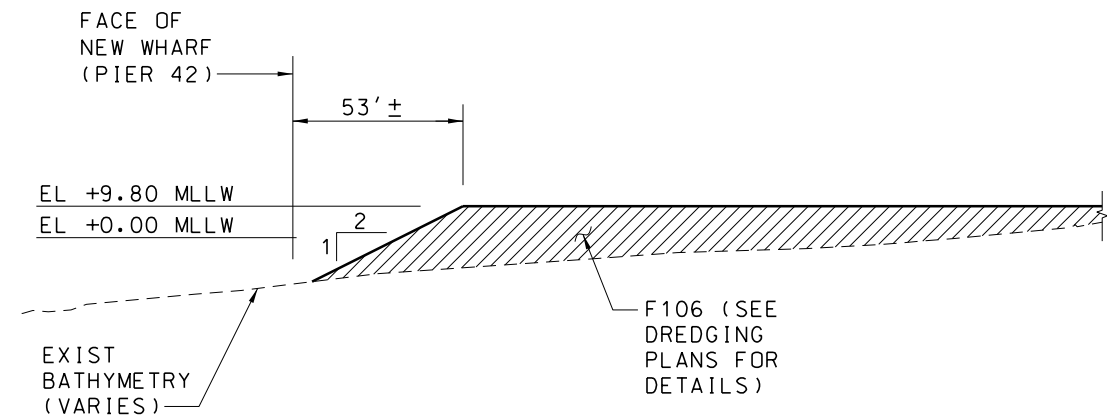
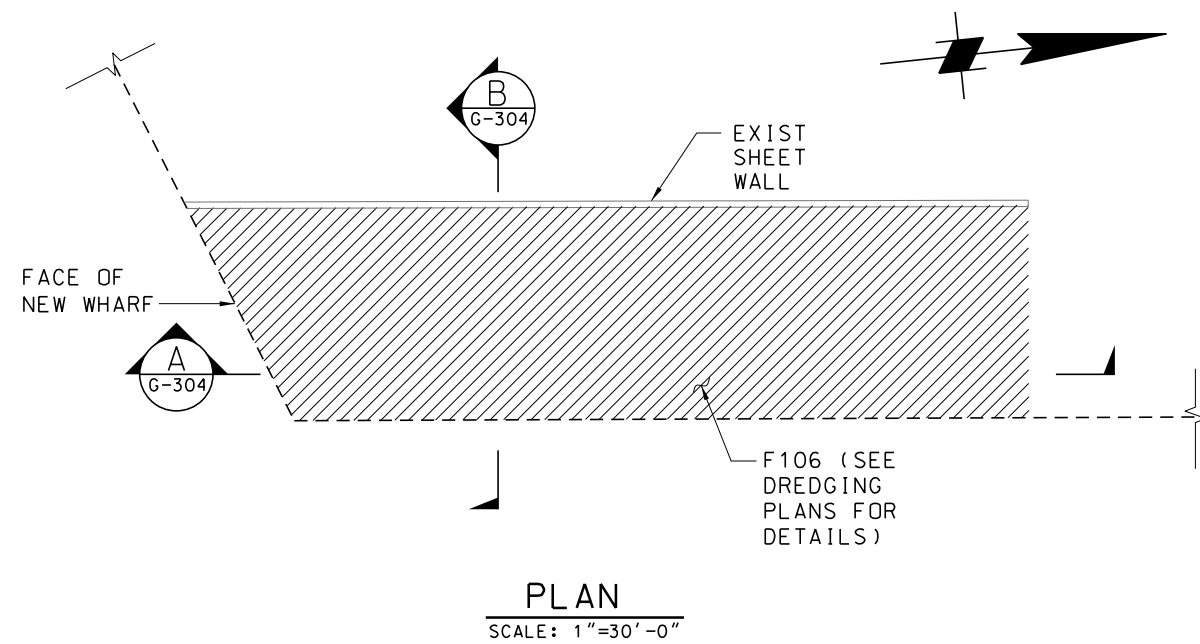


PHASE 1 CONSTRUCTION NOTES:

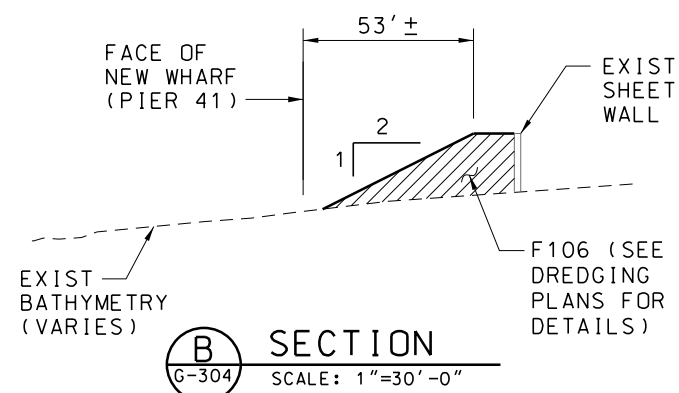
DEMOLISH AND REMOVE EVERYTHING WITHIN THE LIMITS OF RAIL SLIP. SEE DEMOLITION SHEETS FOR DETAILS.

STAGE CONSTRUCTION PHASE 1

SCALE: 1"=30'-0"

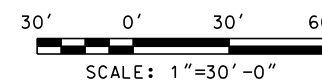


A SECTION
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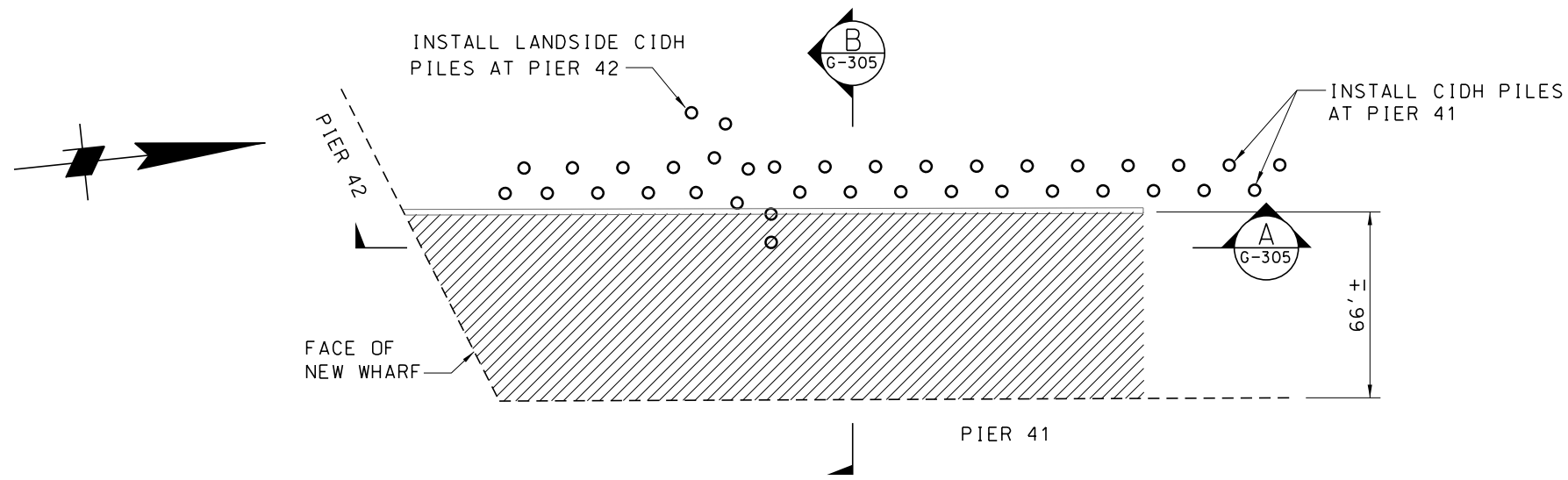
B SECTION
SCALE: 1"=30'-0"

STAGE CONSTRUCTION PHASE 2



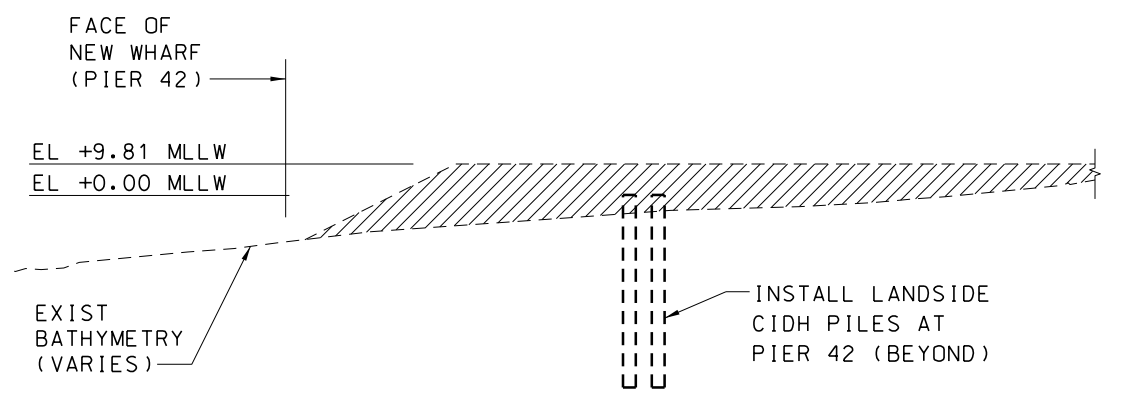
REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE STAGE CONSTRUCTION AT RAIL SLIP AREA - 1				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: RA		APPROVED BY:		
DRAWN BY: FS		HARBORS ADMINISTRATOR		
CHECKED BY: DC/AA		JOB NUMBER		
DATE: 1/9/2015		H.C. 10498		
SCALE: AS SHOWN		SHEET G-304 20 of 259 SHEETS		

P:\7992-HOOT Kapiolani\8_Deliverables\CADD\Active\SheetSet\GENERAL\10498G-304.dgn 1/8/2015 9:22:27 AM



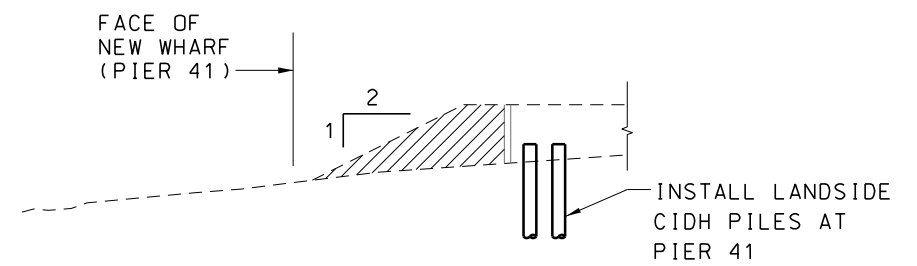
PLAN
SCALE: 1"=30'-0"

STAGE CONSTRUCTION PHASE 3

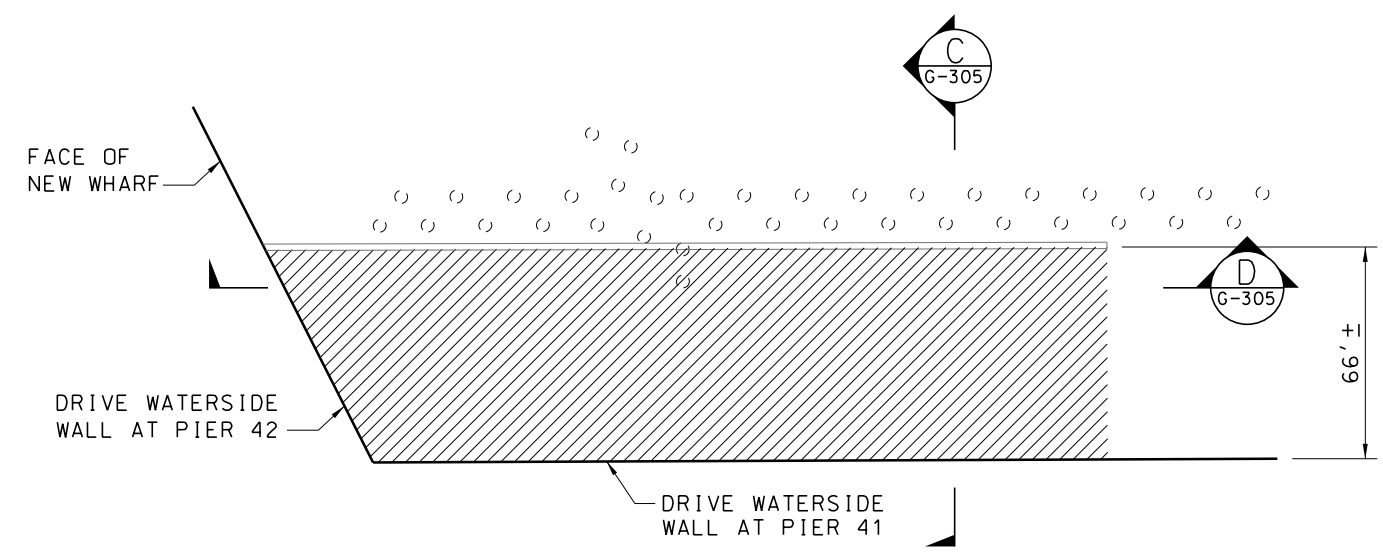


A SECTION
G-305 SCALE: 1"=30'-0"

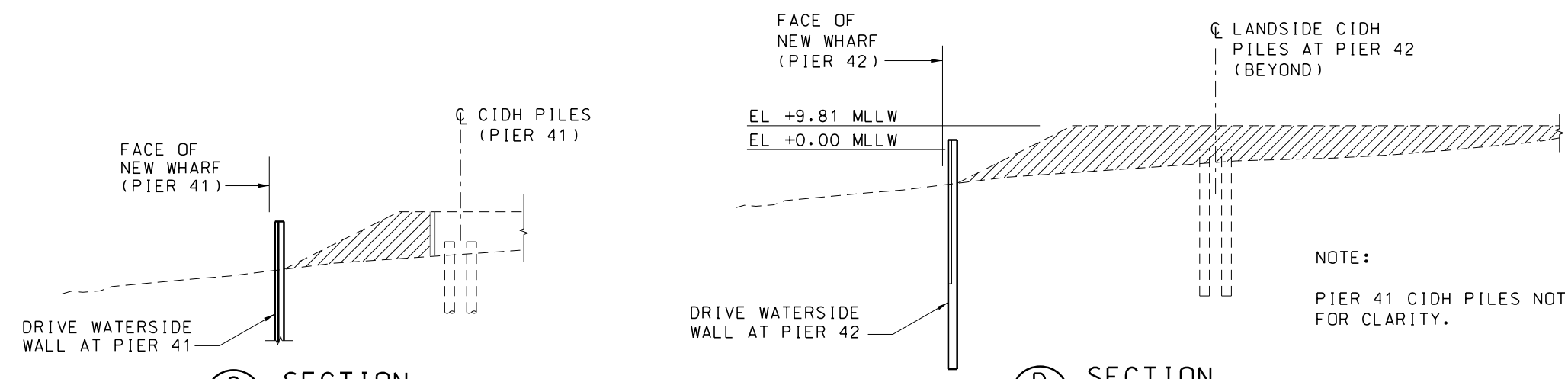
NOTE:
PIER 41 CIDH PILES NOT SHOWN FOR CLARITY.



B SECTION
G-305 SCALE: 1"=30'-0"



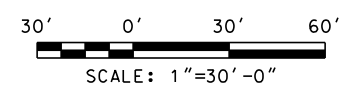
PLAN
SCALE: 1"=30'-0"



C SECTION
G-305 SCALE: 1"=30'-0"

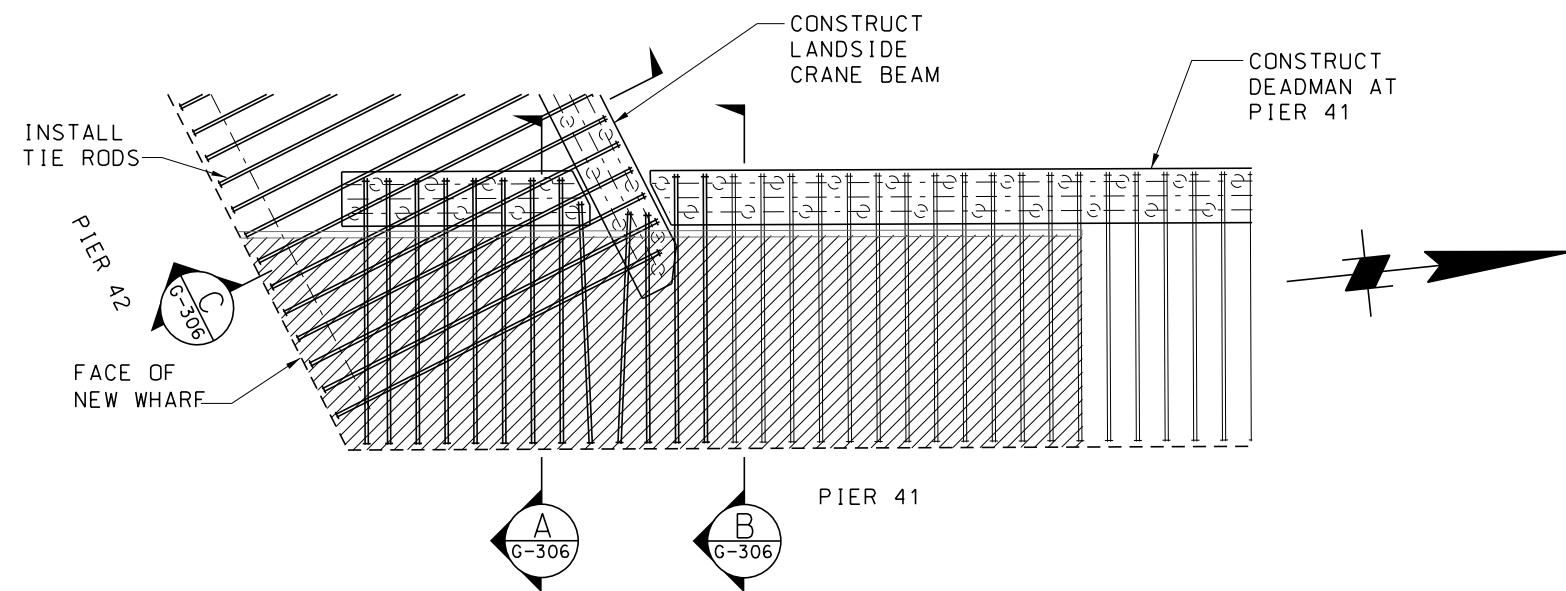
D SECTION
G-305 SCALE: 1"=30'-0"

NOTE:
PIER 41 CIDH PILES NOT SHOWN FOR CLARITY.

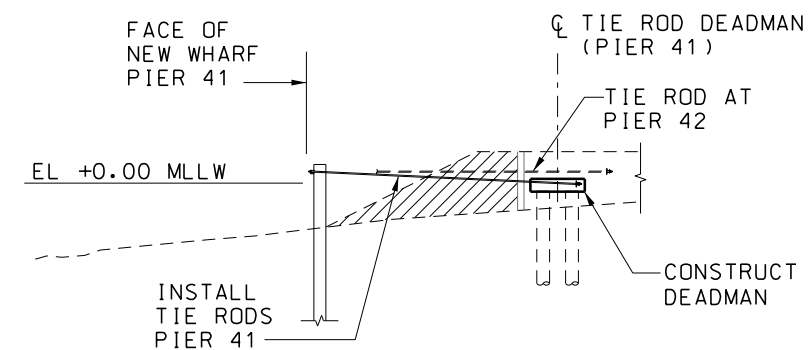


STAGE CONSTRUCTION PHASE 4

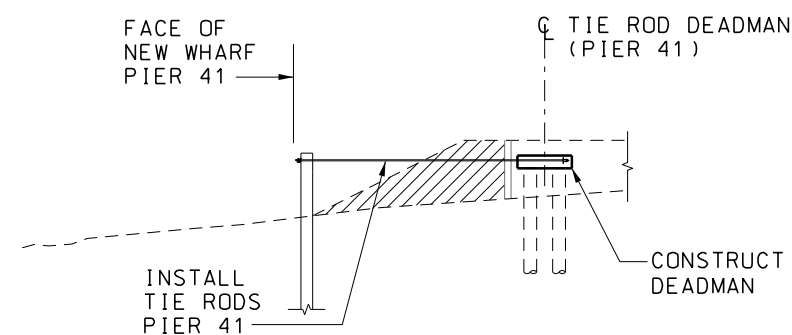
REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE STAGE CONSTRUCTION AT RAIL SLIP AREA - 2				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: RA		APPROVED BY:		
DRAWN BY: FS		HARBORS ADMINISTRATOR		
CHECKED BY: DC/AA		JOB NUMBER		
DATE: 1/9/2015		H.C. 10498		
SCALE: AS SHOWN		G-305		
		21 of 259 SHITS		



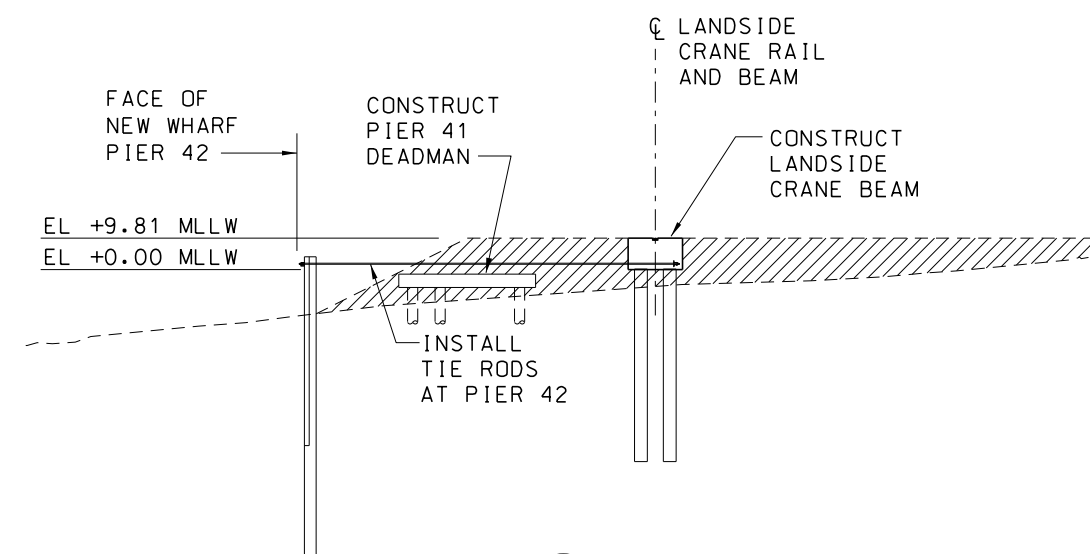
PLAN
SCALE: 1"=30'-0"



A SECTION
G-306 SCALE: 1"=30'-0"

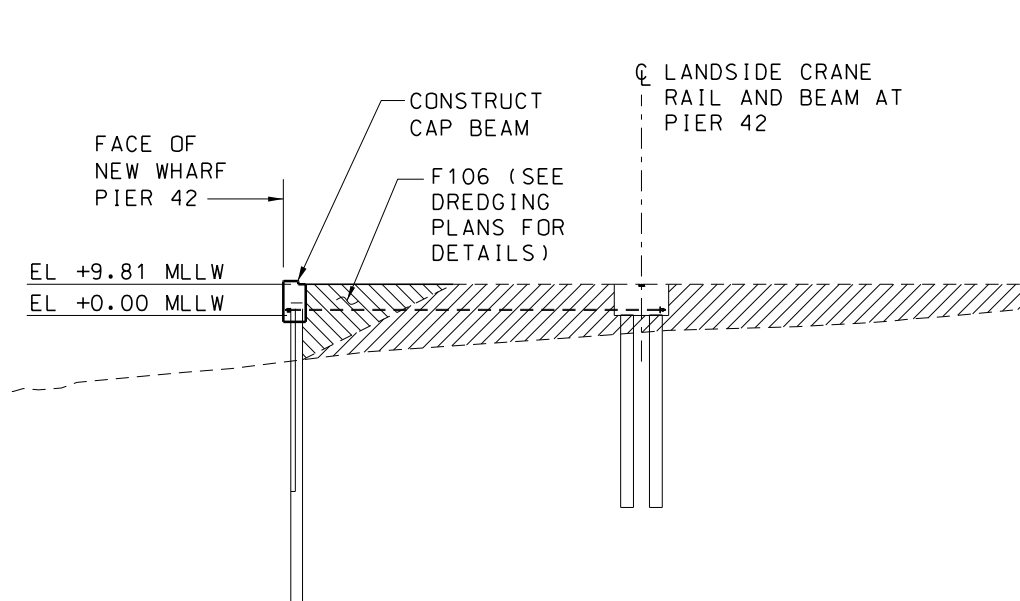


B SECTION
G-306 SCALE: 1"=30'-0"

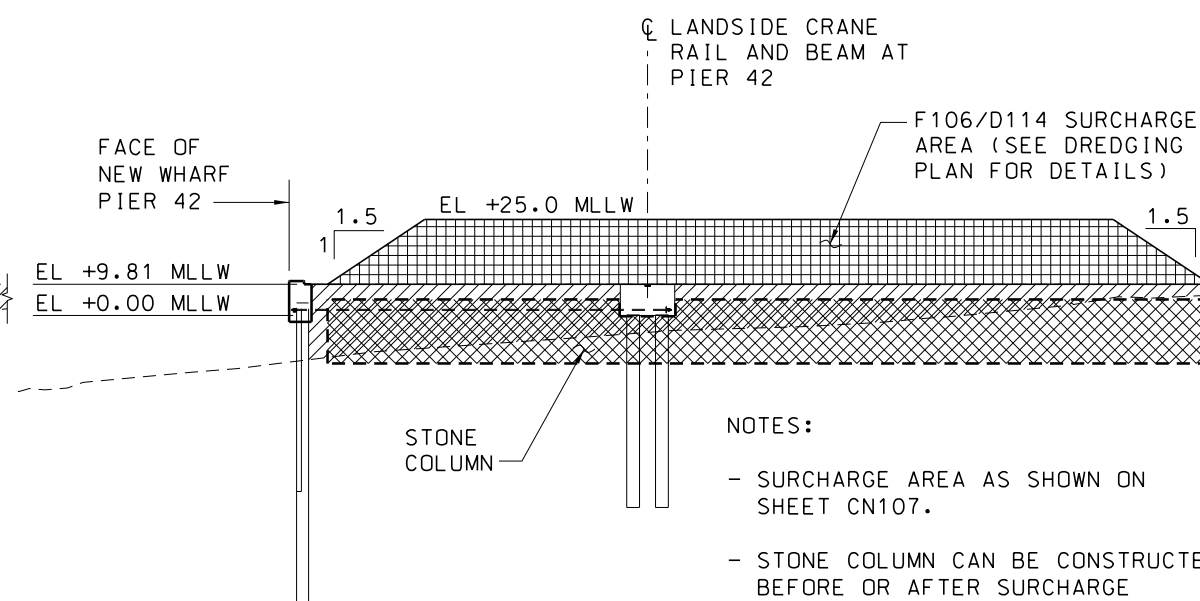


C SECTION
G-306 SCALE: 1"=30'-0"

STAGE CONSTRUCTION PHASE 5



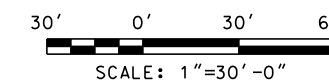
STAGE CONSTRUCTION PHASE 6
SCALE: 1"=30'-0"



STAGE CONSTRUCTION PHASE 7
SCALE: 1"=30'-0"

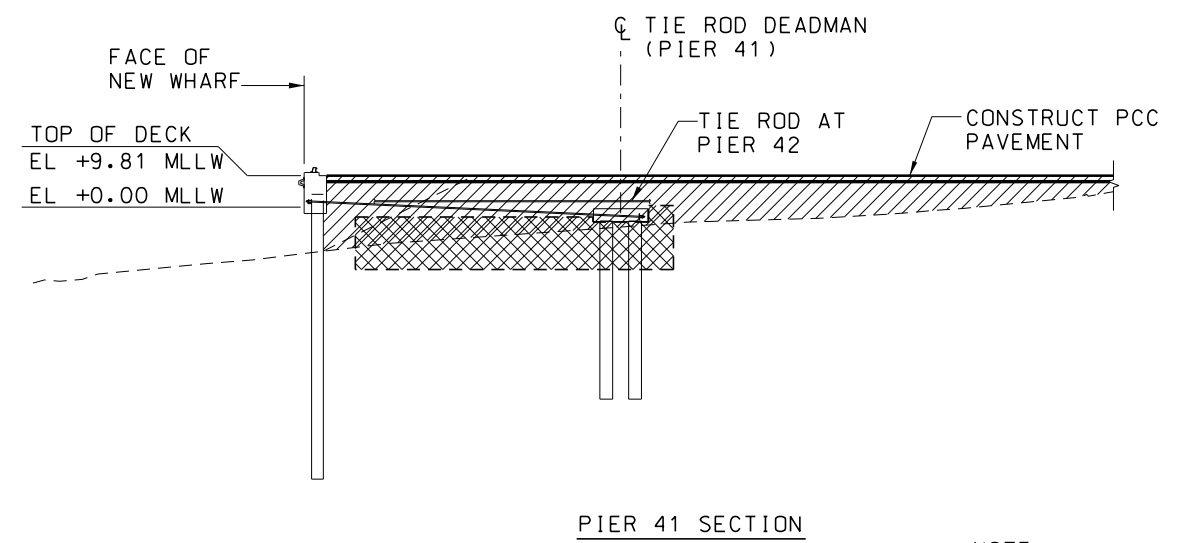
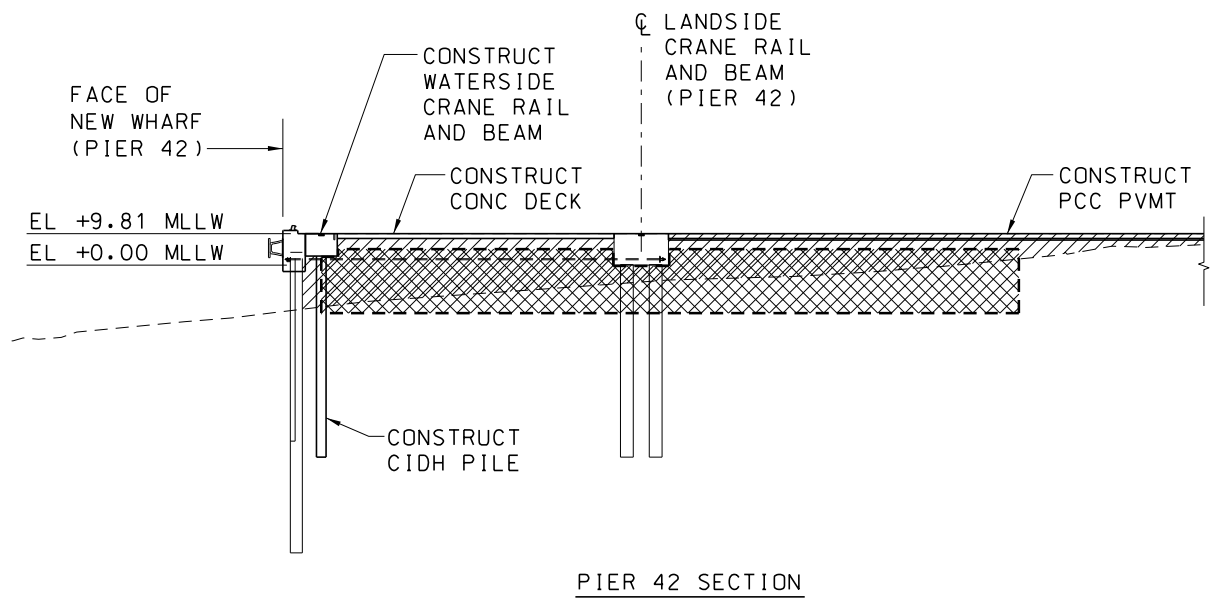
NOTES:

- SURCHARGE AREA AS SHOWN ON SHEET CN107.
- STONE COLUMN CAN BE CONSTRUCTED BEFORE OR AFTER SURCHARGE



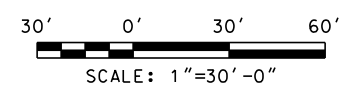
REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE: THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE: STAGE CONSTRUCTION AT RAIL SLIP AREA - 3				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: RA		SECTION HEAD:		APPROVED BY:
DRAWN BY: FS		HARBORS ADMINISTRATOR:		SHEET
CHECKED BY: DC/AA		JOB NUMBER:		G-306
DATE: 1/9/2015		H.C. 10498-00081		22 of 259 SHTS.
SCALE: AS SHOWN				

LICENSE EXPIRATION DATE:
THIS WORK WAS PREPARED BY ME
OR UNDER MY SUPERVISION.



NOTE:
 CONSTRUCT ALL REMAINING ELEMENTS
 AT PIER 41 AND 42.

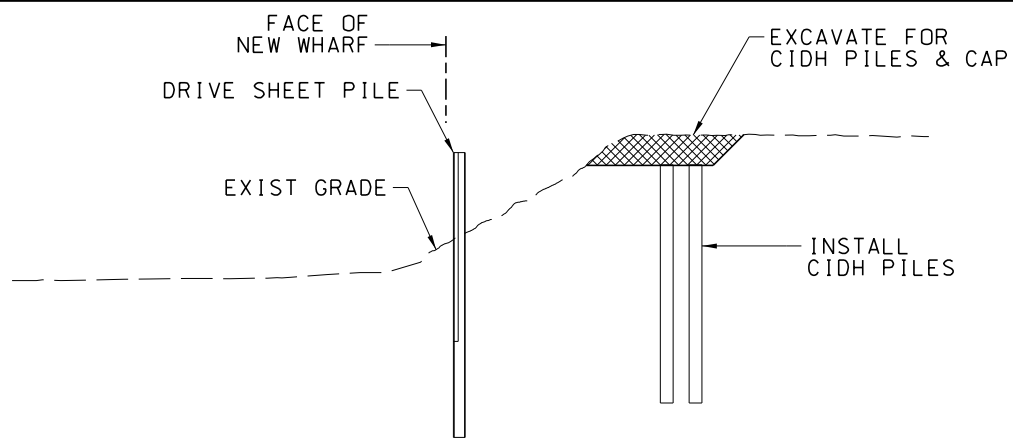
STAGE CONSTRUCTION PHASE 8
 SCALE: 1"=30'-0"



REVISION		DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					
SHEET TITLE STAGE CONSTRUCTION AT RAIL SLIP AREA - 4					
SUBMITTED BY:			RECOMMENDED BY:		
DESIGNED BY: RA			APPROVED BY:		
DRAWN BY: FS			HARBORS ADMINISTRATOR		
CHECKED BY: DC/AA			JOB NUMBER		
DATE: 1/9/2015			H.C. 10498		
SCALE: AS SHOWN			23 of 259 SHEETS		

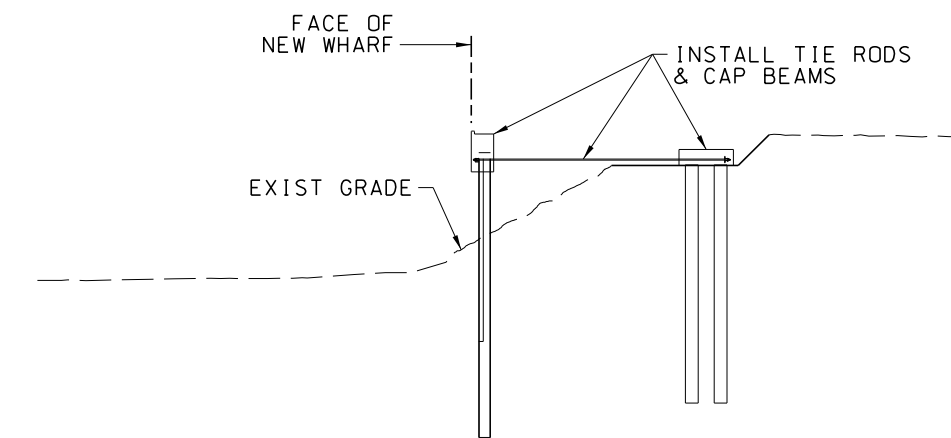
LICENSE EXPIRATION DATE:
 THIS WORK WAS PREPARED BY ME
 OR UNDER MY SUPERVISION.

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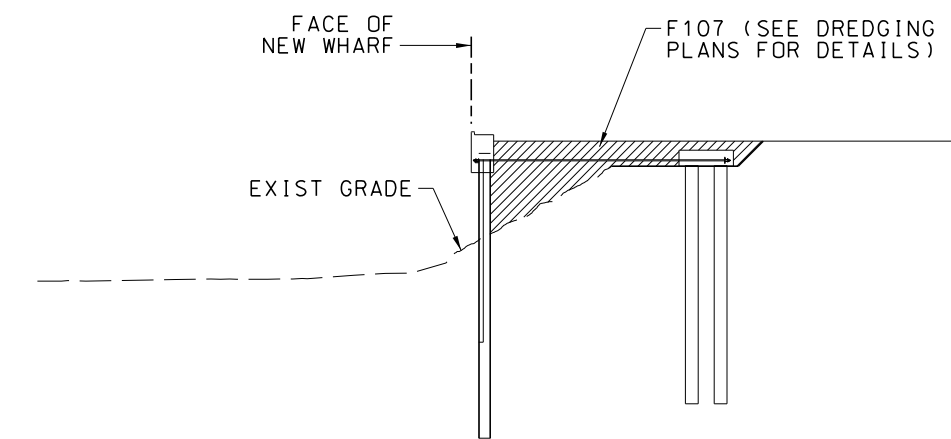
STAGE CONSTRUCTION PHASE 2

SCALE: 1"=30'-0"



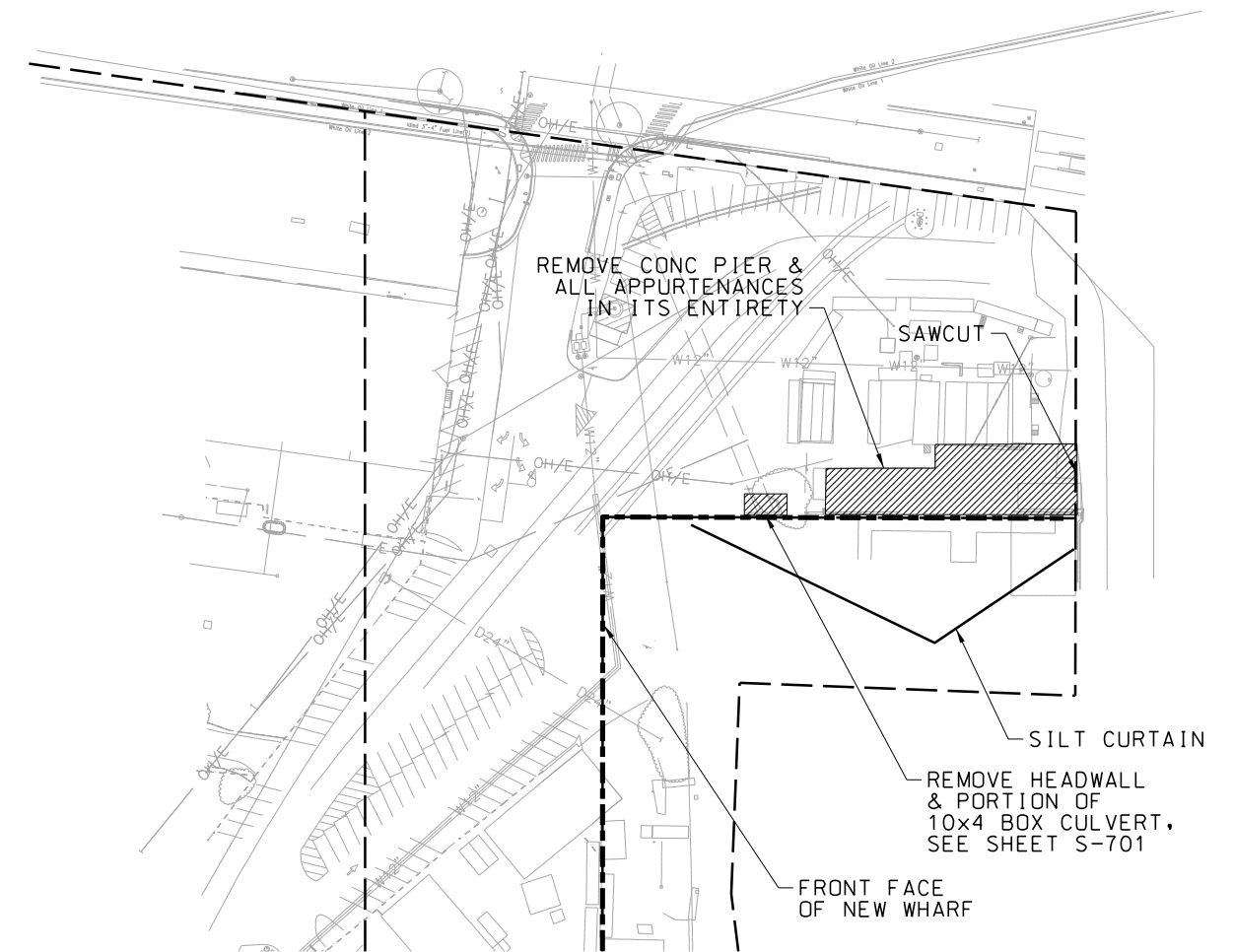
STAGE CONSTRUCTION PHASE 3

SCALE: 1"=30'-0"



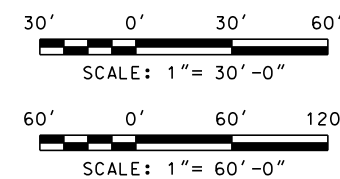
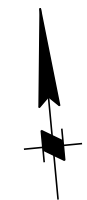
STAGE CONSTRUCTION PHASE 4

SCALE: 1"=30'-0"



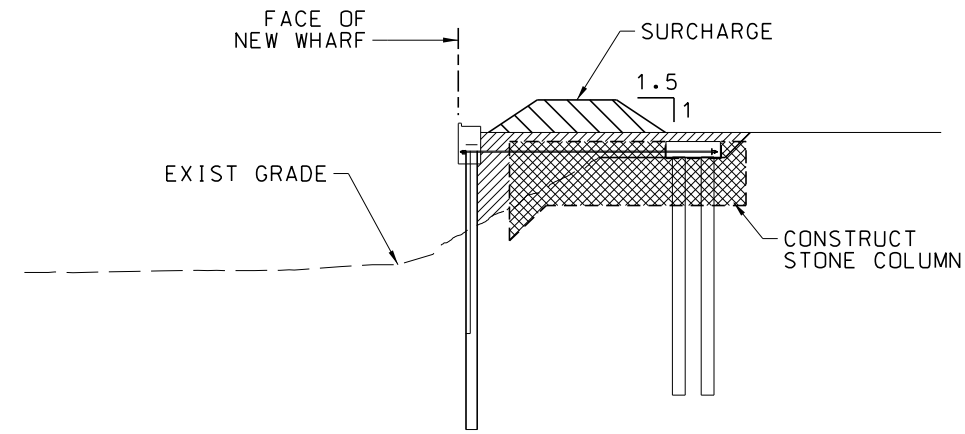
STAGE CONSTRUCTION PHASE 1

SCALE: 1"=60'-0"



REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE: THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE: STAGE CONSTRUCTION AT PIER 40F - 1				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: VS		APPROVED BY:		
DRAIN BY: WS		HARBORS ADMINISTRATOR		
CHECKED BY: DC/AA		JOB NUMBER: H.C. 10498-00081		
DATE: 1/9/2015		SHEET: G-308		
SCALE: AS SHOWN		24 of 259 SHEETS		

LICENSE EXPIRATION DATE:
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

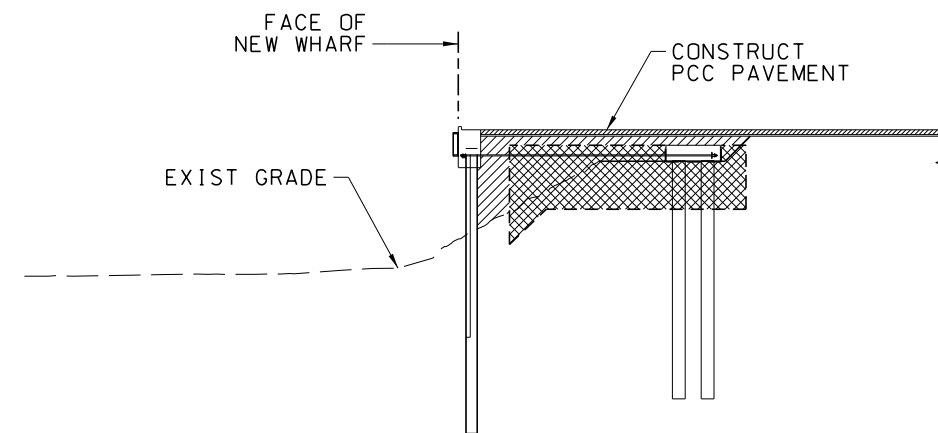


NOTES:

1. SURCHARGE AREA AS SHOWN ON CN107.
2. STONE COLUMN CAN BE CONSTRUCTED BEFORE OR AFTER SURCHARGE.

STAGE CONSTRUCTION PHASE 5

SCALE: 1"=30'-0"

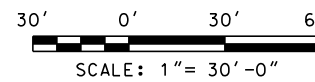


NOTE:

CONSTRUCT ALL REMAINING ELEMENTS.

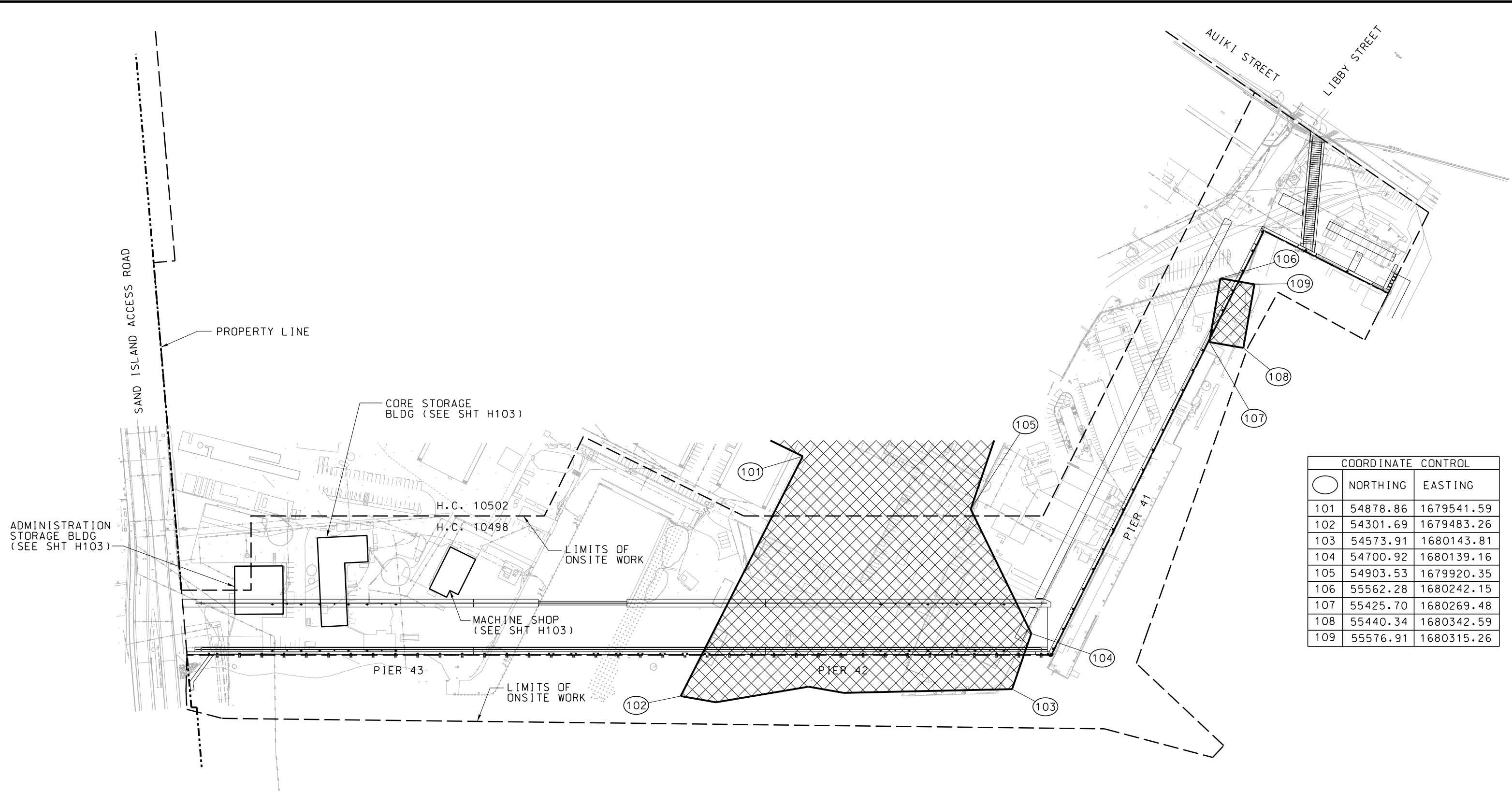
STAGE CONSTRUCTION PHASE 6

SCALE: 1"=30'-0"



REVISION		DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					
SHEET TITLE STAGE CONSTRUCTION AT PIER 40F - 2					
SUBMITTED BY:			RECOMMENDED BY:		
DESIGNED BY: VS			APPROVED BY:		
DRAWN BY: WS			HARBORS ADMINISTRATOR		
CHECKED BY: DC/AA			JOB NUMBER		
DATE: 1/9/2015			H.C. 10498		
SCALE: AS SHOWN			25 of 259 SHEETS		

LICENSE EXPIRATION DATE:
THIS WORK WAS PREPARED BY ME
OR UNDER MY SUPERVISION.

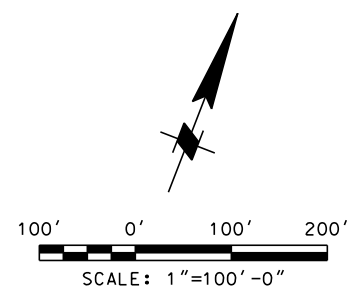


COORDINATE CONTROL		
	NORTHING	EASTING
101	54878.86	1679541.59
102	54301.69	1679483.26
103	54573.91	1680143.81
104	54700.92	1680139.16
105	54903.53	1679920.35
106	55562.28	1680242.15
107	55425.70	1680269.48
108	55440.34	1680342.59
109	55576.91	1680315.26

GENERAL HAZARDOUS MATERIAL PLAN
SCALE: 1"=100'-0"

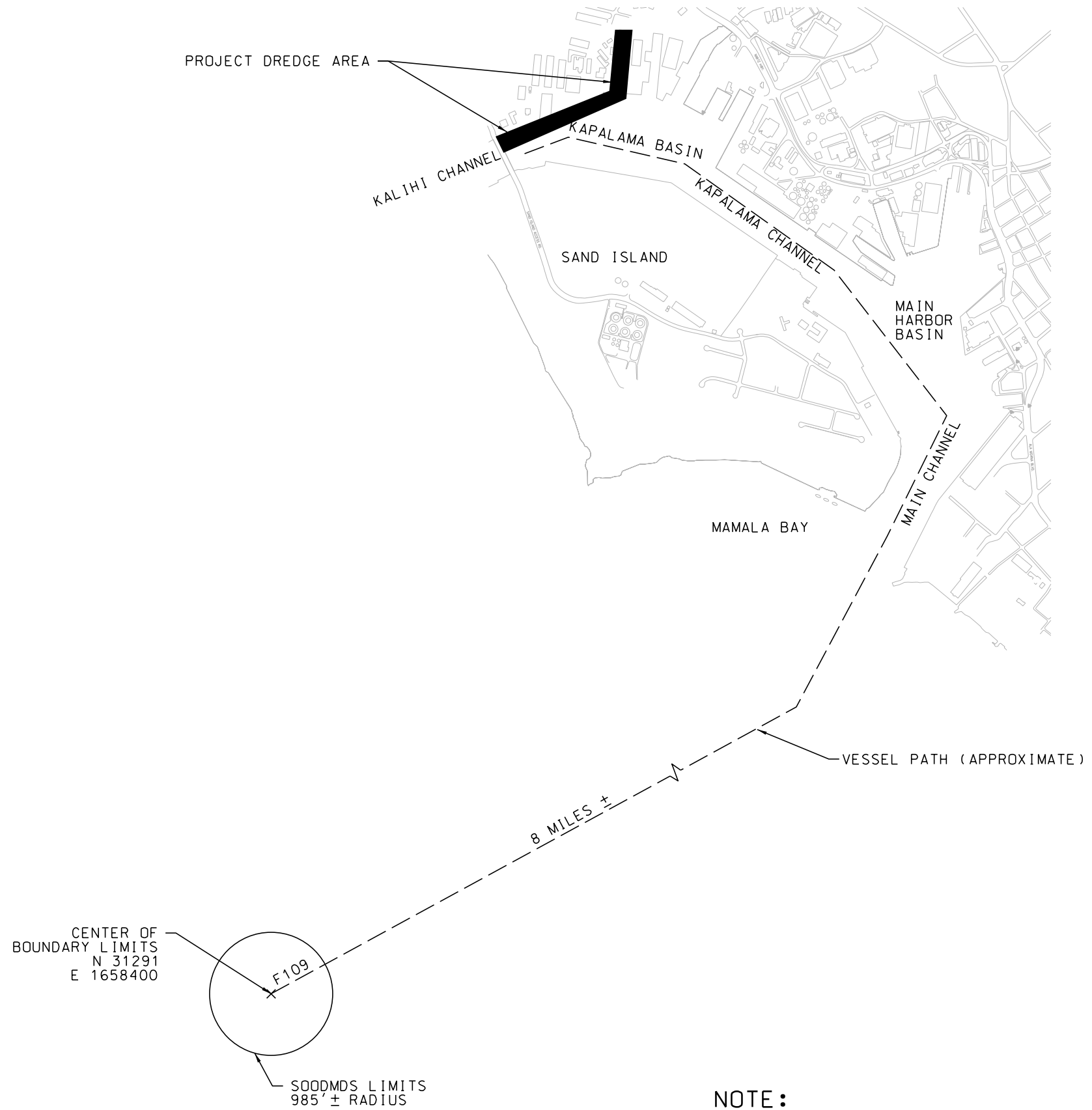
LEGEND:

 POTENTIAL AREA OF GROSSLY CONTAMINATED SOIL



REVISION		DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					
JOB TITLE					
THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					
SHEET TITLE					
GENERAL HAZARDOUS MATERIAL PLAN					
SUBMITTED BY:			RECOMMENDED BY:		
DESIGNED BY: RK			APPROVED BY:		
DRAWN BY: FS			HARBORS ADMINISTRATOR		
CHECKED BY: DC			JOB NUMBER		
DATE: 1/9/2015			H.C. 10498-00081		
SCALE: AS SHOWN			SHEET		
			H-101		
			34 of 259 SHEETS		

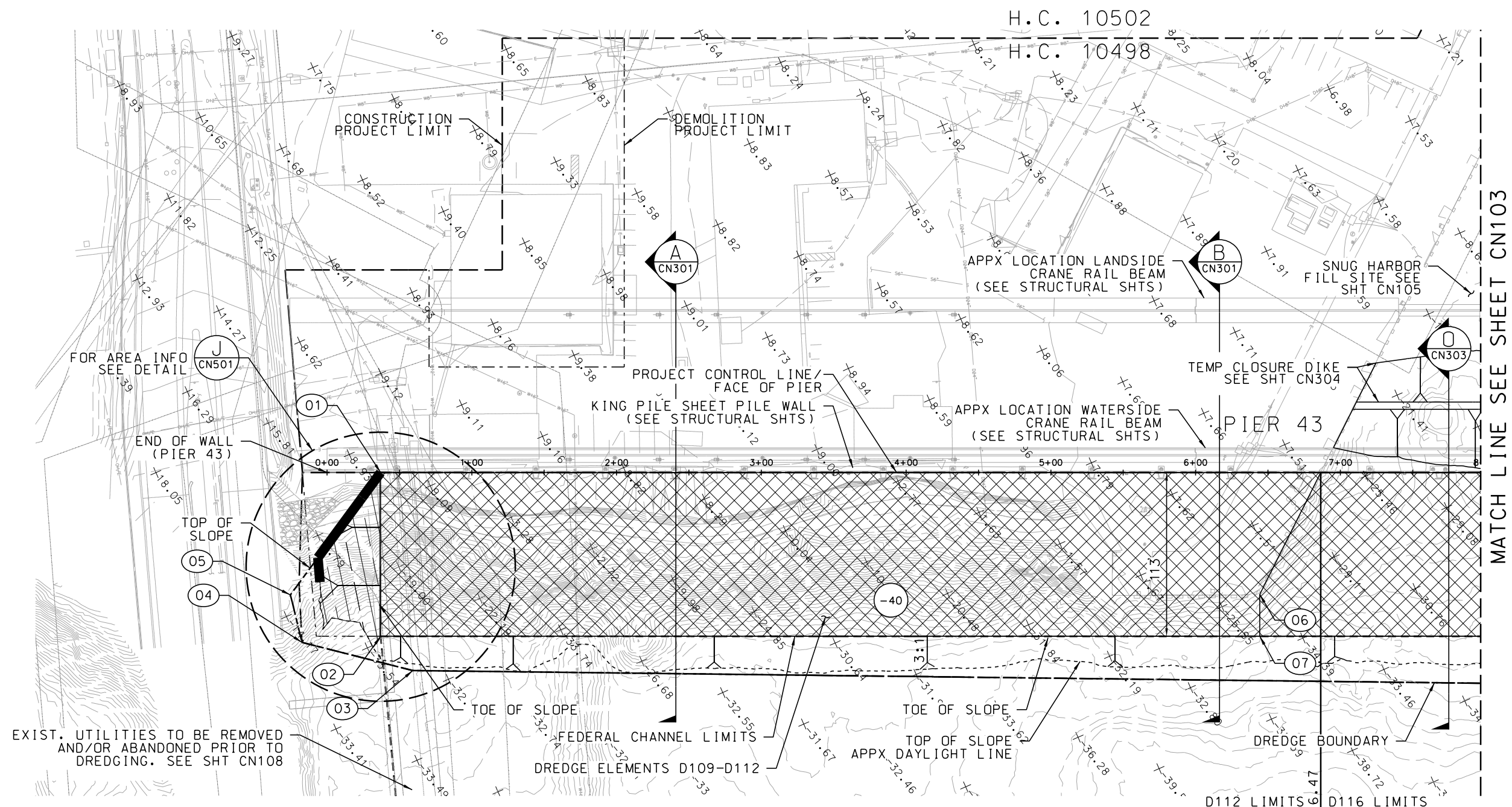
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NOTE:
 WHEN MATERIAL IS DISCHARGED WITHIN THE SOODMDS, NO PORTION OF THE VESSEL FROM WHICH MATERIALS ARE TO BE RELEASED MAY BE FURTHER THAN 985' FROM THE CENTER OF THE DISPOSAL SITE. ENTIRE VESSEL SHALL BE WITHIN 985' FROM CENTER OF SOODMDS PRIOR TO DISCHARGE. CONTRACTOR SHALL STAGGER DISCHARGE LOCATIONS SUCH THAT NO SEQUENTIAL DISCHARGE SHALL OVERLAP.

LICENSE EXPIRATION DATE: THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.		<table border="1"> <thead> <tr> <th>REVISION</th> <th>DATE</th> <th>DESCRIPTION</th> <th>BY</th> <th>APPROVED</th> </tr> </thead> <tbody> <tr> <td colspan="5" style="text-align: center;">STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION</td> </tr> <tr> <td colspan="5" style="text-align: center;">JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU</td> </tr> <tr> <td colspan="5" style="text-align: center;">SHEET TITLE DREDGE MATERIAL OFFSHORE DISPOSAL SITE MAP</td> </tr> <tr> <td colspan="2">SUBMITTED BY:</td> <td colspan="3">RECOMMENDED BY:</td> </tr> <tr> <td colspan="2">DESIGNED BY:</td> <td colspan="2">APPROVED BY:</td> <td>SHEET</td> </tr> <tr> <td colspan="2">DRAWN BY:</td> <td colspan="2">HARBORS ADMINISTRATOR</td> <td rowspan="2">CN101</td> </tr> <tr> <td colspan="2">CHECKED BY:</td> <td colspan="2">JOB NUMBER</td> </tr> <tr> <td colspan="2">DATE: 1/9/2015</td> <td colspan="2">H.C. 10498-00081</td> <td>38 of 259 SHEETS</td> </tr> <tr> <td colspan="2">SCALE: AS SHOWN</td> <td colspan="3"></td> </tr> </tbody> </table>		REVISION	DATE	DESCRIPTION	BY	APPROVED	STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					SHEET TITLE DREDGE MATERIAL OFFSHORE DISPOSAL SITE MAP					SUBMITTED BY:		RECOMMENDED BY:			DESIGNED BY:		APPROVED BY:		SHEET	DRAWN BY:		HARBORS ADMINISTRATOR		CN101	CHECKED BY:		JOB NUMBER		DATE: 1/9/2015		H.C. 10498-00081		38 of 259 SHEETS	SCALE: AS SHOWN				
REVISION	DATE	DESCRIPTION	BY	APPROVED																																																
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION																																																				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU																																																				
SHEET TITLE DREDGE MATERIAL OFFSHORE DISPOSAL SITE MAP																																																				
SUBMITTED BY:		RECOMMENDED BY:																																																		
DESIGNED BY:		APPROVED BY:		SHEET																																																
DRAWN BY:		HARBORS ADMINISTRATOR		CN101																																																
CHECKED BY:		JOB NUMBER																																																		
DATE: 1/9/2015		H.C. 10498-00081		38 of 259 SHEETS																																																
SCALE: AS SHOWN																																																				

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MATCH LINE SEE SHEET CN103

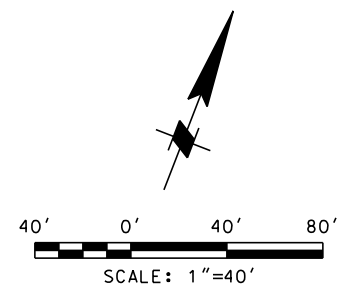
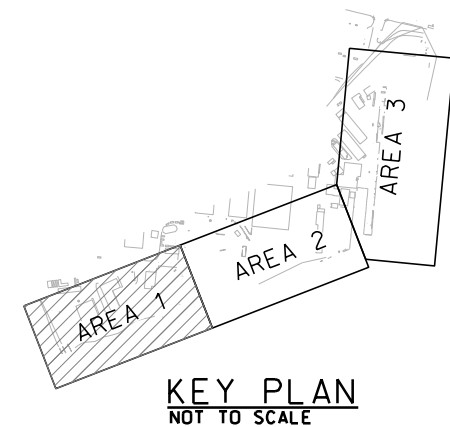
COORDINATE CONTROL		
○	NORTHING	EASTING
01	54018.89	1678509.51
02	53913.54	1678550.37
03	53899.45	1678579.60
04	53889.93	1678501.20
05	53917.59	1678481.89
06	54160.03	1679106.02
07	54133.11	1679116.46

NOTES:

1. SHEET PILE WALL AND TIEBACK SYSTEM ARE SHOWN ON STRUCTURAL SHEETS.
2. SEE DEMOLITION SHEETS FOR REMOVAL OF SLOPE AND LANDSIDE DEBRIS.
3. FOR DREDGE MATERIAL OFFLOADING SEE DETAIL N
CN501

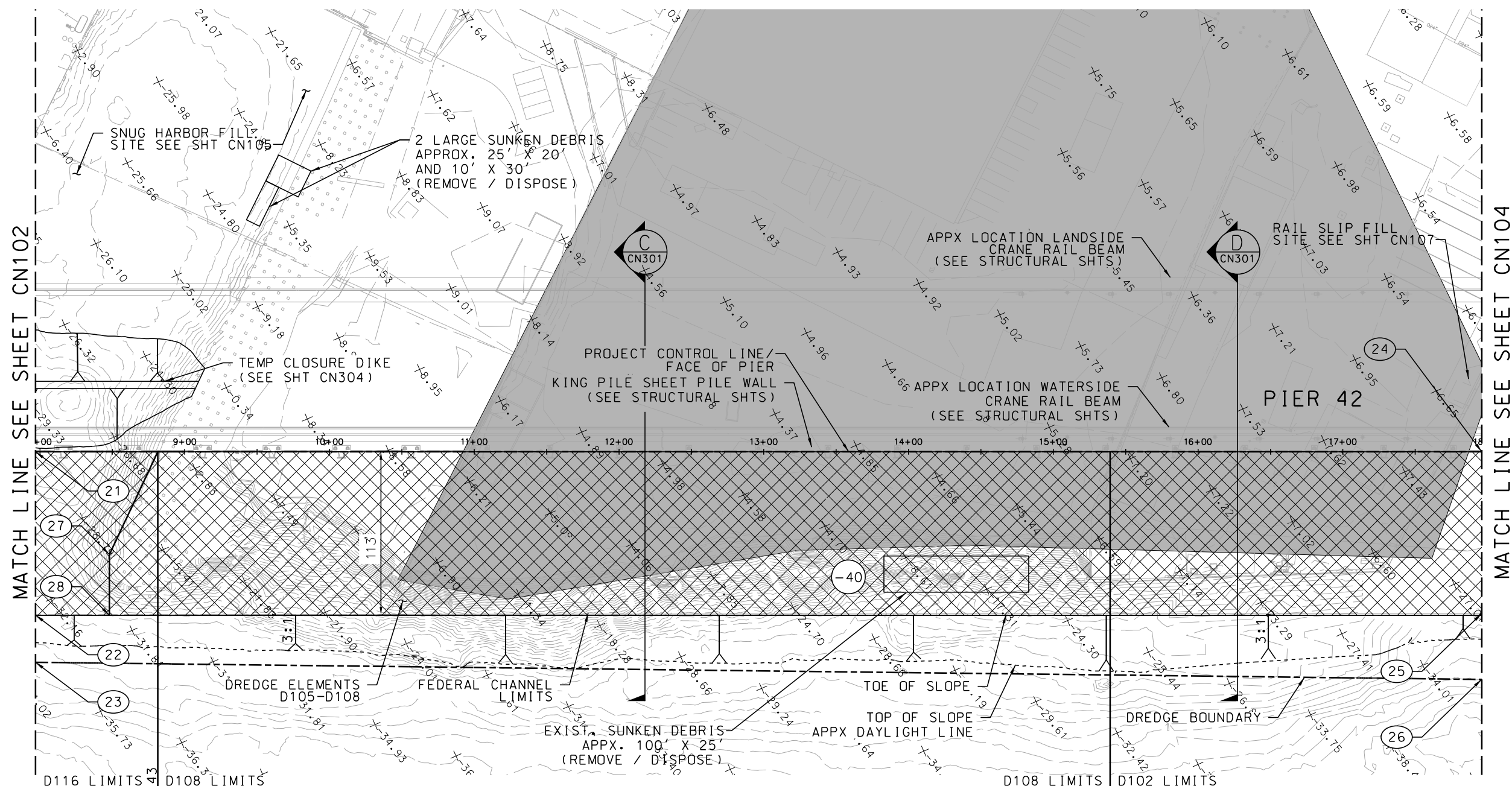
LEGEND:

- XX DREDGING CONTROL POINT
- XX PROJECT DREDGE DEPTH/ELEVATION
- DREDGE AREA
- XX EXISTING BATHYMETRY ELEVATIONS. SURVEY FROM SEA ENG. INC DATED 03/15/2013
- SLOPE SCOUR PROTECTION



LICENSE EXPIRATION DATE: THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.		STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION	
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU		SHEET TITLE DREDGE AREA 1	
SUBMITTED BY: _____		RECOMMENDED BY: _____	
DESIGNED BY: _____		APPROVED BY: _____	
DRAWN BY: _____		HARBORS ADMINISTRATOR	
CHECKED BY: _____		JOB NUMBER H.C. 10498-00081	
DATE: 1/9/2015		CN102	
SCALE: AS SHOWN		39 OF 259 SHTS.	

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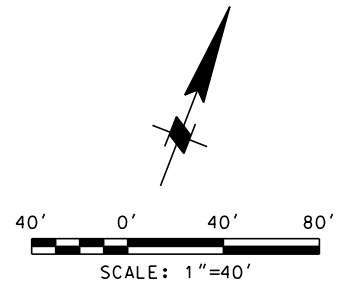
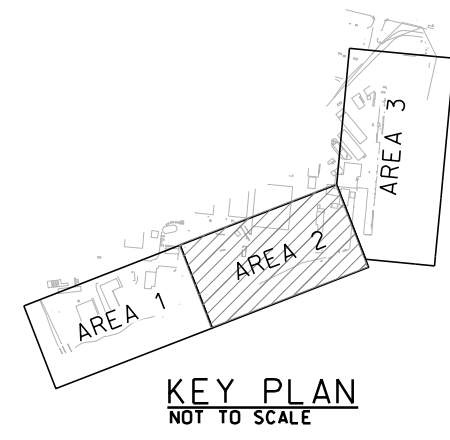
COORDINATE CONTROL		
	NORTHING	EASTING
21	54293.65	1679217.88
22	54188.30	1679258.75
23	54158.06	1679270.47
24	54654.95	1680149.37
25	54549.60	1680190.24
26	54508.33	1680206.24
27	54245.91	1679291.20
28	54206.77	1679306.38

NOTES:

1. SHEET PILE WALL AND TIEBACK SYSTEM ARE SHOWN ON STRUCTURAL SHEETS.
2. SEE DEMOLITION SHEETS FOR REMOVAL OF SLOPE AND LANDSIDE DEBRIS.
3. CONTRACTOR SHALL REMOVE, TEST FOR CONTAMINANTS, AND DISPOSE SUNKEN DEBRIS.
4. FOR DREDGE MATERIAL OFFLOADING SEE DETAIL (N) CN501

LEGEND:

- (XX) DREDGING CONTROL POINT
- (-XX) PROJECT DREDGE DEPTH/ELEVATION
- [Hatched Box] DREDGE AREA
- [Grey Box] AREA OF KNOWN CHEMICALLY CONTAMINATED SOIL, SEE SHT H-101
- xx EXISTING BATHYMETRY ELEVATIONS, SURVEY FROM SEA ENG. INC DATED 03/15/2013



REVISION		DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					
SHEET TITLE DREDGE AREA 2					
SUBMITTED BY:			RECOMMENDED BY:		
DESIGNED BY:			APPROVED BY:		
DRAWN BY:			HARBORS ADMINISTRATOR		
CHECKED BY:			JOB NUMBER		
DATE: 1/9/2015			H.C. 10498		
SCALE: AS SHOWN			40 of 259 SHTS		

LICENSE EXPIRATION DATE: _____
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

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MATCH LINE SEE SHEET CN103

APPX LOCATION LANDSIDE CRANE RAIL BEAM (SEE STRUCTURAL SHTS)
FOR FILL AREA SEE SHT CN107

APPX LOCATION TIE ROD DEADMAN (SEE STRUCTURAL SHTS)

KING PILE SHEET PILE WALL/ FACE OF PIER (SEE STRUCTURAL SHTS)

PROJECT CONTROL LINE/ FACE OF PIER

PIER 41

EXISTING OUTFALL SEE UTILITY SHTS

SHEET PILE WALL (SEE STRUCTURAL SHTS)

DREDGE BOUNDARY (APPX)

DREDGE ELEMENTS D101- D104

DREDGE ELEMENT D102

FACE OF PIER 40

PIER 40

DREDGE ELEMENTS D102, D105-D107

FEDERAL CHANNEL LIMIT

COORDINATE CONTROL		
	NORTHING	EASTING
41	54673.04	1680196.01
42	55693.89	1680292.52
43	55689.19	1680342.30
44	55672.23	1680519.54
45	55560.52	1680508.94
46	55579.16	1680368.92
47	55446.37	1680351.04
48	54722.24	1680373.57
49	54625.52	1680613.24
50	54593.08	1680600.15
51	54566.03	1680360.39
52	54718.06	1680242.95
53	54704.52	1680263.34
54	54570.62	1680244.43
55	54700.88	1680198.64

NOTES:

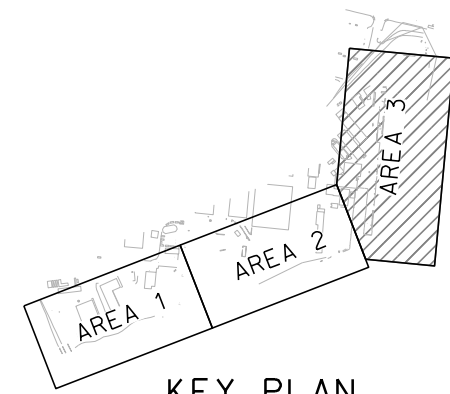
1. SHEET PILE WALL AND TIEBACK SYSTEM ARE SHOWN ON STRUCTURAL SHEETS.
2. SEE DEMOLITION SHEETS FOR REMOVAL OF SLOPE AND LANDSIDE DEBRIS.

DEBRIS ENCOUNTERED IN THE DREDGE MATERIAL SHALL BE REMOVED AND DISPOSED IN ACCORDANCE WITH CONTRACT DOCUMENTS AND LOCAL REGULATIONS.

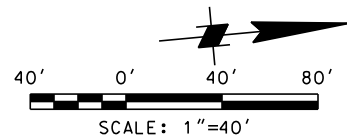
FOR DREDGE MATERIAL OFFLOADING SEE DETAIL

LEGEND:

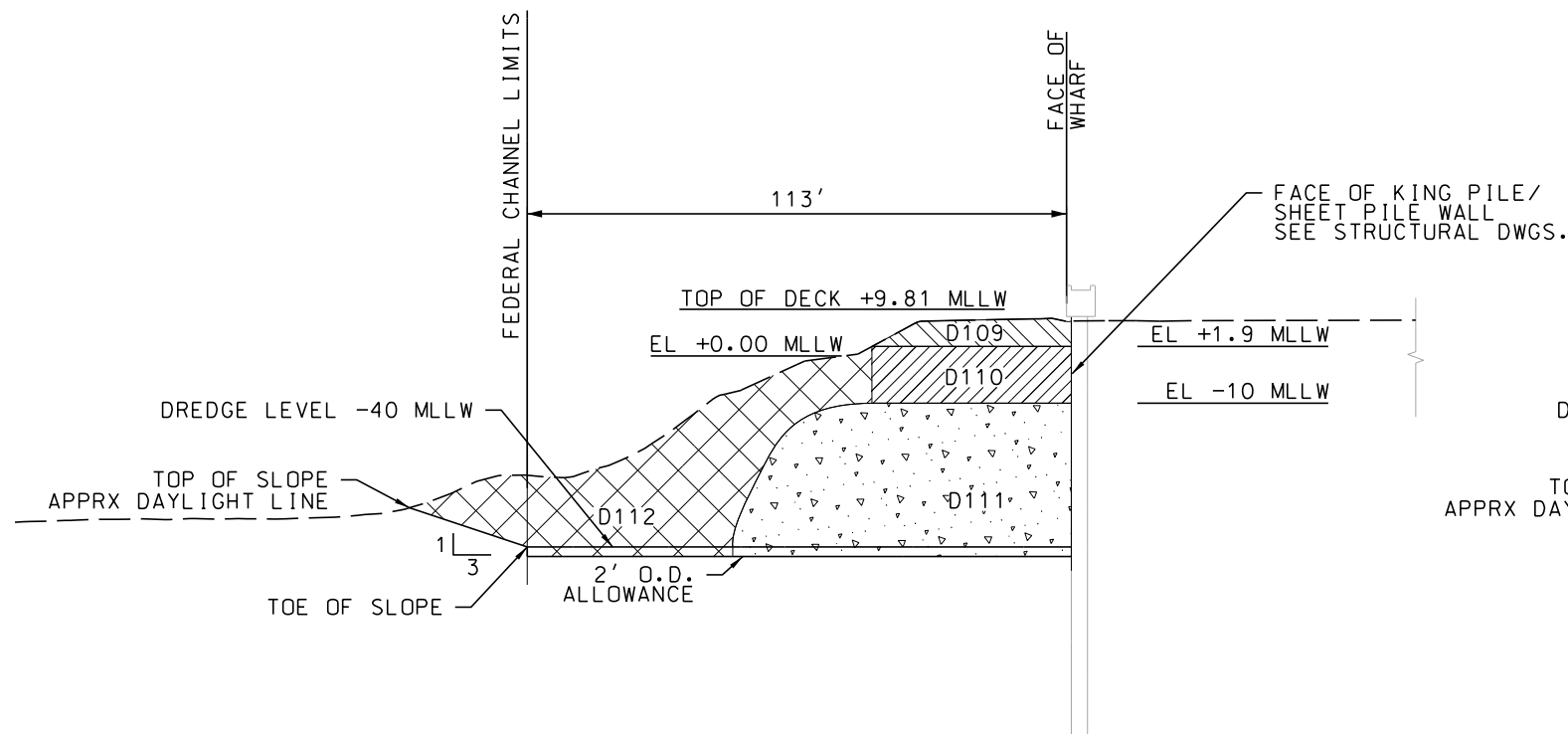
- (XX) DREDGING CONTROL POINT
- (-XX) PROJECT DREDGE DEPTH/ELEVATION
- [Hatched Box] DREDGE AREA
- [Solid Grey Box] AREA OF KNOWN CHEMICALLY CONTAMINATED SOIL, SEE SHT H-101
- [Diagonal Line Box] FILL AREA
- XX EXISTING BATHYMETRY ELEVATIONS. SURVEY FROM SEA ENG, INC DATED 03/15/2013



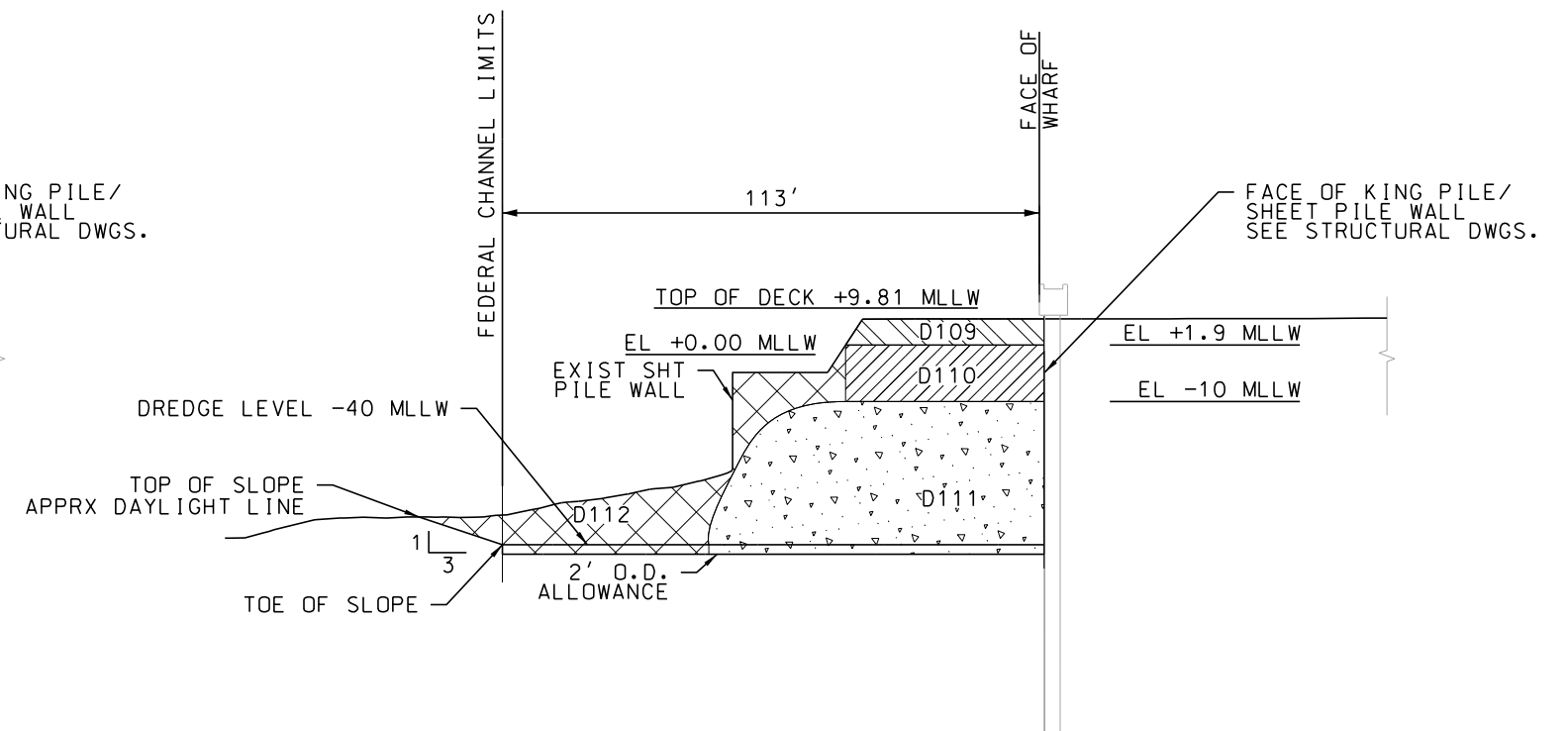
KEY PLAN NOT TO SCALE



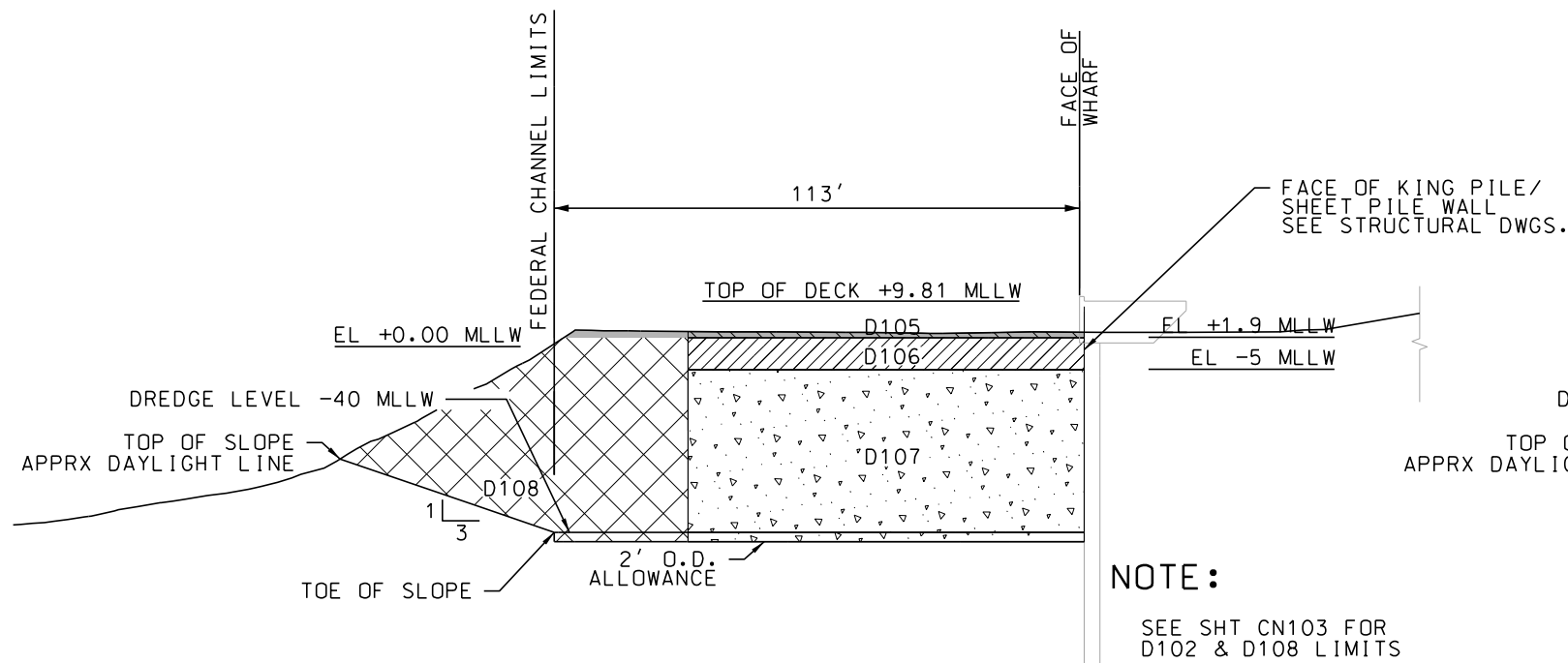
REVISION		DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					
SHEET TITLE DREDGE AREA 3					
SUBMITTED BY:			RECOMMENDED BY:		
DESIGNED BY:			APPROVED BY:		
DRAWN BY:			HARBORS ADMINISTRATOR		
CHECKED BY:			JOB NUMBER		
DATE: 1/9/2015			H.C. 10498		
SCALE: AS SHOWN			CN104 41 of 259 SHTS		



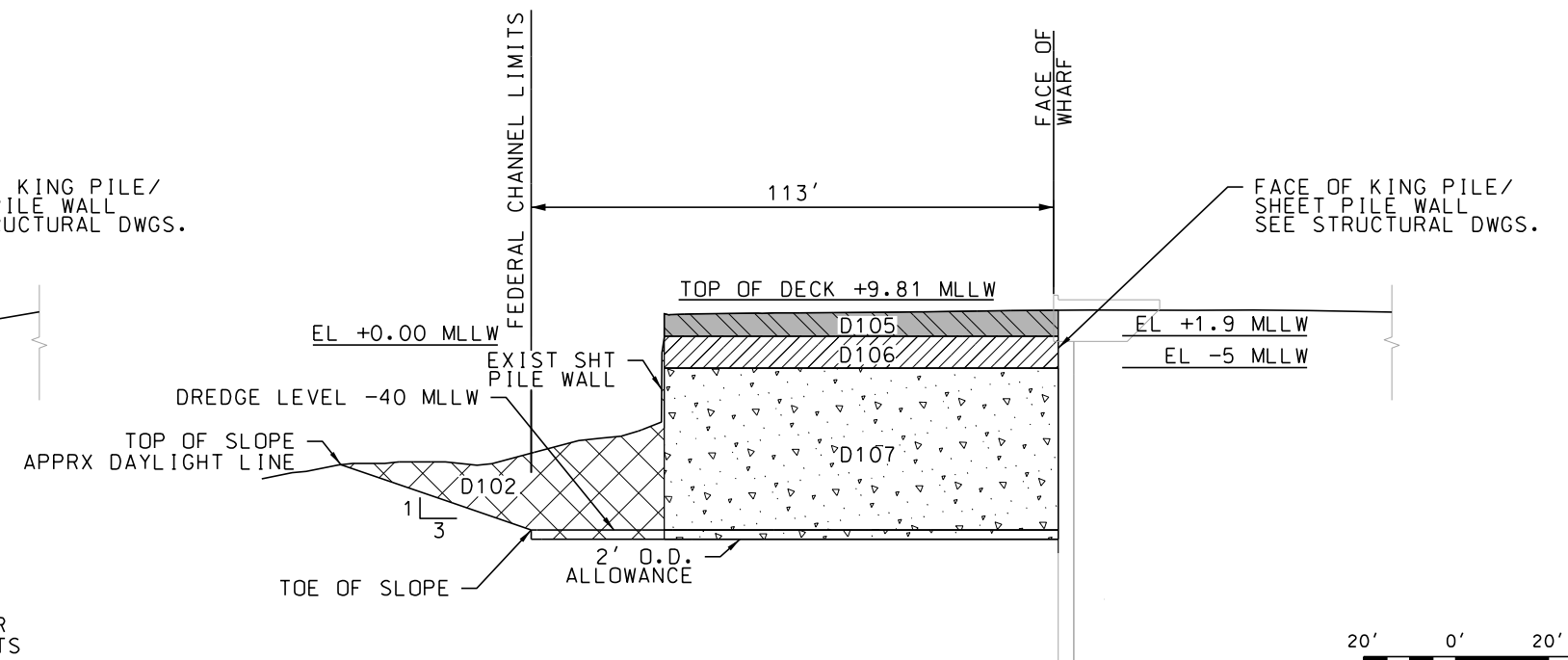
A PIER 43 TYPICAL SECTION STA 0+37.08-5+00.00
 CN102 SCALE: 1"=20'



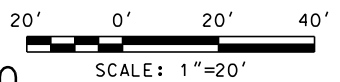
B PIER 43 TYPICAL SECTION STA 5+00.00-6+86.50
 CN102 SCALE: 1"=20'



C PIER 42 SECTION STA 8+81.43-15+39.28
 CN103 SCALE: 1"=20'



D PIER 42 SECTION STA 15+39.28-17+50.00
 CN103 SCALE: 1"=20'



LEGEND:

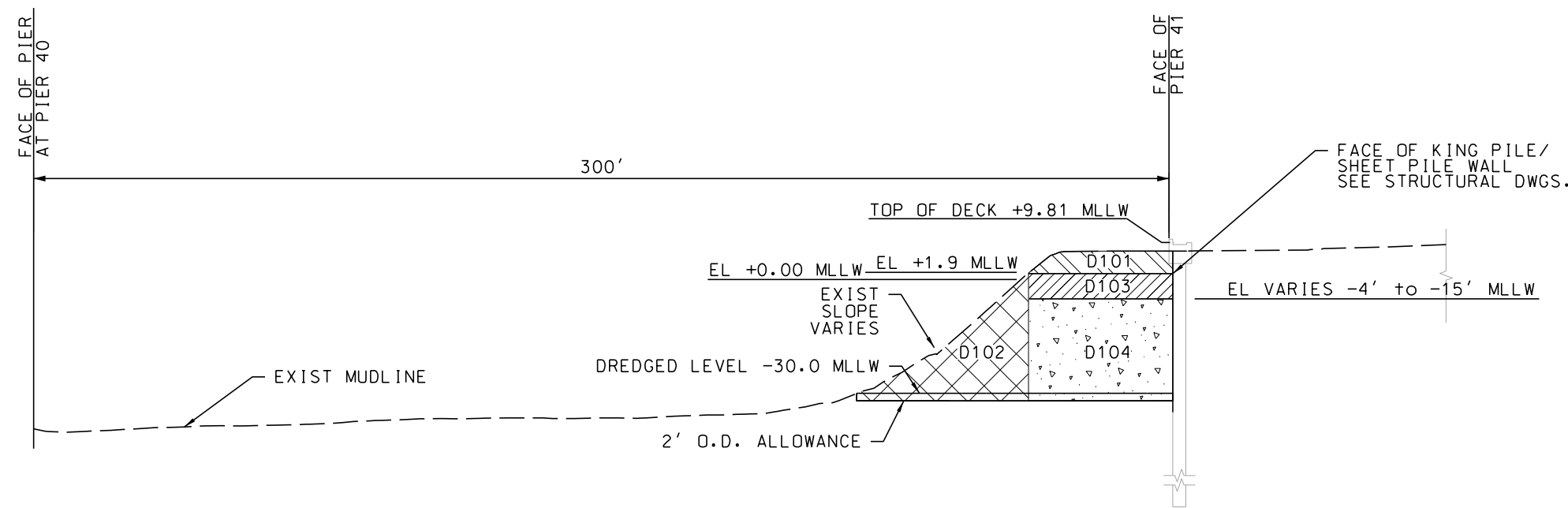
- EXISTING FILL
- LAGOONAL DEPOSITS
- CORALLINE FORMATION
- HARBOR DEPOSITS
- AREA OF KNOWN CHEMICALLY CONTAMINATED SOILS - SEE SHT CN001

NOTES:

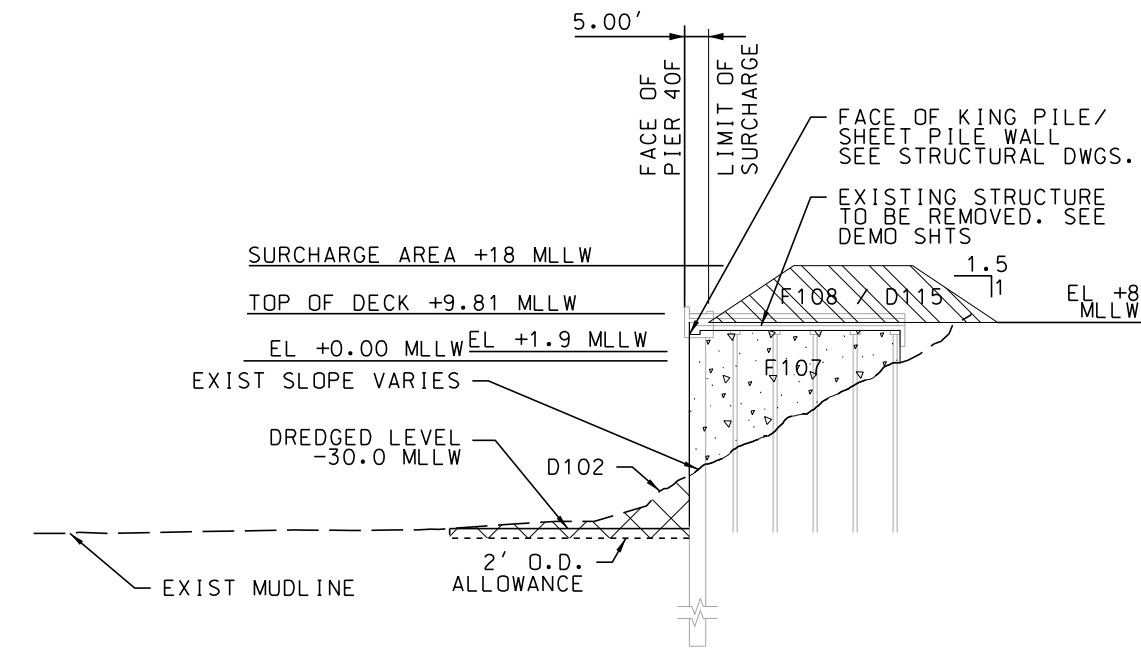
1. MATERIAL CHARACTERISTICS SHOWN ON THESE PLANS BASED ON THE GEOTECHNICAL REPORT CONDUCTED BY GEOLABS, Inc. TITLED: "GEOTECHNICAL ENGINEERING EXPLORATION KAPALAMA CONTAINER WHARF AND DREDGING DESIGN HONOLULU, OAHU, HAWAII" AUGUST 8, 2014
2. FOR DREDGE ELEMENT (DXXX) AND FILL ELEMENT (FXXX) SEE LEGENDS SHEET CN001.

Appendix A: Reduced Size Plans Showing Phasing of Wharf and Dredging Project

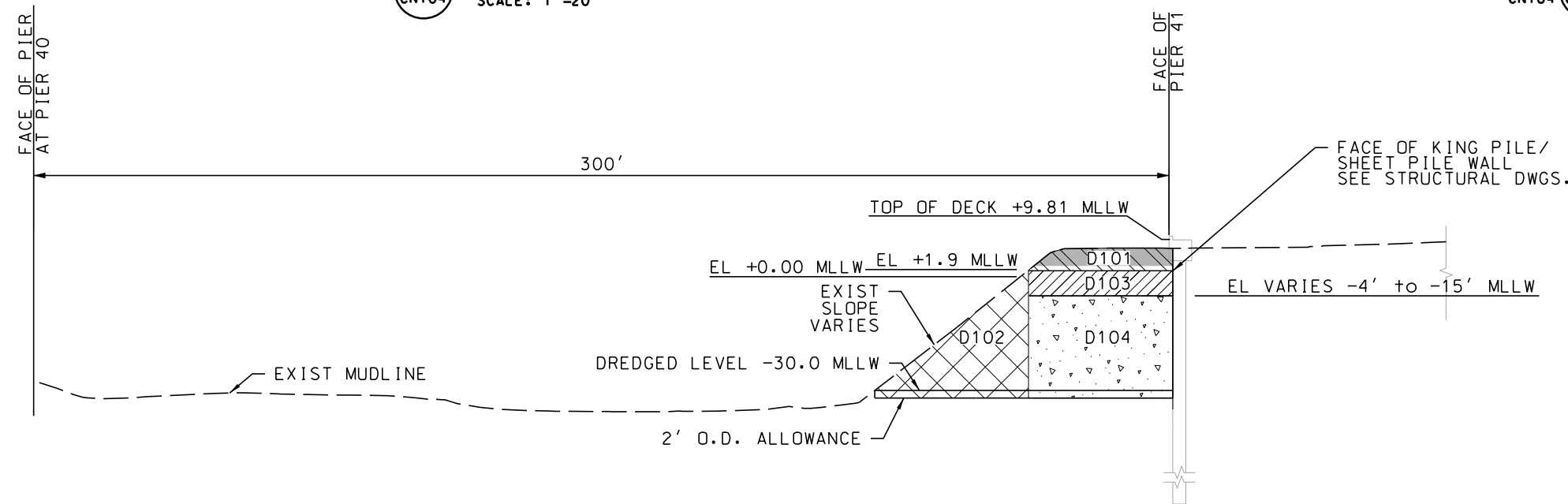
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION							
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU							
SHEET TITLE DREDGE SECTIONS 1							
SUBMITTED BY:				RECOMMENDED BY:			
DESIGNED BY:				APPROVED BY:			
DRAWN BY:				HARBORS ADMINISTRATOR			
CHECKED BY:				JOB NUMBER			
DATE: 1/9/2015				H.C. 10498 46 OF 259 SHEETS			
SCALE: AS SHOWN							



E PIER 41 TYPICAL SECTION STA 19+01.00-26+02.23
 CN104 SCALE: 1"=20'



G PIER 40F TYPICAL SECTION STA 28+71.41-31+70.00
 CN104 CN107 SCALE: 1"=20'



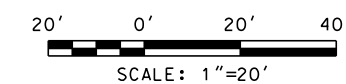
F PIER 41 SECTION STA 26+02.23-28+71.41
 CN104 SCALE: 1"=20'

LEGEND:

- EXISTING FILL / SURCHARGE FILL
- LAGOONAL DEPOSITS
- CORALLINE FORMATION / FILL
- HARBOR DEPOSITS
- AREA OF KNOWN CHEMICALLY CONTAMINATED SOIL, SEE SHT H-101

NOTE:

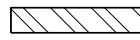
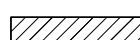
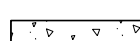
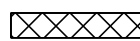

1. MATERIAL CHARACTERISTICS SHOWN ON THESE PLANS BASED ON THE GEOTECHNICAL REPORT CONDUCTED BY GEOLABS, Inc. TITLED:
 "GEOTECHNICAL ENGINEERING EXPLORATION KAPALAMA CONTAINER WHARF AND DREDGING DESIGN, HONOLULU, OAHU, HAWAII"
 AUGUST 8, 2014
2. FOR DREDGE ELEMENT (DXXX) AND FILL ELEMENT (FXXX) SEE LEGENDS SHEET CN001.

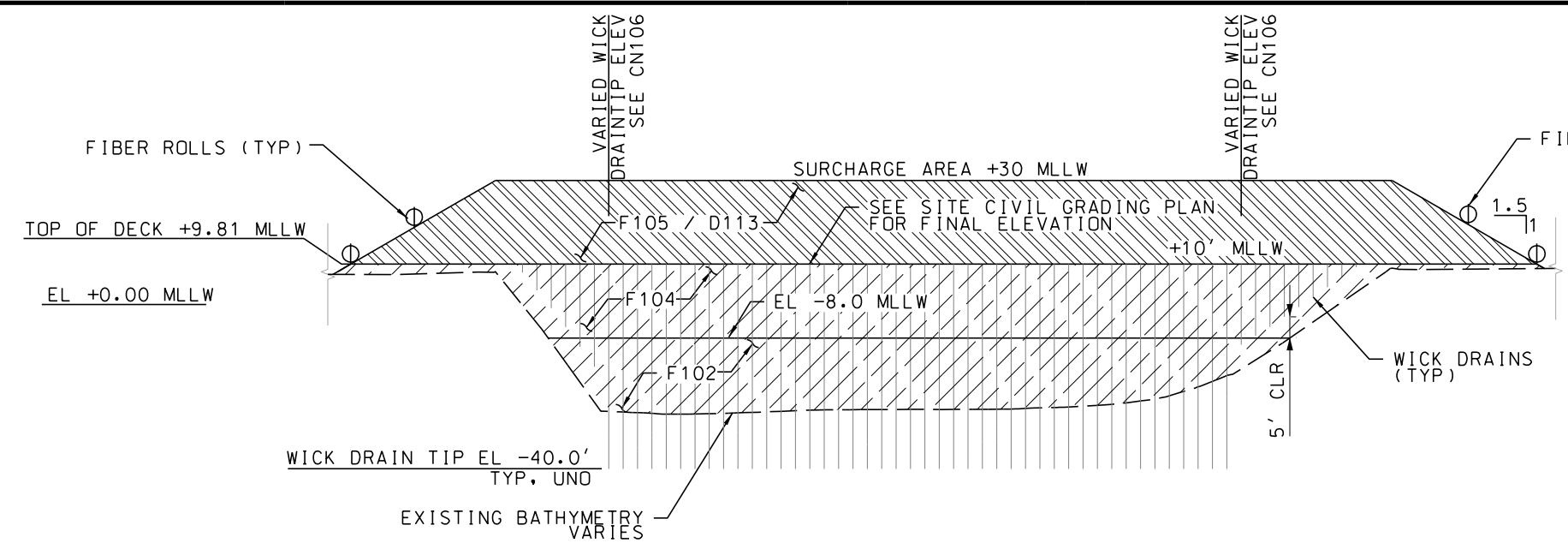


REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE DREDGE SECTIONS 2				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY:		APPROVED BY:		SHEET
DRAWN BY:		HARBORS ADMINISTRATOR		CN302
CHECKED BY:		JOB NUMBER		
DATE: 1/9/2015		H.C. 10498-00081		
SCALE: AS SHOWN		47 of 259 SHIS.		

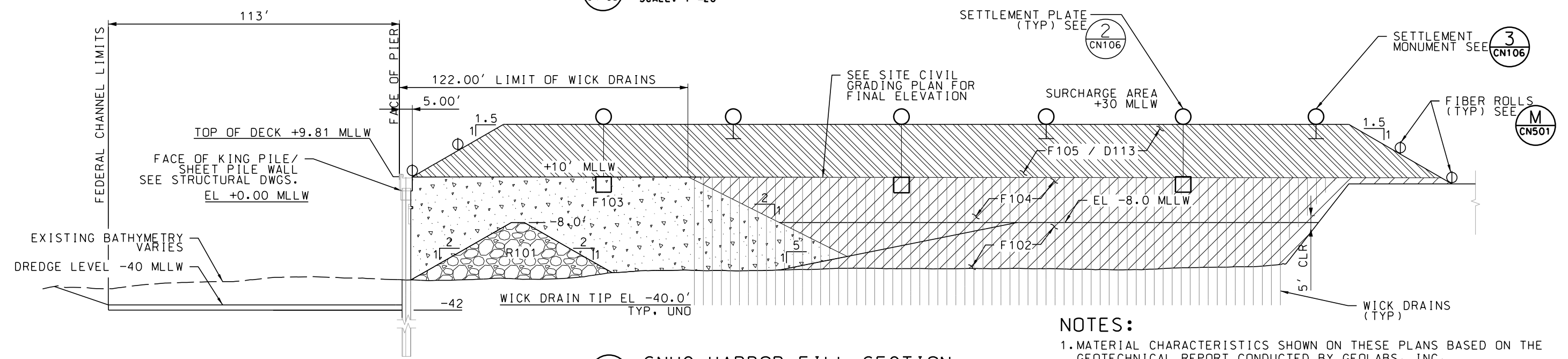
LICENSE EXPIRATION DATE:
 THIS WORK WAS PREPARED BY ME
 OR UNDER MY SUPERVISION.

LEGEND:

-  SURCHARGE FILL
-  HARBOR DEPOSITS / NON-CORALLINE FILL
-  CORALLINE FILL
-  HARBOR DEPOSITS
-  GRAVEL OR PROCESSED / RECYCLED CONCRETE DIKE



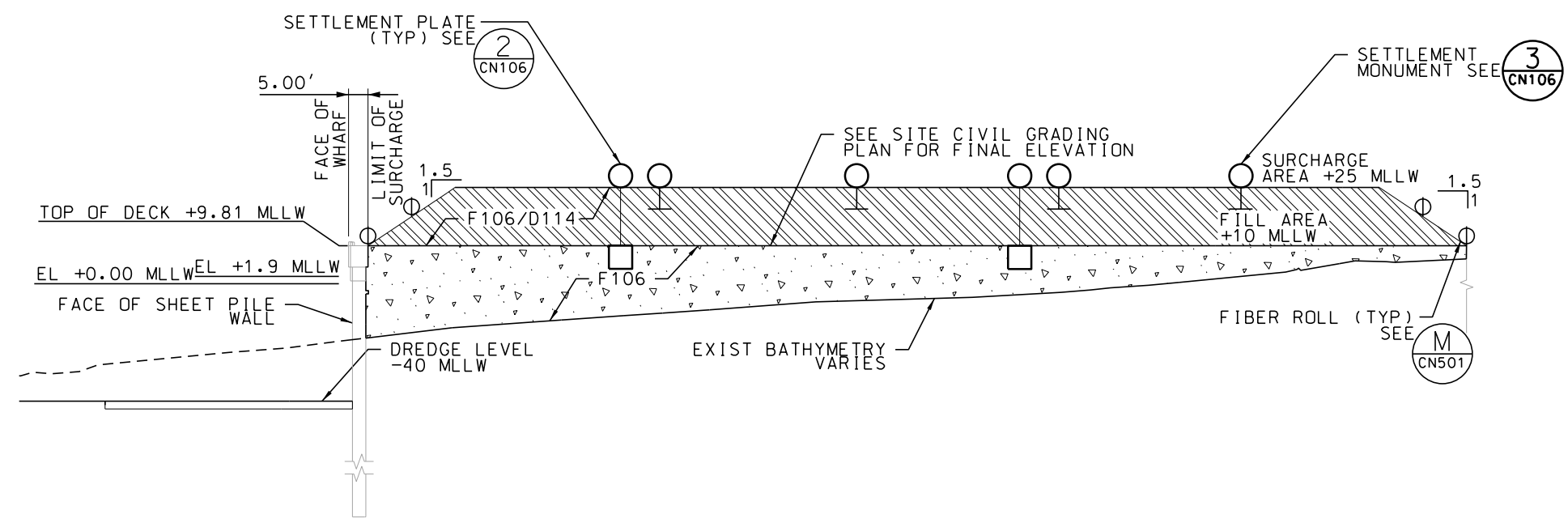
H SNUG HARBOR FILL SECTION
 CN105 SCALE: 1"=20'



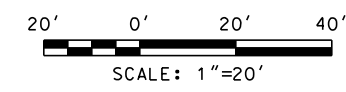
I SNUG HARBOR FILL SECTION
 CN105 SCALE: 1"=20'

NOTES:

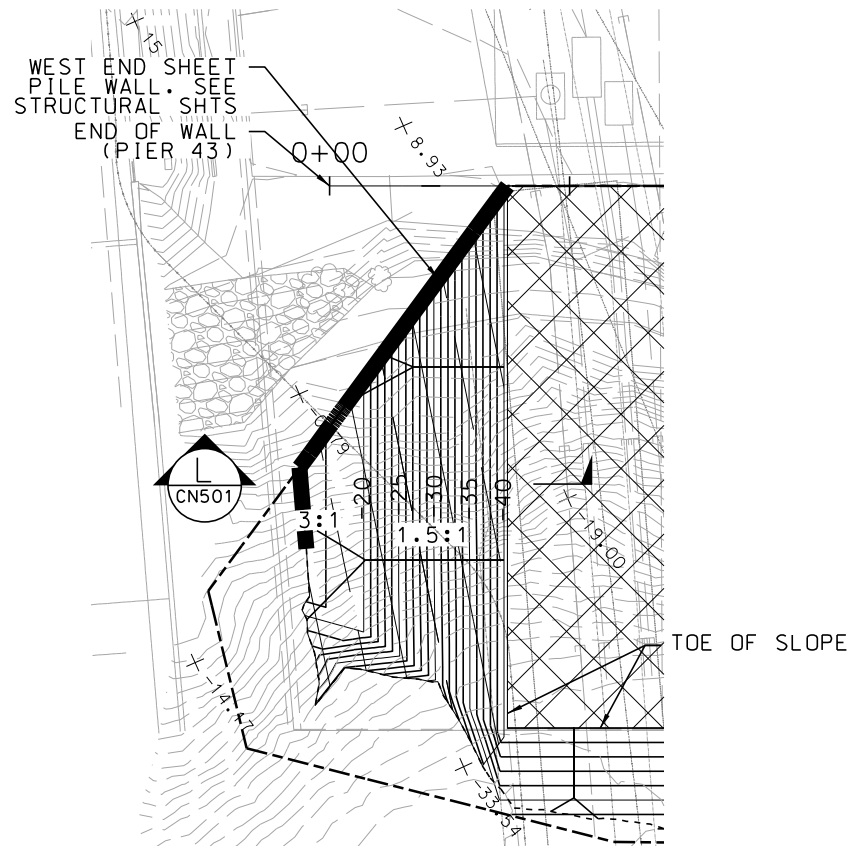
1. MATERIAL CHARACTERISTICS SHOWN ON THESE PLANS BASED ON THE GEOTECHNICAL REPORT CONDUCTED BY GEOLABS, INC. TITLED: "GEOTECHNICAL ENGINEERING EXPLORATION KAPALAMA CONTAINER WHARF AND DREDGING DESIGN" HONOLULU, OAHU, HAWAII, AUGUST 8, 2014
2. SNUG HARBOR SURCHARGE SHALL REMAIN IN PLACE FOR A MINIMUM PERIOD OF 6 MONTHS. RAIL SLIP SURCHARGE SHALL BE IN PLACE A MINIMUM OF 8 MONTHS.
3. WORKING SURFACE FOR WICK DRAINS CAN BE ANYWHERE BETWEEN EL. +10' AND EL. 30' MLLW, AS DETERMINED BY THE ENGINEER
4. FOR DREDGE ELEMENT (DXXX) AND FILL ELEMENT (FXXX) SEE LEGENDS SHEET CN001.



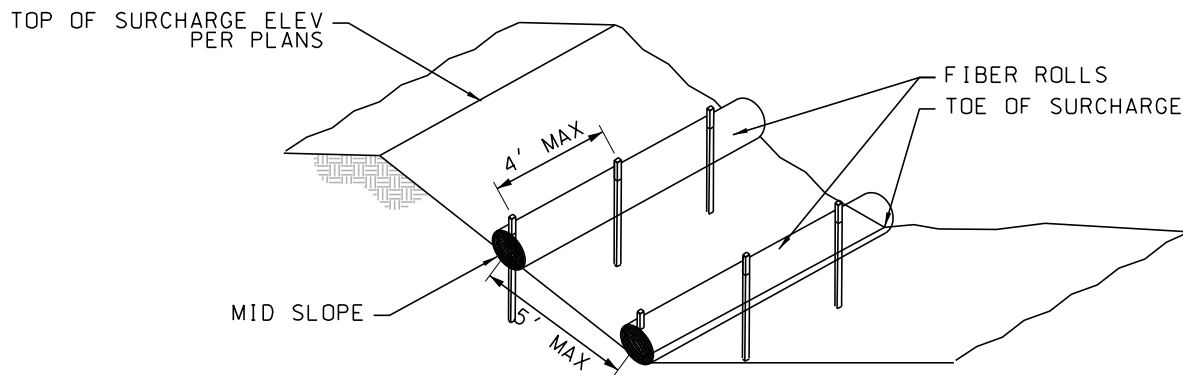
A RAIL SLIP FILL SECTION
 CN107 SCALE: 1"=20'



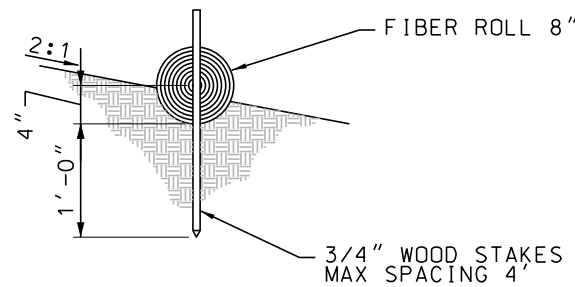
REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE FILL SECTIONS				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY:		APPROVED BY:		SHEET
DRAWN BY:		HARBORS ADMINISTRATOR		CN304
CHECKED BY:		JOB NUMBER		
DATE: 1/9/2015		H.C. 10498-00081		
SCALE: AS SHOWN		49 of 259 SHEETS		



J DREDGE AREA AT EXIST BRIDGE
SCALE: 1"=20'



FIBER ROLL INSTALLATION

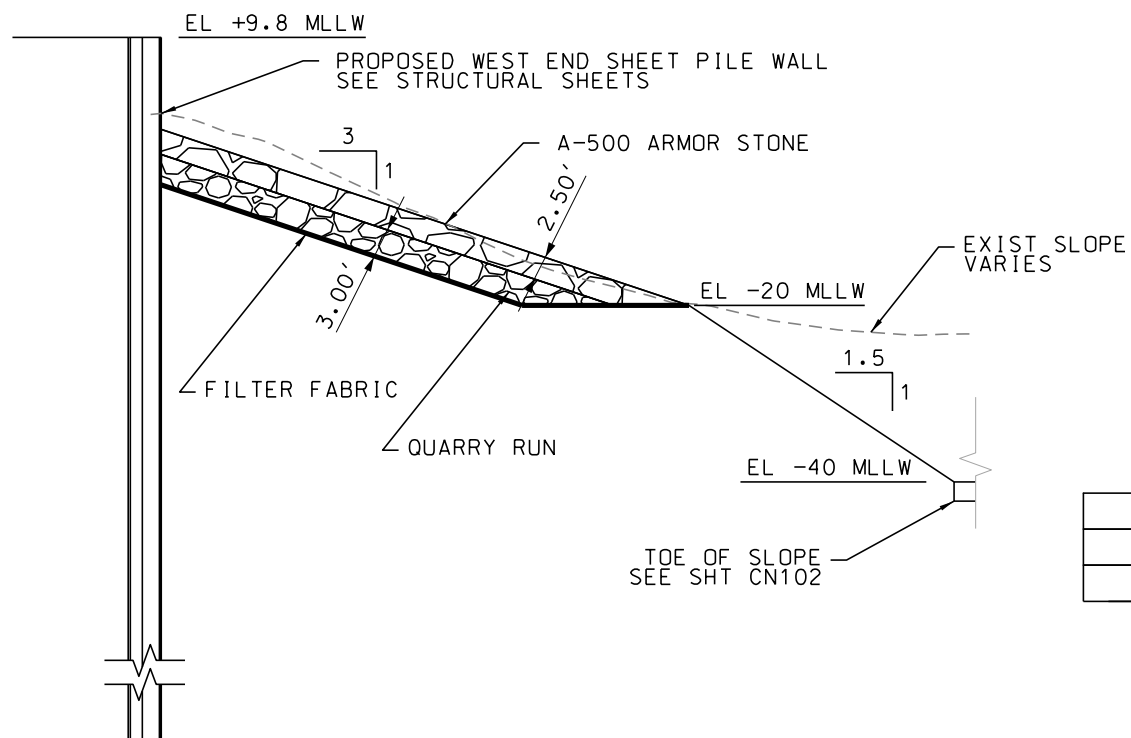


ENTRENCHMENT DETAIL

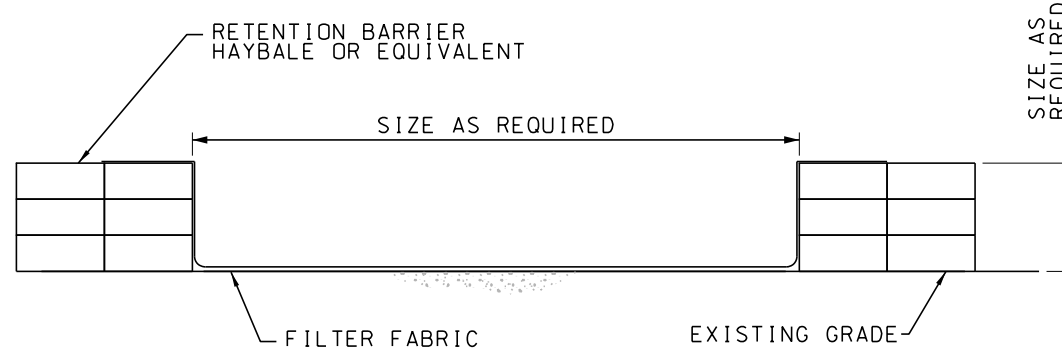
M FIBER ROLL DETAIL
SCALE: NTS

NOTES:

1. FIBER ROLLS SHALL BE EITHER PREFABRICATED ROLLS OR ROLLED TUBES OF EROSION CONTROL BLANKET.
2. BIND ROLL AT EACH END AND EVERY 4' ALONG LENGTH OF ROLL WITH JUTE-TYPE TWINE.
3. IF MORE THAN ONE FIBER ROLL IS PLACED IN A ROW, THE ROLL SHALL BE OVERLAPPED MIN. 6".
4. DREDGE MATERIAL TRANSFER AREA TO BE DETERMINED BY CONTRACTOR WITH ENGINEER'S APPROVAL.



L ROCK REVETMENT DETAIL
SCALE: 1"=10'

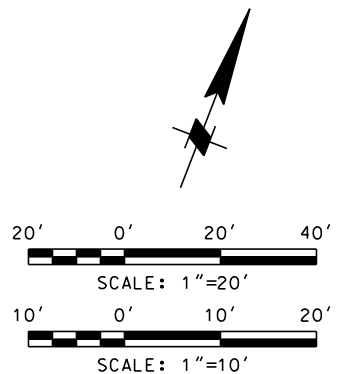


DREDGE TRANSFER DETAIL NONCONTAMINATED MATERIAL (SEE NOTE 3)

N SCALE: NTS

NOTES:

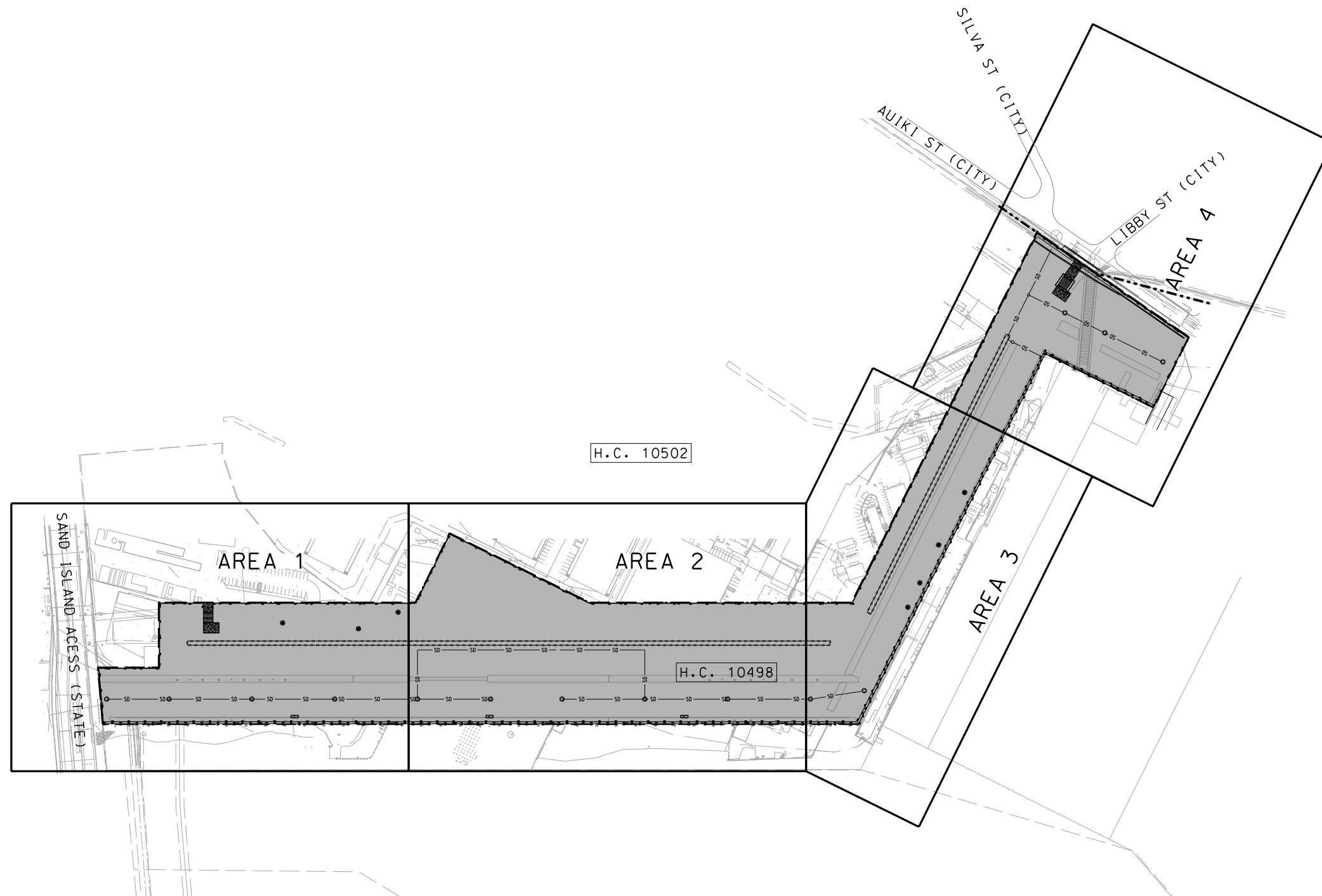
1. SHEET PILE PENETRATION WILL BE DETERMINED BASED ON GEOTECHNICAL REPORT
2. FOR WEST END SHEET PILE WALL DETAILS SEE STRUCTURAL SHEETS.
3. FOR TRANSFER / TEMPORARY STORAGE OF CONTAMINATED MATERIAL SEE SHEET CE503



REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE DREDGE DETAILS 1				
SUBMITTED BY:			RECOMMENDED BY:	
DESIGNED BY:			APPROVED BY:	
DRAWN BY:			HARBORS ADMINISTRATOR	
CHECKED BY:			JOB NUMBER	
DATE: 1/9/2015			H.C. 10498-00081	
SCALE: AS SHOWN			CN501	
			50 of 259 SHTS.	

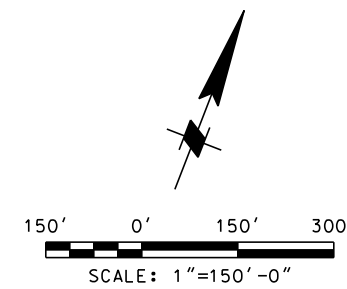
EROSION CONTROL NOTES:

1. EQUIPMENT FOR EMERGENCY WORK SHALL BE MADE AVAILABLE ON SITE AND STOCKPILED AT CONVENIENT LOCATIONS AND WORKERS SHALL BE AVAILABLE TO FACILITATE RAPID CONSTRUCTION OF TEMPORARY DEVICES WHEN RAIN IS IMMINENT.
2. EROSION CONTROL DEVICES SHALL NOT BE MOVED OR MODIFIED WITHOUT THE APPROVAL OF THE ENGINEER.
3. ALL REMOVABLE EROSION PROTECTION DEVICES SHALL BE IN PLACE AT THE END OF EACH WORKING DAY WHEN THE 5-DAY RAIN PROBABILITY FORECAST EXCEEDS 40%.
4. AFTER A RAINSTORM, ALL SILT AND DEBRIS SHALL BE REMOVED FROM STREETS AND EROSION CONTROL DEVICES SHALL BE CLEANED/CLEARED OF COLLECTED SILT AND OTHER DEBRIS AND REPAIRED/RESET AS NECESSARY. CONTRACTOR SHALL CHECK BERMS, BASINS, DRAINS, INLETS, TRENCH DRAINS, ETC. FOR SILT AND DEBRIS AND MODIFY EROSION CONTROL DEVICES AS NECESSARY..
5. GRADED AREAS ON THE PERMITTED AREA PERIMETER MUST DRAIN AWAY FROM THE FACE OF SLOPES AT THE END OF EACH WORKING DAY. DRAINAGE TO BE DIRECTED TOWARD DESILTING FACILITIES.
6. THE PERMITTEE SHALL BE RESPONSIBLE AND TAKE NECESSARY PRECAUTIONS TO PREVENT PUBLIC TRESPASS ONTO AREAS WHERE IMPOUNDED WATER CREATES A HAZARDOUS CONDITION.
7. INSTALL STABILIZED CONSTRUCTION ENTRANCE AT ALL POINTS OF ACCESS/EGRESS FOR CONSTRUCTION VEHICLES. SEE SHEET CE502.
8. ENSURE NO SOILS/SEDIMENT/MUD LEAVE THE SITE.
9. PROTECT ALL STORM DRAIN INLETS WITH SEDIMENT FILTERS. SEE SHEET CE501.
10. COMPLY WITH ALL APPLICABLE NPDES BMP'S REQUIRED FOR CONSTRUCTION ACTIVITIES.



LEGEND:

PROJECT AREA

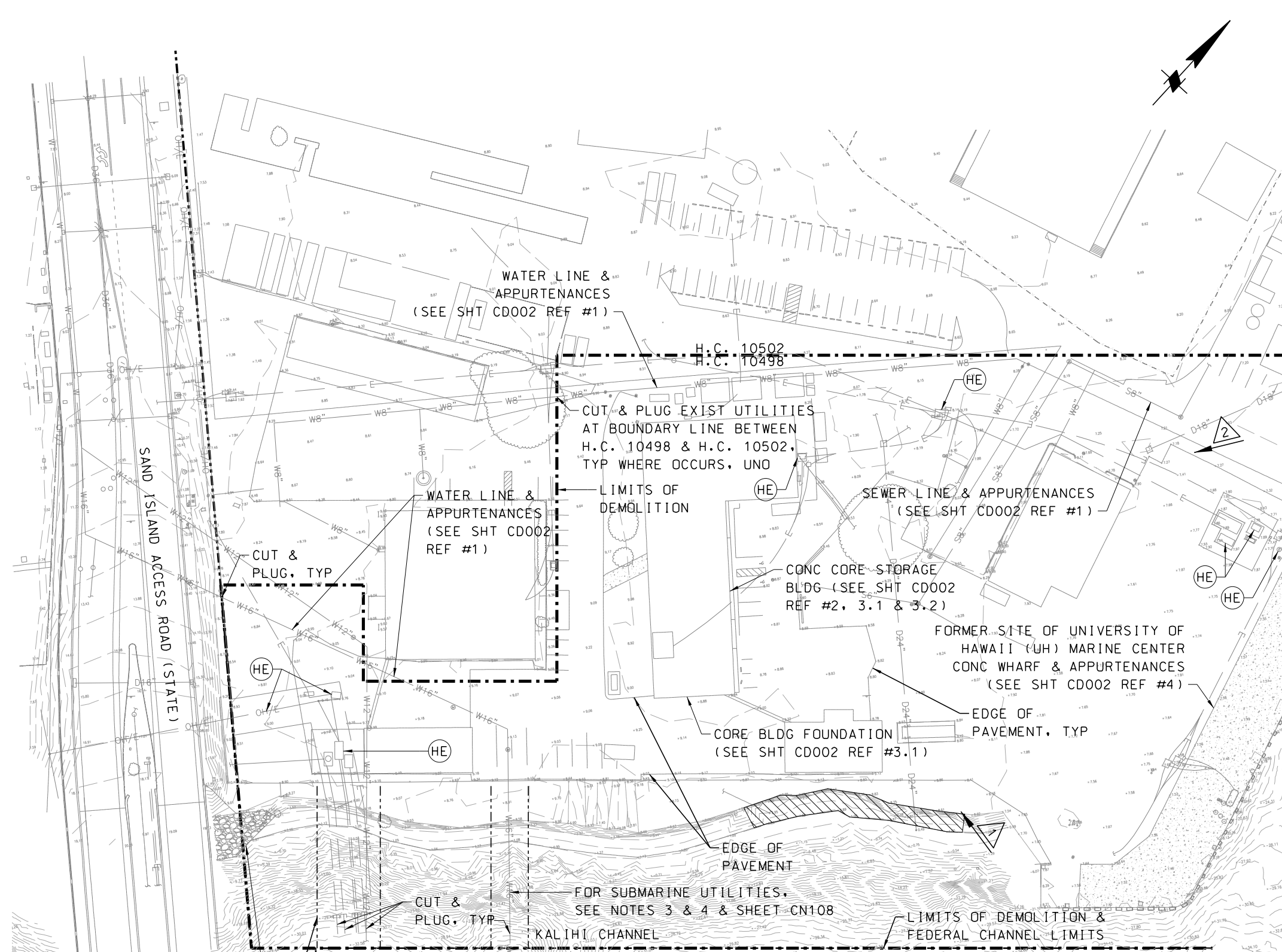


APPROVED: _____ Date _____
 Chief, Civil Engineering Branch, DPP
 City and County of Honolulu
 (FOR WORK WITHIN CITY RIGHTS OF WAY ONLY)

LICENSE EXPIRATION DATE: _____
 THIS WORK WAS PREPARED BY ME
 OR UNDER MY SUPERVISION.

REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE EROSION CONTROL PLAN KEY MAP				
SUBMITTED BY: _____		RECOMMENDED BY: _____		
DESIGNED BY: GLL		APPROVED BY: _____		SHEET
DRAWN BY: AP		HARBORS ADMINISTRATOR		CE101
CHECKED BY: RK		JOB NUMBER H.C. 10498-00081		
DATE: 1/9/2015		52 of 259 SHIS		
SCALE: AS SHOWN				

P:\7992-HOOT Kapiolani\8_Deliverables\CADD\Active_SheetSet\GRADING\10498BCE101.dgn 1/9/2015 9:15:50 AM



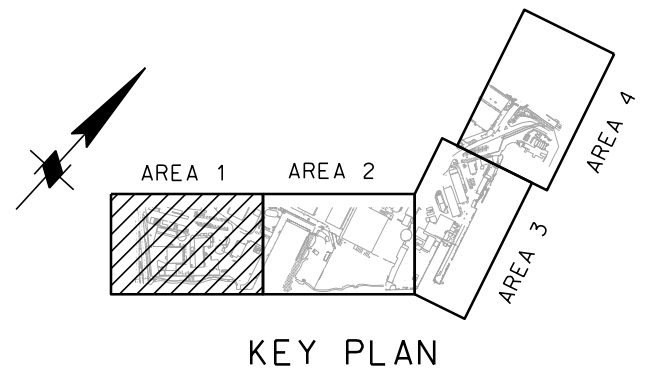
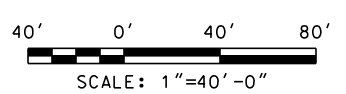
- NOTES:
- FOR GENERAL DEMOLITION NOTES, SEE SHT CD001.
 - DEMOLISH & REMOVE EVERYTHING WITHIN THE LIMITS OF DEMOLITION. DEMOLITION & REMOVAL GENERALLY INCLUDES BUT IS NOT LIMITED TO, PAVEMENT, TREES, SHRUBS, STAIRS, UST'S AND AST'S, RAILINGS, CONCRETE & STEEL BEAMS, WHARF STRUCTURES, SHORELINE DEBRIS, FENCING, CRANE RAILS, UTILITY LINES (ELECTRICAL, SEWER, WATER, FUEL, OIL) DRAIN LINES, SIGNS, SIGN POSTS, AND FOOTINGS, AND ALL OTHER EXIST FEATURES BELOW & ABOVE GROUND, BELOW & ABOVE WATER, WITHIN THE LIMITS OF DEMOLITION, UNLESS NOTED OTHERWISE.
 - THE LOCATIONS OF SUBMARINE UTILITY LINES CROSSING KALIHI CHANNEL ON THE MAUKA (EAST) SIDE OF THE SAND ISLAND ACCESS ROAD BRIDGE ARE BASED ON RECORD DRAWINGS AND SHALL BE FIELD VERIFIED BY CONTRACTOR PRIOR TO START OF CONSTRUCTION.
 - SUBMARINE UTILITIES WITHIN THE LIMITS OF CONSTRUCTION/DREDGING SHALL BE CUT/CAPPED/PLUGGED AND REMOVED. SUBMARINE UTILITIES BEYOND THE CONSTRUCTION/DREDGING FOOTPRINT SHALL BE ABANDONED IN PLACE. EXISTING UTILITIES INCLUDE:
 - TWO (2) 46kv HECO ELECTRICAL SUBMARINE POWER CABLES
 - ONE DEPARTMENT OF ARMY SIGNAL CORPS COMMUNICATIONS CABLE
 - ONE ARMY POWER CABLE
 - ONE ABANDONED 24" SEWER FORCE MAIN
 - ONE 12" WATER LINE (BWS)
 - ONE 16" WATER LINE (BWS)
- REFER TO SHEET CN108 FOR MORE INFORMATION
- ADJUSTED PROJECT LIMITS AFTER DEMOLITION NOT SHOWN FOR CLARITY.
 - UTILITIES NOTED "CUT AND PLUG" SHALL BE PLUGGED IN ACCORDANCE WITH THE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, 2005". FOR PIPES SMALLER THAN 12" IN DIAMETER, PLUG END OF PIPE WITH ONE SACK SLURRY SEAL, MINIMUM 12" FROM END OF PIPE. FOR PIPES LARGER THAN 12" DIAMETER, PLUG END OF PIPE WITH BRICK AND MORTAR.

MATCH LINE SEE SHEET CD104

DEMOLITION SITE PLAN - AREA 1
 (FORMER SITE OF UH MARINE CENTER)
 SCALE: 1"=40'-0"

LEGEND

- ELECTRICAL EQUIPMENT TO BE REMOVED BY HECO; REMOVAL OF EQUIPMENT PAD AND ELEMENTS BELOW PAD BY H.C. 10498 CONTRACTOR
 - REFERENCE PHOTO (SEE SHEET CD901)
 - APPROX LIMITS OF CONCRETE STRUCTURE/DECK/FOUNDATION/PAVEMENT (CONTRACTOR TO VERIFY)
 - APPROX LIMITS OF SHORELINE DEBRIS (CONTRACTOR TO VERIFY)
- Appendix A: Reduced-Sized Plans Showing Phasing of Wharf and Dredging Project

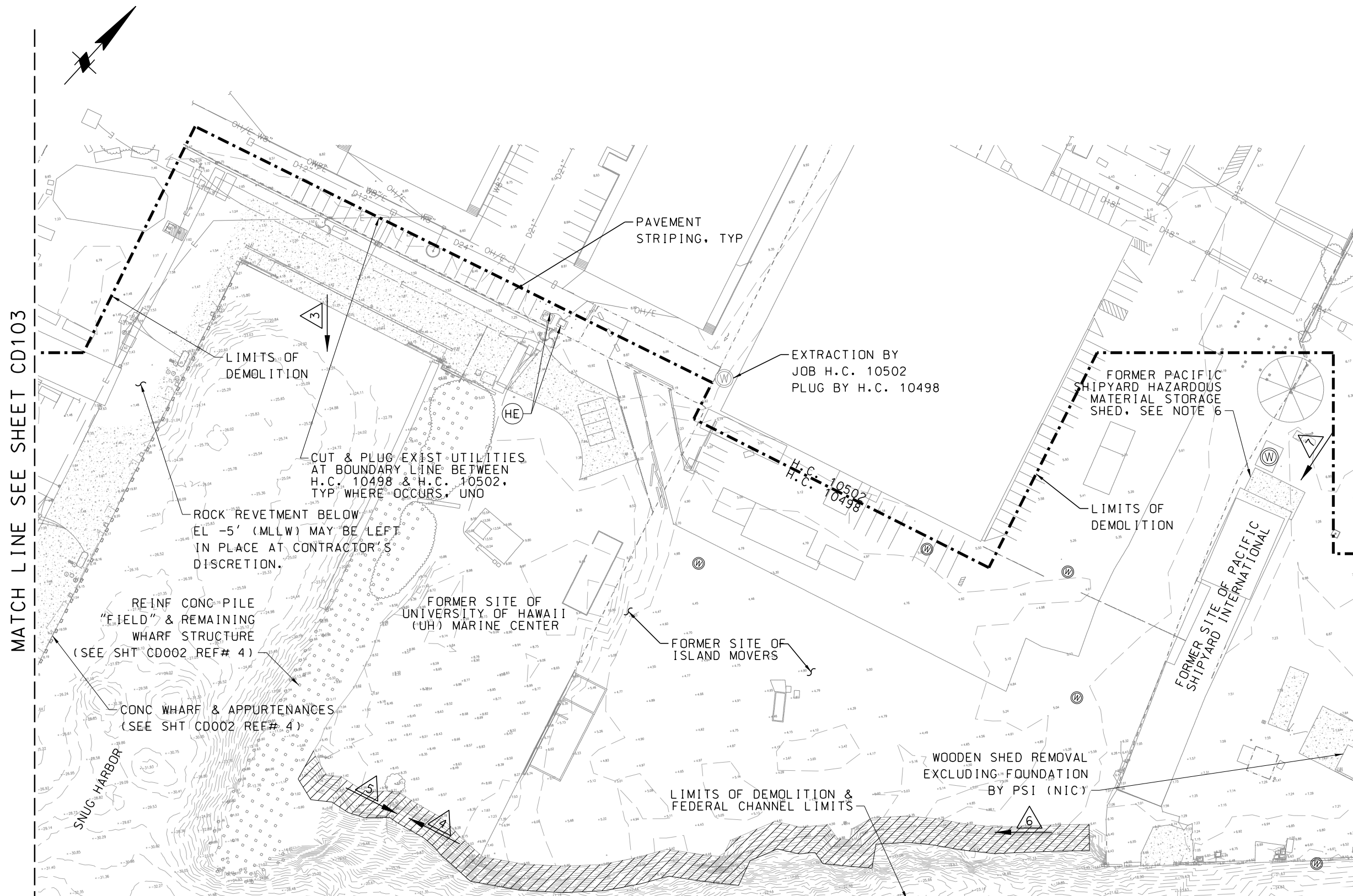


LICENSE EXPIRATION DATE:
 THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE: THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE: DEMOLITION PLAN AREA 1				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: VS		APPROVED BY:		SHEET
DRAWN BY: WS		HARBORS ADMINISTRATOR		CD103 66 of 259 SHTS
CHECKED BY: DC		JOB NUMBER: H.C. 10498-00081		
DATE: 1/9/2015		SCALE: AS SHOWN		

NOTES:

- FOR GENERAL DEMOLITION NOTES, SEE SHT CD001.
- DEMOLISH & REMOVE EVERYTHING WITHIN THE LIMITS OF DEMOLITION. DEMOLITION & REMOVAL GENERALLY INCLUDES BUT IS NOT LIMITED TO, PAVEMENT, TREES, SHRUBS, STAIRS, UST'S AND AST'S, RAILINGS, CONCRETE & STEEL BEAMS, WHARF STRUCTURES, SHORELINE DEBRIS, FENCING, CRANE RAILS, UTILITY LINES (ELECTRICAL, SEWER, WATER, FUEL, OIL) DRAIN LINES, SIGNS, SIGN POSTS, AND FOOTINGS, AND ALL OTHER EXIST FEATURES BELOW & ABOVE GROUND, BELOW & ABOVE WATER, WITHIN THE LIMITS OF DEMOLITION, UNLESS NOTED OTHERWISE.
- APPROXIMATELY 261 REINFORCED CONCRETE PILES LOCATED ON DIAMOND HEAD (EAST) SIDE OF SNUG HARBOR (PILE "FIELD") ARE REMNANTS OF A PARTIALLY DEMOLISHED SNUG HARBOR WHARF (SEE REF DWG LIST SHEET CD002, REF #4). TOP OF PILE ELEVATIONS VARY FROM APPROXIMATELY +1.5 FT TO +7.0 FT MLLW.
- ADJUSTED PROJECT LIMITS AFTER DEMOLITION NOT SHOWN FOR CLARITY.
- UTILITIES NOTED "CUT AND PLUG" SHALL BE PLUGGED IN ACCORDANCE WITH THE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, 2005". FOR PIPES SMALLER THAN 12" IN DIAMETER, PLUG END OF PIPE WITH ONE SACK SLURRY SEAL, MINIMUM 12" FROM END OF PIPE. FOR PIPES LARGER THAN 12" DIAMETER, PLUG END OF PIPE WITH BRICK AND MORTAR.
- CONTRACTOR SHALL BE AWARE THAT FORMER PACIFIC SHIPYARDS INTERNATIONAL HAZARDOUS MATERIALS STORAGE SHED HAS A SUBSTANTIAL SUBSURFACE COMPONENT AND THERE COULD BE A STORAGE TANK/SECONDARY CONTAINMENT STRUCTURE BENEATH SHED.
- CONTRACTOR SHALL BE AWARE THAT THERE ARE NUMEROUS ABANDONED SUMPS LOCATED WITHIN THE FORMER SITE OF PACIFIC SHIPYARDS INTERNATIONAL TO BE DEMOLISHED, ALTHOUGH SPECIFIC LOCATIONS ARE UNKNOWN, SOME OF THEM CONTAIN OILY WATER AND MOST ARE FILLED WITH SOIL AND/OR COVERED WITH METAL PLATES.



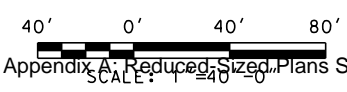
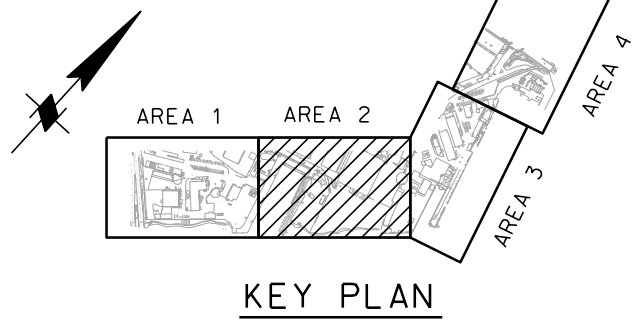
MATCH LINE SEE SHEET CD103

MATCH LINE SEE SHEET CD105

DEMOLITION SITE PLAN - AREA 2
 (FORMER SITE OF UH MARINE CENTER,
 ISLAND MOVERS, PACIFIC SHIPYARDS INTERNATIONAL)
 SCALE: 1"=40'-0"

LEGEND

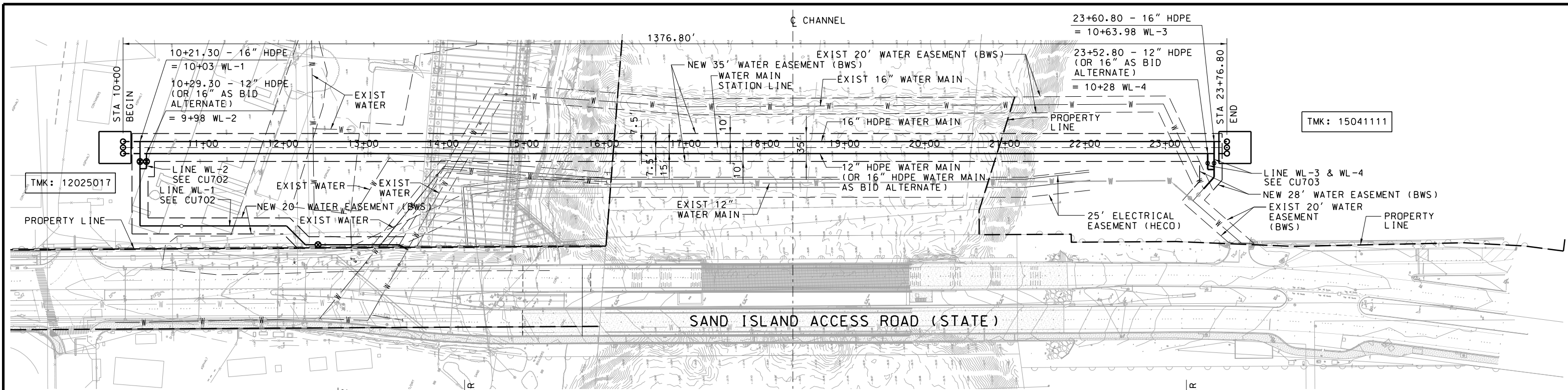
- (HE) ELECTRICAL EQUIPMENT TO BE REMOVED BY HECO; REMOVAL OF EQUIPMENT PAD AND ELEMENTS BELOW PAD BY H.C. 10498 CONTRACTOR
- # REFERENCE PHOTO (SEE SHEET CD901)
- [Dotted Pattern] APPROX LIMITS OF CONCRETE STRUCTURE/DECK/FOUNDATION/PAVEMENT (CONTRACTOR TO VERIFY)
- [Hatched Pattern] APPROX LIMITS OF SHORELINE DEBRIS (CONTRACTOR TO VERIFY)
- (W) GROUND WATER MONITORING WELL TO BE ABANDONED-EXTRACT CASING AND PLUG WELL



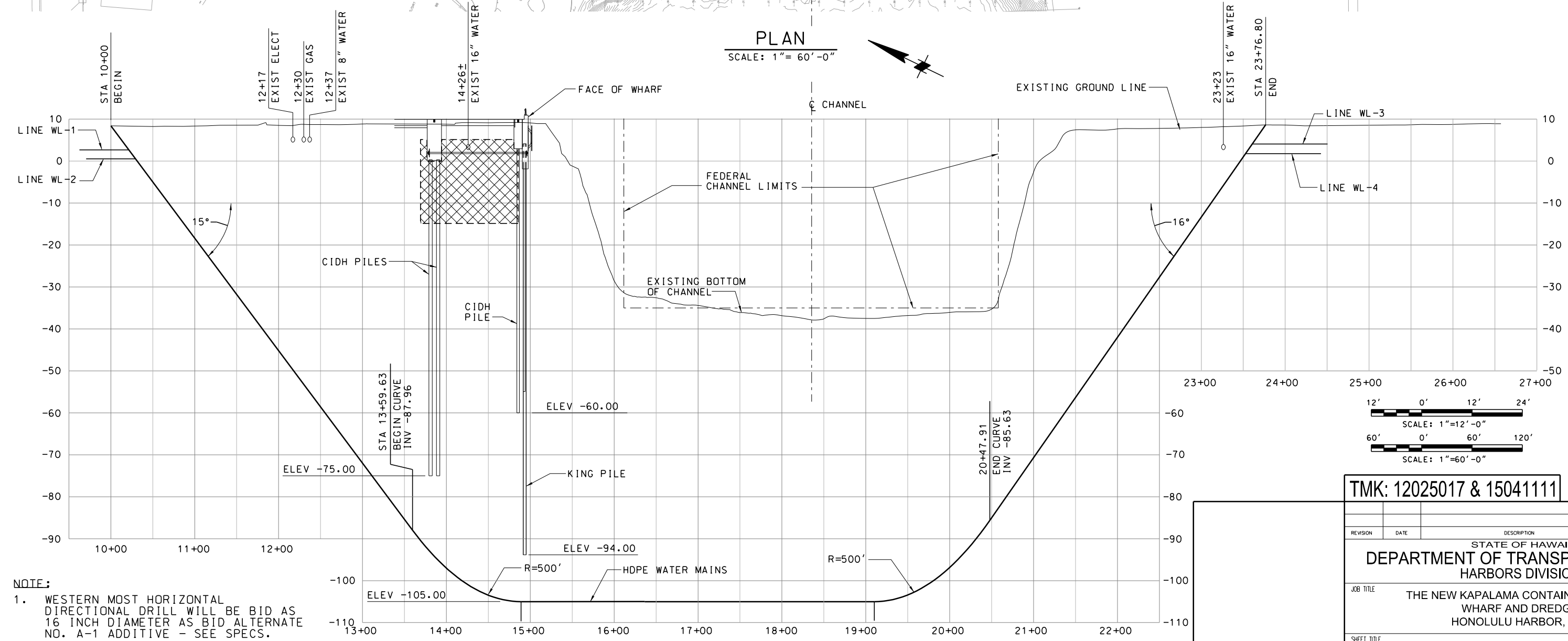
Appendix A, Reduced Size Plans Showing Phasing of Wharf and Dredging Project
 SCALE: 1"=40'-0"

LICENSE EXPIRATION DATE:
 THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE: THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE: DEMOLITION PLAN AREA 2				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: VS		APPROVED BY:		
DRAWN BY: WS		HARBORS ADMINISTRATOR		
CHECKED BY: DC		JOB NUMBER: H.C. 10498-00081		
DATE: 1/9/2015		CD104		
SCALE: AS SHOWN		67 of 259 SHTS.		



PLAN
SCALE: 1" = 60'-0"



PROFILE HDD HDPE
WATER MAINS
SCALE: HORIZ 1" = 60'-0"
VERT 1" = 12'-0"

- NOTE:
- WESTERN MOST HORIZONTAL DIRECTIONAL DRILL WILL BE BID AS 16 INCH DIAMETER AS BID ALTERNATE NO. A-1 ADDITIVE - SEE SPECS.
 - CONTRACTOR SHALL INSTALL BOTH NEW HDPE SUBMARINE WATER MAINS, ON-LAND DIP, HYDROTEST, CERTIFY FOR USE, AND PLACE NEW SYSTEM IN SERVICE.
 - CONTRACTOR SHALL MAINTAIN UNINTERRUPTED WATER SERVICE TO SAND ISLAND AT ALL TIMES AND COORDINATE WORK RELATED

Appendix A Reduced Size Plans Showing Phasing BWS Wharf and Dredging Project

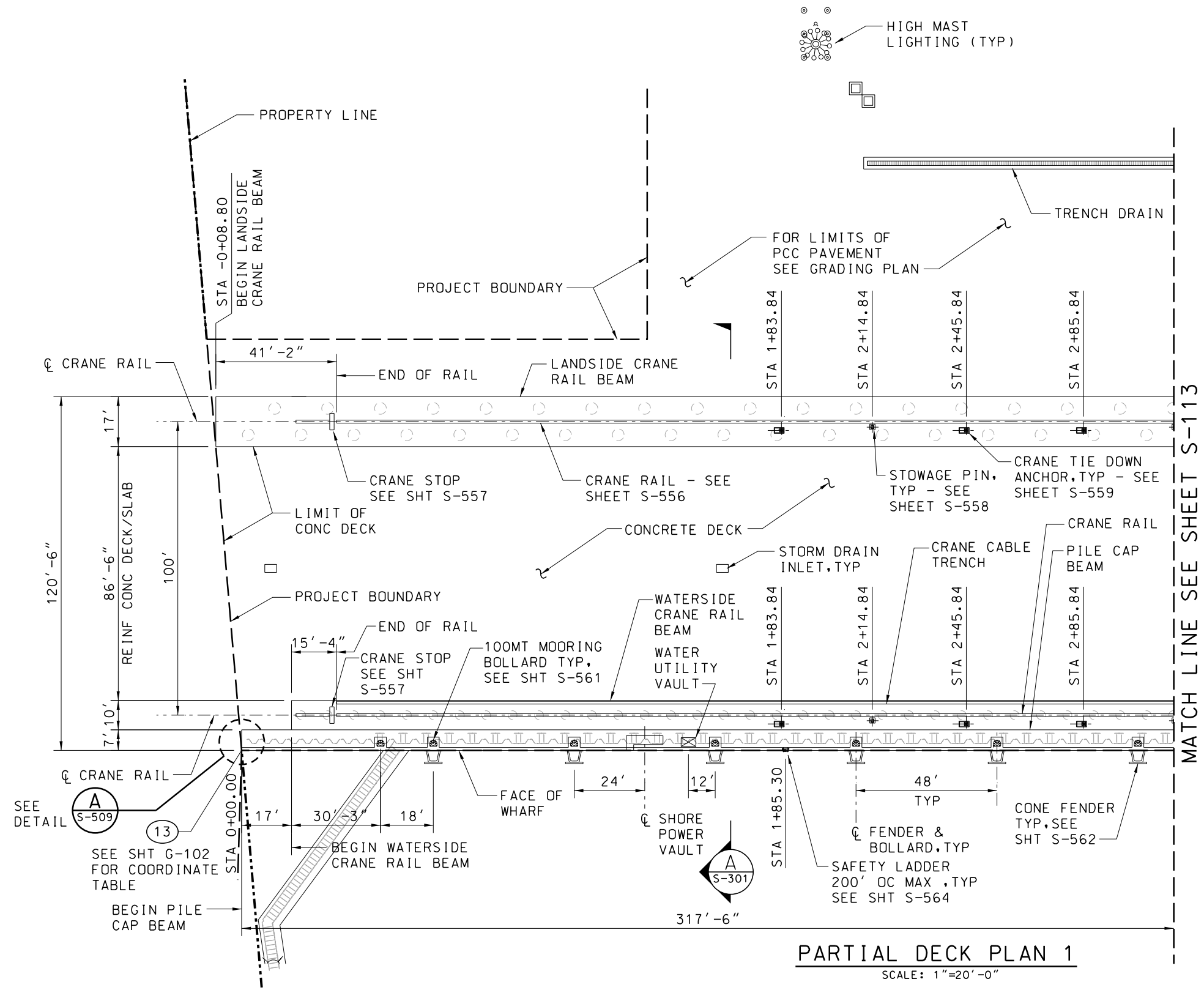
APPROVED BY: _____ DATE _____
MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
(FOR WORK AFFECTING BWS FACILITIES IN CITY/STATE R/W AND BWS EASEMENTS ONLY)

LICENSE EXPIRATION DATE: _____
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

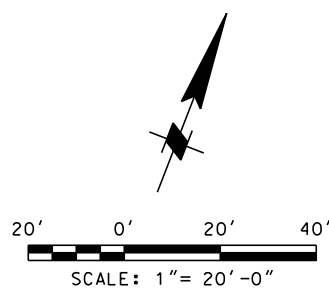
TMK: 12025017 & 15041111

REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE WATER MAIN PLAN AND PROFILE 1 HDD HDPE WATER MAINS				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: GLL		APPROVED BY:		SHEET
DRAWN BY: AP		HARBORS ADMINISTRATOR		CU701
CHECKED BY: AK		JOB NUMBER		
DATE: 1/9/2015		H.C. 10498-00081		
SCALE: AS SHOWN		127 of 259 SHTS.		

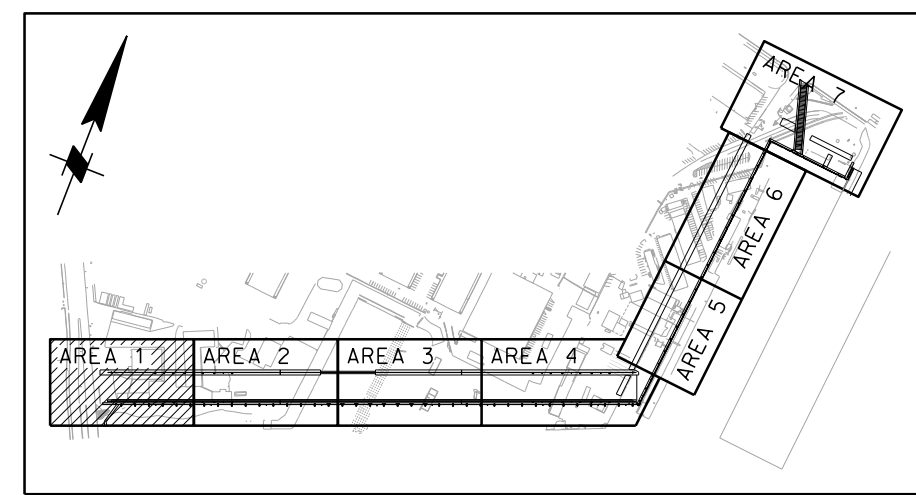
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PARTIAL DECK PLAN 1
SCALE: 1"=20'-0"



Appendix A: Reduced-Sized Plans Showing Phasing of Wharf and Dredging Project



REVISION	DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION				
JOB TITLE: THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU				
SHEET TITLE: WHARF DECK PLAN AREA 1				
SUBMITTED BY:		RECOMMENDED BY:		
DESIGNED BY: RA		APPROVED BY:		
DRAWN BY: FS		SECTION HEAD:		
CHECKED BY: DC		ENGINEERING PROGRAM MANAGER:		
DATE: 1/9/2015		HARBORS ADMINISTRATOR:		
SCALE: AS SHOWN		JOB NUMBER: H.C. 10498-00081		
				SHEET S-112 152 of 259 SHITS

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TOP OF CURB
ELEV +10.81 MLLW

ELEV +9.81 MLLW
TOP OF CONCRETE
CAP BEAM

ELEV 0.00 MLLW

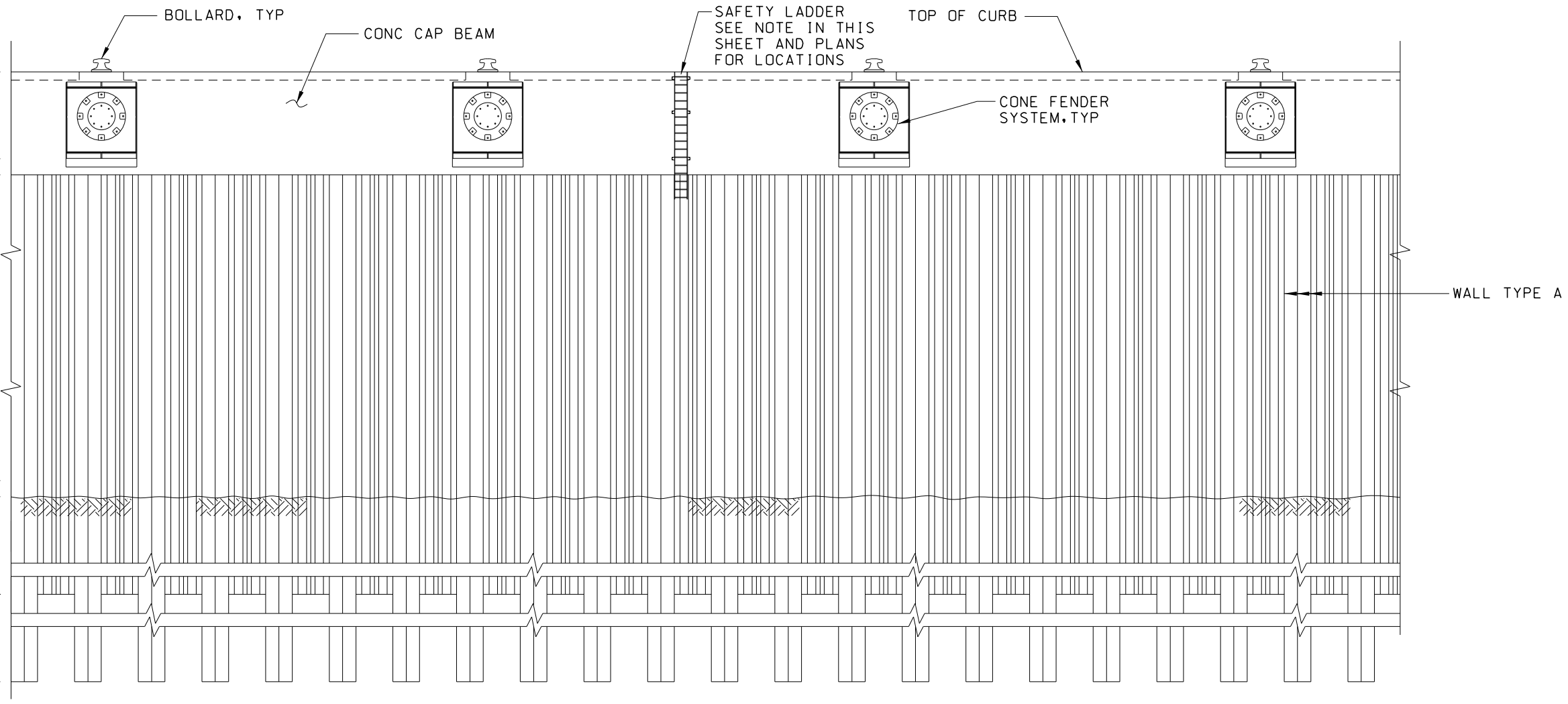
ELEV -2.00 MLLW
BOTTOM OF CAP
BEAM

ELEV -40.00 MLLW
MUD LINE

ELEV -42.00 MLLW
OVER DREDGE LEVEL

ELEV -55.00 MLLW
TIP OF SHEET PILES

ELEV -94.00 MLLW
(-97.00 MLLW AT SNUG HARBOR)
TIP OF KING PILES



TOP OF CURB
ELEV +10.81 MLLW

ELEV +9.81 MLLW
TOP OF CONCRETE
CAP BEAM

ELEV 0.00 MLLW

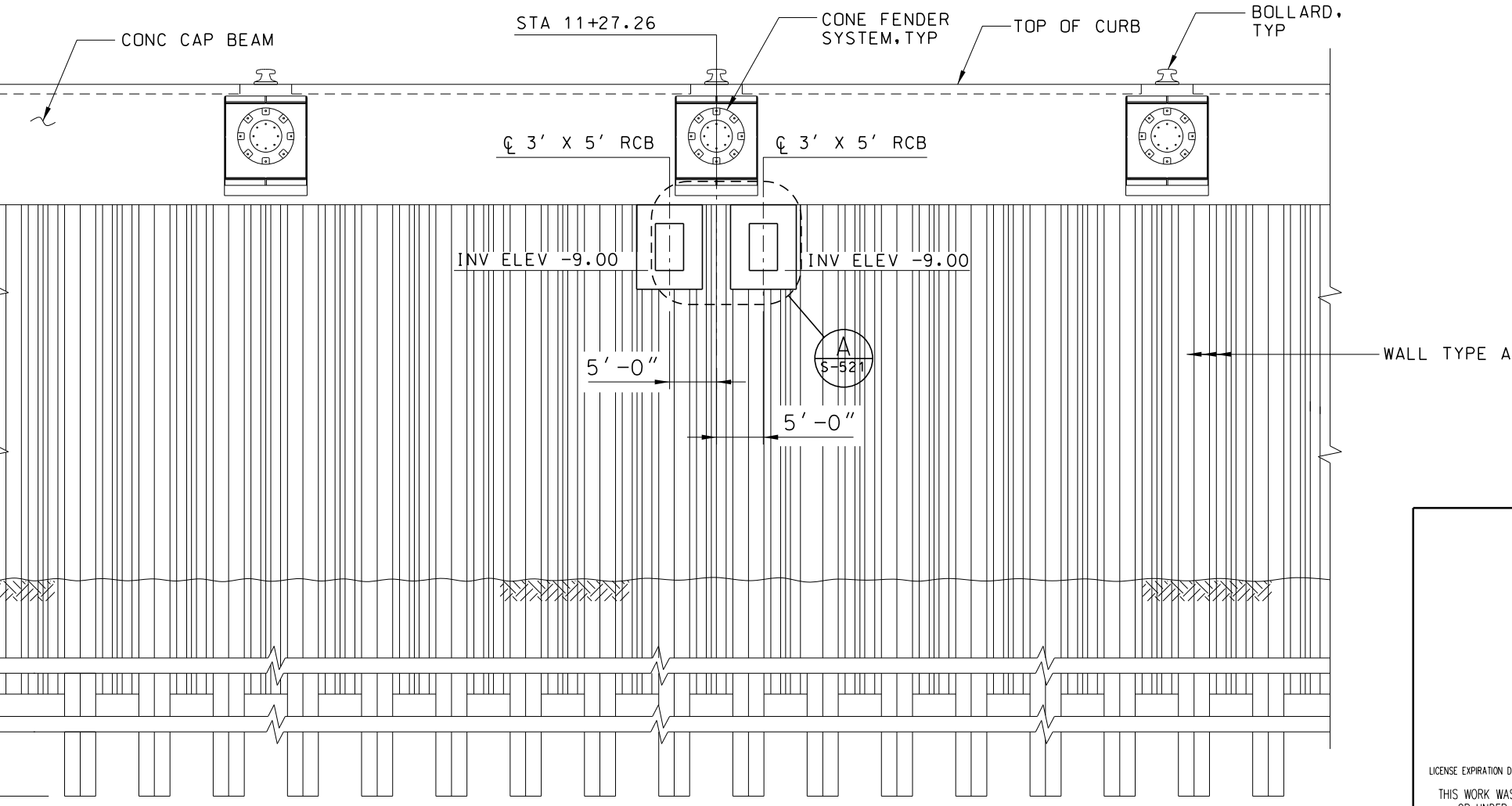
ELEV -2.00 MLLW
BOTTOM OF CAP
BEAM

ELEV -40.00 MLLW
MUD LINE

ELEV -42.00 MLLW
OVER DREDGE LEVEL

ELEV -55.00 MLLW
TIP OF SHEET PILES

ELEV -94.00 MLLW
(-97.00 MLLW AT SNUG HARBOR)
TIP OF KING PILES



NOTE:
SAFETY LADDERS, SHALL HAVE A MIN
CLEARANCE OF 4'-6" FROM CENTER OF
LADDER TO EDGE OF FENDER PANEL.

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

8' 0' 8' 16'
SCALE: 1/8"=1'-0"

Appendix A: Reduced-Size Plans Showing Phasing of Wharf and Dredging Project

REVISION		DATE	DESCRIPTION	BY	APPROVED
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION					
JOB TITLE THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING HONOLULU HARBOR, OAHU					
SHEET TITLE TYPICAL WHARF ELEVATION - PIERS 42-43					
SUBMITTED BY:			RECOMMENDED BY:		
DESIGNED BY: RA			APPROVED BY:		
DRAWN BY: FS			HARBORS ADMINISTRATOR		
CHECKED BY: DC			JOB NUMBER		
DATE: 1/9/2015			H.C. 10498		
SCALE: AS SHOWN			161 of 259 SHIS		

LICENSE EXPIRATION DATE:
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Baseline assessment for Kapālama Container Terminal Improvements, Honolulu Harbor, Honolulu, O‘ahu

September 10, 2014
Revised November 5, 2016

AECOS No. 1354B

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Introduction	2
Project Description	2
Methods.....	5
Shallow water “shoreline” surveys.....	6
Vertical concrete pier piles.....	8
Vertical concrete sheet pier piles.....	8
Deep harbor bottom.....	9
Quantitative survey of corals.....	11
Coral community analysis.....	11
Quantitative survey of seagrasses, algae and macro-invertebrates	11
Macro-invertebrate community analysis	12
Quantitative survey of fishes	12
Fish data analysis	12
Qualitative survey of invasive and protected species	13
Deviations in methods from sampling plan	13
Sub-sample areas.....	13
Quantitative surveys	14
Results	14
Coral size class distribution	14
Benthic community composition	46
Algae.....	50
Macro-invertebrates.....	56
Fish abundance, biomass, and functional groups.....	67
Trophic Groups	71
Protected species.....	74
Conditions and safety issues	74
Summary.....	74
References.....	77
APPENDIX A	A-1
APPENDIX B	B-1

Introduction

Project Description

Department of Transportation, Harbors Division (State of Hawai'i, DOT-H) is proposing to develop a new container terminal (Kapālama Container Terminal) in Honolulu Harbor, O'ahu ("Project"; Fig. 1). The Project will include the construction of a pier to berth two container ships and cargo barges. This new pier (Piers 42 and 43) will require dredging and filling in the harbor, including complete infilling of a slip site known as Snug Harbor. At the eastern end of the Project site, an existing pier (Pier 41) will be modified for use by interisland cargo barges. The existing pier will be demolished and rebuilt with the slip area between Piers 40 and 41 widened from 256 feet to 300 feet.

In 2012, Marine Research Consultants (MRC) conducted a quantitative baseline assessment to describe existing marine biotic communities within the Project area (DOT-H, 2012). However, a release of unrefined molasses into Honolulu Harbor in September 2013 precipitated the need for the State of Hawai'i to undertake a new baseline assessment. AECOS conducted the new baseline assessment from March – May, 2014, following the protocol outlined in the 2014 sampling plan (AECOS, 2014).

Survey

This 2014 baseline survey quantified marine resources in the proposed dredge and fill areas (direct impact areas) and other areas that may be impacted indirectly (e.g., turbidity and vibrations during construction). The baseline survey was designed to: (1) quantify coral colony size-frequency (size, diversity, new recruits, health); (2) quantify diversity, size, density, and biomass of fishes; (3) identify and categorize algae (including crustose coralline algae) and seagrass abundance (common vs. uncommon); and (4) identify and quantify non-coral macro-invertebrates greater than 3 cm. The data collected will be used to develop a Habitat Equivalency Analysis (HEA) model and assess impacts to Essential Fish Habitat (EFH; NOAA NMFS, 2002).

The seaward Project limits and biological survey area are displayed in Figure 2. The biological survey area extends into the federal navigation channel to assess resources that may be affected by channel dredging and silt curtain placement during Project construction. After dredging, the Project area will be deeper than the federal channel, and material will slough from the channel into the newly dredged area.



Figure 1. Kapālāma Container Terminal wharf and dredging project area (DOT-H, 2012).

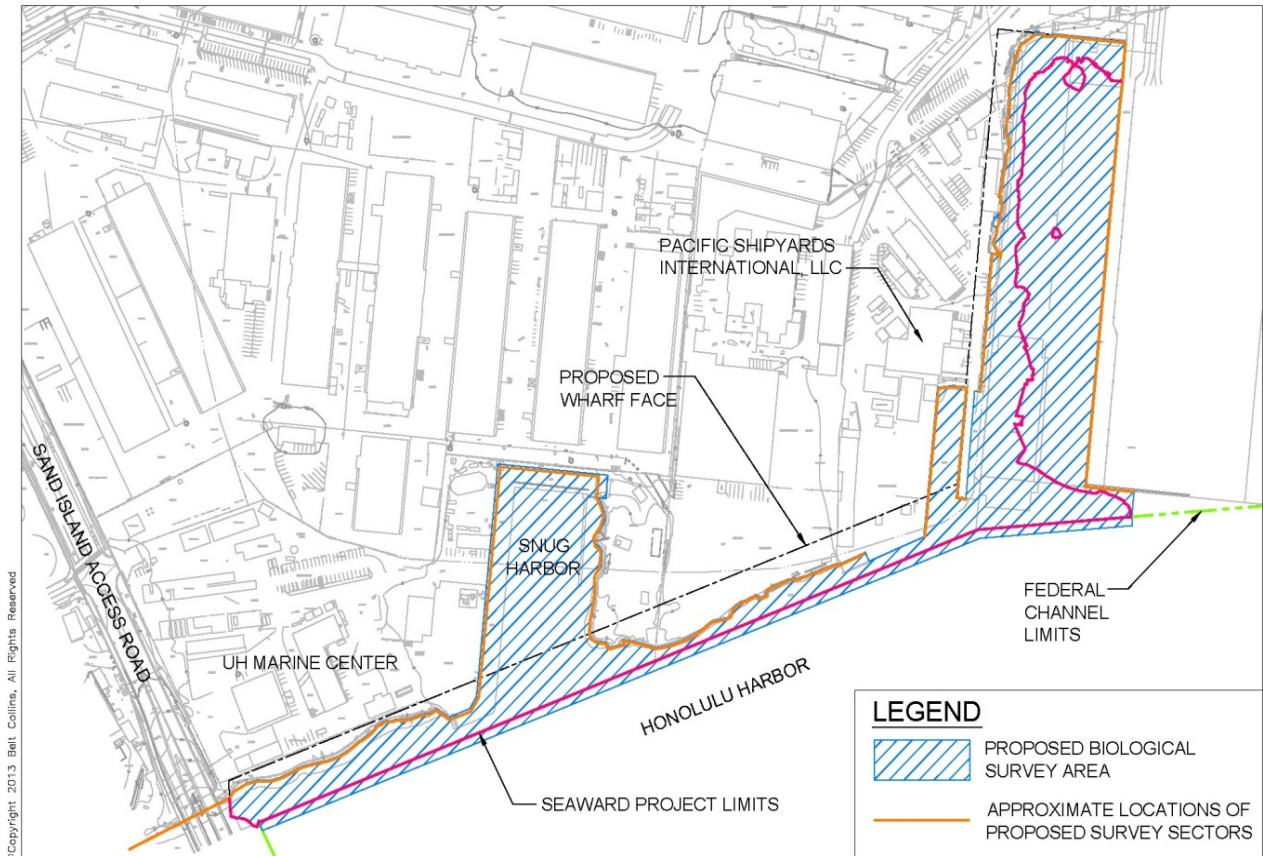


Figure 2. Kapālama Container Terminal Wharf Project area, dredging limits and proposed survey area.

Consistent with the original quantitative baseline assessment by MRC (DOT-H, 2012), data for our baseline survey were collected in sectors A – L (Fig. 3). Also consistent with the 2012 survey, several of the sectors were divided into sub-sectors with the intent of evaluating spatial variability within a single pier face or channel shelf. Sectors with sub-sectors include: A, B (see Fig. 4), C, and K (see Fig. 5). The 2012 survey divided Sector C into four sub-sectors; based on AECOS prior knowledge of variability at Sector C, we surveyed only two sub-sectors. Within each sector or sub-sector, as applicable, AECOS biologists conducted dive surveys of three habitat types: (1) shallow water off shoreline; (2) pier piles; and (3) pier sheet piles. A fourth habitat type, deep-water harbor bottom, was surveyed across the entire Project area. The biologists surveyed only a portion of the habitats present in each sector (or sub-sector) and extrapolated these data to the entire sector (or sub-sector), as described in detail below.



Figure 3. Survey sectors lettered A through L marked with red lines. Dashed line at Sector H indicates part of Sector H not surveyed due to work on the dry docks.

Methods

A stratified random sub-sample was established for each of the four sub-habitat survey areas. Sub-sample areas were calculated from previously estimated sector data (linear width, linear length, available surface area for coral settlement, and number of piles; DOT-H, 2012). As applicable, *AECOS* biologists sub-sampled at least 15% of the total area (shallow water or vertical sheet pile) or 15% of the total number of piles in each sector. Based on our experience with various projects in Honolulu Harbor and other state harbors, and given the variability of coral distribution, a sub-sample of 15% of the total area is adequate to capture at least 10% of the coral colonies present in a sector.

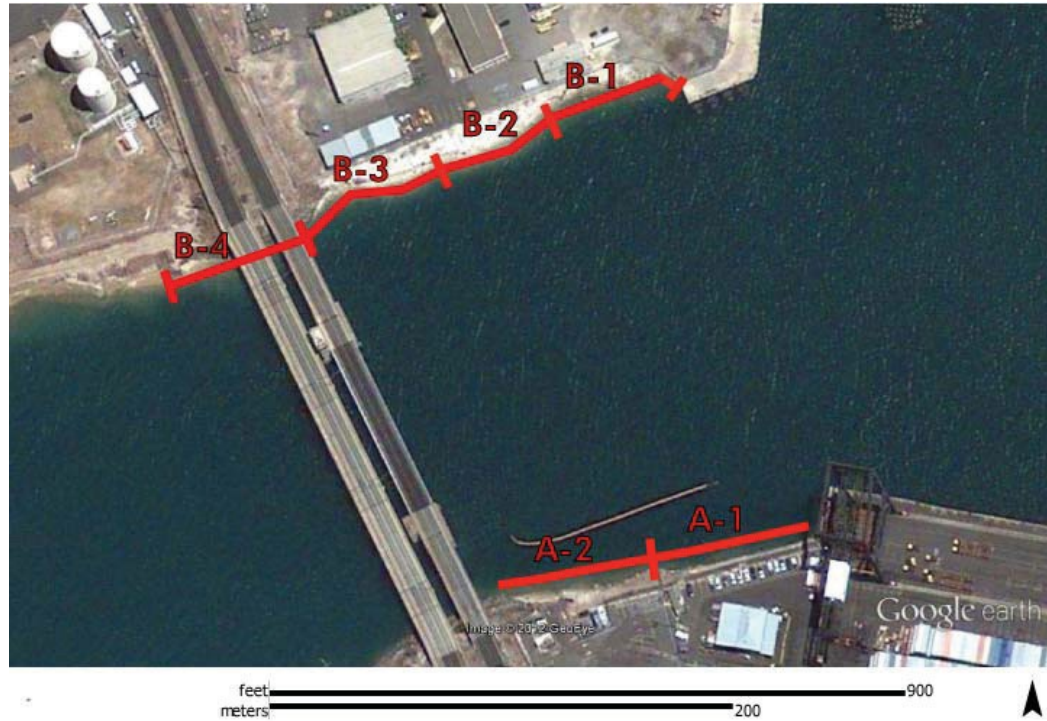


Figure 4. Location of sectors A and B, both of which were divided into sub-sectors, as conducted in 2012 survey (DOT-H, 2012).

Shallow water “shoreline” surveys

Sectors with shallow water habitat include: A (sub-sectors 1 and 2), B (sub-sectors 1-4), E, F, G, and I (See Figs. 4 and 5, above). Table 1 provides total area of the sea floor in the Project area (values from DOT-H, 2012), the area we surveyed as a sub-sample, and the percent of total area the sub-sample represents. In all, 18% (1,100 m²) of the total amount of seafloor habitat was surveyed. Within the six shoreline sectors, predetermined, randomly-located sub-sample areas were surveyed. Fish surveys were performed first along a 25-m² (or larger) belt transect line laid parallel to the shore, as described further below. One or more Stationary Point Count (SPC) surveys were conducted in each sector. Percent benthic composition (including algae and macro-invertebrates) was measured using the line point-intercept method along each 10-m portion of the 25-m transect, as described below. Along the same 25-m² transect line, 20-m² was used to inventory corals by species, class size, and morphology.



Figure 5. Location of sectors C (including sub-sectors C-1 and C-2), D, E and F (left). Location of sectors H, I, J, K, and L. Sector K is divided into three sub-sectors, as conducted in 2012 survey (DOT-H, 2012; right).

Table 1. Sea floor area in each sector and area surveyed.

Sector	Total seafloor area (m ²)	Survey area (m ²)	Survey (%)
A-1	568	80	14
A-2	448	60	13
B-1	480	80	18
B-2	600	80	13
B-3	480	80	17
B-4	666	100	15
E*	1250	180	14
F	410	60	15
G	1420	220	15
I	1070	160	15
Total	7392	1100	18

*Shoreline transects added to sector E, as described below in the deviations in methodology section

Vertical concrete pier piles

Sectors with vertical concrete pier piles include: C (sub-sectors 1 and 2), D, E, G, I, and J (See Fig. 3, above). While in the field, the AECOS team counted the number of outer piles in each sector; surface area values were derived from DOT-H (2012). A total of 64 outer piles was sampled: 10 pre-determined, randomly-selected outer piles in sector C (2 at C-1 and 8 at C-2), 3 outer piles in sector D, 37 piles (inner and outer) in sector E, 3 outer piles in sector G, 5 outer piles in sector I, and 6 outer piles in sector J (Table 2). The dive team moved up and down each pile. All corals on the piles were surveyed, as described below. A census (following protocol, described below) of corals, macro-invertebrates (> 3 cm), algae, and fish was conducted in the sub-sample area. One or more Stationary Point Count (SPC) surveys were conducted in each sector.

Vertical concrete sheet pier piles

Sectors with vertical concrete sheet pier piles include H, K (sub-sectors 1-3), and L (see Fig. 3, above). The area to be sub-sampled was calculated from the known area of the sector (values provided by DOT-H). Biologists surveyed pre-determined, randomly-selected sub-sample segments: 42 m² at sector H, 144 m² at sub-sector K-1, 197 m² at sub-sector K-2, 176 m² at sub-sector K-3, and 154 m² at sector L (Table 3). A census (following protocol, described below) of corals, macro-invertebrates (> 3 cm), algae, and fish was conducted in each sub-

sample area. One or more Stationary Point Count (SPC) surveys were conducted in each sector.

Table 2. Pier pile sectors and sub-sample areas.

Sector	Total surface area (m ²) [†]	Survey area (m ²)	Total number of piles in sector	Number of surveyed piles	Survey (%)
C-1	240	32	15	2	13
C-2	944	128	59	8	14
D	279	44	19	3	16
E	3329	543	227	37*	16
G	173	52	10	3	30
I	368	80	23	5	22
J	484**	88	33	6	18
Total	5817	967	380	64	17

[†] Pile surface area was derived from MRC survey (DOT-H, 2012), which surveyed 3 sides of each pile. AECOS survey included all sides of surveyed piles.

*37 piles surveyed for coral, 35 piles surveyed for community composition, invertebrates and algae

** Total surface area calculated from total number of piles and surface area of each pile.

Table 3. Total sheet pier pile area in each sector and total area surveyed.

Sector	Total sheet pier pile area (m ²)	Survey area (m ²)	Survey (%)
H	317.0	42.0	13
K-1	833	144.3	15
K-2	991.9	196.6	18
K-3	991.9	174.7	16
L	823.9	154.1	19
Total	3957.7	711.6	18

Deep harbor bottom

Deep harbor bottom survey areas extend throughout all sectors. Ten, stratified-random stations were pre-determined prior to entering the field (Table 4 and Fig. 6). At each deep harbor bottom station, biologists surveyed a 25-m belt transect for corals (see protocol below), macro-invertebrates (> 3 cm), algae,

and fishes. The width of the belt was dependent upon visibility at each site, and ranged from 0.3-1.2 m (1-4 ft).

Table 4. Harbor bottom sectors water depth and location description.

Sector	Water depth (m)	Location description
HB1	10	Located off shoreline of sector B
HB2	10	Located off shoreline of sector B
HB3	7.6-8.8	Located in Snug Harbor
HB4	7.6-8.2	Located in Snug Harbor
HB5	7.6	Located in Snug Harbor
HB6	10.7-11.9	Located off shoreline of sectors F and G
HB7†	--	Located off shoreline of sector H
HB8	10-10.4	Located between sector K and I
HB9	9.4	Located between sector K and I
HB10	8.8-9.4	Located between sector K and I

† HB7 station was not surveyed due to hazardous barge activity commencing immediately prior to divers entering the water.



Figure 6. Location of randomly selected deep water harbor bottom survey locations (HB1-HB10) with overlay of project area and dredging limits.

Quantitative survey of corals

All corals within a survey area (1 m on both sides of transect line, or entire pier pile [all four or eight sides], or entire concrete sheet pile area, as applicable) were identified to species (where possible) and the size class (maximum diameter) recorded (<5 cm; 6 to 10 cm; 11 to 20 cm; 21 to 40cm; 41 to 80 cm; 81 to 160 cm; or >161 cm; NOAA, 2008). Each coral head was assessed for morphology, and health was categorized as one of the following: alive, dead, or partially dead (0-10%, 10-50%, 50-90% or >90%). In addition, the location of each individual live coral colony species proposed for ESA listing (*Montipora flabellata*/*M. dilatata*/*M. turgescens* and *Montipora patula*/*verrilli*; NOAA-NMFS, 2012, 2013) was identified. AECOS biologists also conducted swims across hard substrates (piles, sheet piles, etc.) in the Project area to count all live ESA proposed coral species.

Coral community analysis - Coral abundance and size class distribution data from sub-samples were extrapolated to provide total coral count and size class distribution for each sub-sector or sector, as applicable. The mean number of corals in each size class from individual transect data was calculated and then extrapolated to the sub-sector or sector. Total counts in Tables 5 through 48 are based on these projected means. Range (minimum and maximum count) for each coral species in a size class was based on transect data for each sub-sector. Dead corals (90-100% mortality) are included in separate tables.

To calculate coral density, the area available for colonization was calculated from previously estimated sector data (linear width, linear length, available surface area for coral settlement, and number of piles; DOT-H, 2012) and data provided by DOT-H. For pile sectors, total surface area of each sector, and the total survey area was calculated as the product of the number of piles and the surface area of each pile. Coral density was calculated as the number of colonies divided by the survey area (m²), and for pile sectors, the number of colonies divided by the total number of piles.

Quantitative survey of seagrasses, algae and macro-invertebrates

For the shallow water, so-called "shoreline" sectors, the 10-m transects were surveyed for substrate composition using the point-intercept line method. Vertical faces were surveyed using a different methodology, as described below in the deviations from the sampling plan. At every meter mark, the substratum type (sand, rubble, consolidated limestone, macroalgae, coral, and crustose coralline algae) was recorded. In addition to the point-intercept line method, all

seagrass and algae (macroalgae and crustose coralline algae) within the survey area (1 m of both sides of each transect line, entire pier pile, entire concrete sheet pier pile area, as applicable) was assigned an abundance category (less than common or more than common). All macro-invertebrates (>3 cm) within the survey area (described above) were identified to species (where possible).

Macro-invertebrate community analysis - Macro-invertebrate counts from sub-samples were extrapolated to provide total macro-invertebrate count for each sub-sector or sector, as applicable. The mean number of macro-invertebrates from individual transect data was calculated and then extrapolated to the sub-sector or sector, as applicable. Total macro-invertebrate abundance in Tables 60 through 71 are based on these projected means.

Quantitative survey of fishes

Fish transects (25-m length for shoreline sectors and water depth of pier or sheet pile, up to 10-m) were used to assess fish biomass and diversity. All fishes encountered within the biologists' field of vision along the length of the transect were counted and identified to species, if possible. Fish length (total length or TL) was estimated to the nearest 5-cm for all fishes encountered. Additionally, at every sector, at least three stationary point counts (SPC) were conducted. (An SPC-survey was conducted at nearly every pier pile and sheet pier pile segment). During a five minute count, all fishes within a visually estimated distance of 2 m (or less, depending on conditions) were recorded. Numerical abundance of individuals by species (or lowest taxonomic level) was recorded along with approximate length of each individual during swims and SPC surveys.

Fish data analysis - Fish biomass was calculated by converting estimated fish lengths to weights using the allometric length-weight conversion formula $W = a TL^b$, where parameters a and b are species-specific constants, TL is total length in cm, and W is weight in grams for an individual fish.

$$\text{Weight (g)} = [\text{total length (cm)} \times \text{constant } a]^{\text{constant } b}$$

The species-specific length to weight fitting parameters (a and b) were obtained for each species from the most up-to-date PIFSC-CRED (Pacific Islands Fisheries Science Center - Coral Reef Ecosystem Division) database (provided on Aug 30, 2013 by Ivor Williams, quantitative fisheries ecologist with NOAA PIFSC-CRED) with Hawaiian Islands specific parameters. Where parameters were not available for a particular species, parameters for a similar bodied congener were substituted. Weight parameters not available in the database were

obtained through the FishBase “Length to weight” link (www.fishbase.org; Froese and Pauly, 2012). When parameters were not based on total length, but were based on fork length (FL) or standard length (SL), total length was converted using a length conversion factor obtained through the FishBase “Length to Length” link.

Fish biomass per station was calculated by summing the length adjusted weight estimates (g) and dividing by the survey area (m²) yielding biomass per square meter (g/m²). In order to maximize comparability with previous studies, biomass is expressed as kilograms per hectare (kg/ha), obtained by multiplying g/m² by 10. Fish functional groups were defined by combining three life traits: (1) trophic regime, (2) maximum body size class (which determines position in a food webs), and (3) mobility (which reflects home range). Fish biomass and count data from sub-samples were extrapolated to provide total fish count and biomass for each sub-sector or sector, as applicable. Total counts and biomass in Tables 74 are based on these projected values.

Qualitative survey of invasive and protected species

For each survey area, an inventory was made for invasive species, seagrass, and marine protected species, as well as proposed to be listed species (DLNR, 1998, 2007; NOAA-NMFS, 2012 and 2013; USFWS, 2012). During any surveys, including the larger swim areas, AECOS biologists noted the presence of any live ESA proposed coral species (including *Montipora flabellata*/*M. dilatata*/*M. turgescens* and *Montipora patula*/*verrilli*). For these corals, species, size, morphology, health, and location were to be recorded, though no live colonies were observed in this survey.

Deviations in methods from sampling plan

Sub-sample areas

The sampling plan (AECOS, 2014) described sector E to have a total of 180 piles. Biologists counted a total of 225 piles in the field. Therefore, the number of surveyed piles increased from 27 to 33. While conducting pile surveys at sector E, biologists noted coral cover on the sea floor. Therefore, shallow water transects to quantify corals only (no additional line-intercept, algae/inverts, or fish surveys) were added to sector E. A total of 9 transects were conducted off the shoreline of sector E. Also, in the sampling plan, Sector G was described to have a total of 55 piles. Biologists counted 10 outer piles, and as such, the number of surveyed piles decreased from 8 to 3.

As stated in the original sampling plan, sector H would not be surveyed owing to safety issues with ongoing work on the dry docks, the permanent mooring of dry docks, and suspected contamination in the vicinity. However, divers were able to conduct an underwater survey at a portion of Sector H (corner of pier, facing main channel). A total area of 42 m² sheet pile was surveyed at sector H. Ten pre-determined harbor bottom stations were planned for the baseline survey. The final station was not completed due to safety reasons (barge relocating in the channel). Nine harbor bottom transects were surveyed.

Quantitative surveys

The sampling plan prescribed a point-intercept line method for all sectors. Vertical pier piles and sheet pile sectors were surveyed for substrate composition using a modified protocol. For the pile sectors, the pile length (depth) was divided into three sections (shallow, middle, and deep). One point was randomly selected within each section on all four sides of the pile. For the sheet piles, biologists used a depth gauge to track every meter mark, and randomly selected one point. Fish belt transect surveys for vertical faces were conducted by conducting a 5 minute swim both up and down the vertical face. A 5-minute SPC survey was completed at the base of each vertical face.

Results

Coral size class distribution

Tables 5 through 48 show size class distribution of each coral species across the 12 sectors and harbor bottom locations in Kapālama Basin and Pier 24 for both live (<90% mortality) and dead colonies (90-100% mortality). Table 49 summarizes the live coral data and shows total coral colonies of all species combined by size class in each sector. A total of 206,423 live (<90% mortality) coral colonies occur across the 12 sectors in the Kapālama Basin and near Pier 24. The number of total coral colonies range from a low of 526 colonies at Sector D (0.25% of total) to a high of 109,548 (53.1% of total) at Sector K. Totals in individual size classes range from 17 in the >161 cm to 165,936 in the <5 cm size classes.

At least 10 different taxa of coral were encountered throughout the survey area. All colonies of *Montipora capitata*, *M. patula*, *Pocillopora damicornis*, and *Poc. meandrina* encountered were dead. Colonies of *Porites monticulosa* were only observed at Sector K. Totals for each species in each size class are shown in Table 50 (live) and Table 51 (dead). Across all sectors, the most common

species found is *Porites lobata*, with 115,911 total colonies, most in the <5 cm size class. *Leptastrea* sp. is next most common, with 90,179 colonies.

Table 5. Number of live total coral colonies in each size class for coral species at Sector A-1, as measured using 20-m² transects (n=7). Taxa without assigned mortality category are 0-10% mortality.

Sector A-1		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Cyphastrea ocellina</i>									
Total	107	0	0	0	0	0	0	107	
St dev	±6.2	--	--	--	--	--	--		
Range	0-13	--	--	--	--	--	--		
<i>Leptastrea</i> sp.									
Total	1782	28	0	0	0	0	0	1810	
St dev	±46.9	±2	--	--	--	--	--		
Range	15-116	0-4	--	--	--	--	--		
<i>Porites lobata</i>									
Total	2982	596	85	7	0	0	0	3670	
St dev	±112	±22	±2	±0.5	--	--	--		
Range	14-259	4-48	1-6	0-1	--	--	--		
<i>Porites lobata</i> (10-50% mortality)									
Total	0	0	7	0	0	0	0	7	
St dev	--	--	±0.5	--	--	--	--		
Range	--	--	0-1	--	--	--	--		
Total	4871	624	92	7	0	0	0	5594	

Table 6. Number of dead (90-100%) coral colonies in each size class for coral species at Sector A-1, as measured using 20-m² transects (n=7).

Sector A-1		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Leptastrea</i> sp.								
Total	7	0	0	0	0	0	0	7
St dev	±0.5	--	--	--	--	--	--	
Range	0-1	--	--	--	--	--	--	
<i>Montipora capitata</i>								
Total	28	0	0	0	0	0	0	28
St dev	±2	--	--	--	--	--	--	
Range	0-4	--	--	--	--	--	--	
Total	36	0	0	0	0	0	0	36

Table 7. Number of live total coral colonies in each size class for coral species at Sector A-2, as measured using 20-m² transects (n=3). Taxa without assigned mortality category are 0-10% mortality

Sector A-2		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Cyphastrea ocellina</i>								
Total	22	0	0	0	0	0	0	22
St dev	±0.6	--	--	--	--	--	--	
Range	0-2	--	--	--	--	--	--	
<i>Leptastrea</i> sp.								
Total	276	0	0	0	0	0	0	276
St dev	±13	--	--	--	--	--	--	
Range	0-26	--	--	--	--	--	--	
<i>Porites lobata</i>								
Total	2165	597	45	0	0	0	0	2807
St dev	±112	±29	±3	--	--	--	--	
Range	0-220	0-57	0-6	--	--	--	--	
Total	2463	597	45	0	0	0	0	3105

Table 8. Number of dead (90-100%) coral colonies in each size class for coral species at Sector A-2, as measured using 20-m² transects (n=3).

Sector A-2		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Cyphastrea ocellina</i>									
Total	8	0	0	0	0	0	0	8	
St dev	±0.6	--	--	--	--	--	--		
Range	0-1	--	--	--	--	--	--		
<i>Poc. damicornis</i>									
Total	0	8	15	22	0	0	0	45	
St dev	--	±0.6	±1	±2	--	--	--		
Range	--	0-1	0-2	0-3	--	--	--		
Total	36	8	15	22				53	

Table 9. Number of live total coral colonies in each size class for coral species at Sector B-1, as measured using 20-m² transects (n=4). Taxa without assigned mortality category are 0-10% mortality

Sector B-1		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Leptastrea</i> sp.									
Total	168	0	0	0	0	0	0	168	
St dev	±6	--	--	--	--	--	--		
Range	0-13	--	--	--	--	--	--		
<i>Porites lobata</i>									
Total	1896	552	12	0	0	0	0	2460	
St dev	±89	±34	±1	--	--	--	--		
Range	0-204	0-72	0-2	--	--	--	--		
Total	2064	552	12	0	0	0	0	2628	

Table 10. Number of dead (90-100%) coral colonies in each size class for coral species at Sector B-1, as measured using 20-m² transects (n=4).

Sector B-1		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Poc. damicornis</i>									
Total	54	198	84	30	0	0	0	336	
St dev	±3	±12	±4	±2	--	--	--		
Range	0-5	0-26	0-10	0-3	--	--	--		
Total	54	198	84	30	0	0	0	366	

Table 11. Number of live total coral colonies in each size class for coral species at Sector B-2, as measured using 20-m² transects (n=4). Taxa without assigned mortality category are 0-10% mortality

Sector B-2		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Leptastrea</i> sp.									
Total	360	8	0	0	0	0	0	368	
St dev	±6	±0.5	--	--	--	--	--		
Range	5-19	0-1	--	--	--	--	--		
<i>Porites lobata</i>									
Total	765	135	0	0	0	0	0	900	
St dev	±21	±3	--	--	--	--	--		
Range	4-45	2-8	0-	--	--	--	--		
Total	1125	143	0	0	0	0	0	1268	

Table 12. Number of dead (90-100%) coral colonies in each size class for coral species at Sector B-2, as measured using 20-m² transects (n=4).

Sector B-2		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Poc. damicornis</i>									
Total	82	615	682	352	188	0	0	1290	
St dev	±2	±7	±10	±12	±10	--	--		
Range	0-5	14-30	8-31	1-29	0-20	--	--		
Total	82	615	682	352	188			1290	

Table 13. Number of live total coral colonies in each size class for coral species at Sector B-3, as measured using 20-m² transects (n=4). Taxa without assigned mortality category are 0-10% mortality

Sector B-3		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Leptastrea</i> sp.									
Total	156	42	0	0	0	0	0	198	
St dev	±8	±4	--	--	--	--	--		
Range	0-13	0-7	--	--	--	--	--		
<i>Porites lobata</i>									
Total	576	168	6	0	0	0	0	750	
St dev	±37	±8	±1	--	--	--	--		
Range	0-78	0-15	0-1	--	--	--	--		
Total	732	210	6	0	0	0	0	948	

Table 14. Number of dead (90-100%) coral colonies in each size class for coral species at Sector B-3, as measured using 20-m² transects (n=4).

Sector B-3		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>160	Total
<i>Poc. damicornis</i>								
Total	0	36	30	0	0	0	0	66
St dev	--	±8	±3	--	--	--	--	
Range		0-6	0-5	--	--	--	--	
Total	0	36	30	0	0	0	0	66

Table 15. Number of live total coral colonies in each size class for coral species at Sector B-4, as measured using 20-m² transects (n=5). Taxa without assigned mortality category are 0-10% mortality

Sector B-4		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Leptastrea</i> sp.								
Total	120	7	0	0	0	0	0	127
St dev	±4	±0.4	--	--	--	--	--	
Range	0-10	0-1	--	--	--	--	--	
<i>Porites lobata</i>								
Total	260	100	7	0	0	0	0	367
St dev	±1	±4	±3	--	--	--	--	
Range	0-20	0-10	0-1	--	--	--	--	
Total	380	107	7	0	0	0	0	493

Table 16. Number of dead (90-100%) coral colonies in each size class for coral species at Sector B-4, as measured using 20-m² transects (n=5).

Sector B-4		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Poc. damicornis</i>								
Total	20	60	40	0	0	0	0	120
St dev	±1	±4	±3	--	--	--	--	
Range	0-2	0-9	0-6	--	--	--	--	
Total	20	60	40	0	0	0	0	120

Table 17. Number of live and dead (90 – 100% mortality) total coral colonies in each size class for coral species at Sector C-1, as measured on 2 piles.

Sector C-1		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
Total	0	0	0	0	0	0	0	0

Table 18. Number of live total coral colonies in each size class for coral species at Sector C-2, as measured on 8 piles. Taxa without assigned mortality category are 0-10% mortality

Sector C-2		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Leptastrea</i> sp.								
Total	4314	74	0	0	0	0	0	4388
St dev	±83	±3	--	--	--	--	--	
Range	0-251	0-7	--	--	--	--	--	
<i>Porites lobata</i>								
Total	118	74	15	0	0	0	0	207
St dev	±3	±2	±1	--	--	--	--	
Range	0-7	0-5	0-2	--	--	--	--	
<i>Porites lobata</i> (51-90% mortality)								
Total	0	0	0	0	7	0	0	7
St dev	--	--	--	--	±0.4	--	--	
Range					0-1			
Total	4432	148	15	0	7	0	0	4602

Table 19. Number of dead (90-100%) coral colonies in each size class for coral species at Sector C-2, as measured on 8 piles.

Sector C-2		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Poc. damicornis</i>								
Total	0	22	0	0	0	0	0	22
St dev	--	±1	--	--	--	--	--	
Range		0-3	--	--	--	--	--	
Total	0	22	0	0	0	0	0	22

Table 20. Number of live total coral colonies in each size class for coral species at Sector D, as measured on 3 piles. Taxa without assigned mortality category are 0-10% mortality

Sector D		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Leptastrea</i> sp.									
Total	469	0	0	0	0	0	0	469	
St dev	±25	--	--	--	--	--	--		
Range	0-74	--	--	--	--	--	--		
<i>Porites lobata</i>									
Total	51	6	0	0	0	0	0	57	
St dev	±3	±0.3	--	--	--	--	--		
Range	2-3	0-1	0-	--	--	--	--		
Total	520	6	0	0	0	0	0	526	

Table 21. Number of dead (90-100%) coral colonies in each size class for coral species at Sector D, as measured on 3 piles.

Sector D		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Porites lobata</i>									
Total	0	6	0	0	0	0	0	6	
St dev	--	±0.3	--	--	--	--	--		
Range	--	0-1	--	--	--	--	--		
Total	0	6	0	0	0	0	0	6	

Table 22. Number of live total coral colonies in each size class for coral species at Sector E, as measured on 37 piles (543 m²). Taxa without assigned mortality category are 0-10% mortality

Sector E, piles		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Leptastrea</i> sp.									
Total	3123	252	0	0	0	0	0	3375	
St dev	±23	±2	--	--	--	--	--		
Range	0-99	0-8	--	--	--	--	--		
<i>Porites lobata</i>									
Total	810	620	202	31	6	0	0	1669	
St dev	±7	±5	±1	±0.4	±0.2	--	--		
Range	0-37	0-24	0-4	0-1	0-1	--	--		
<i>Porites lobata</i> (11-50% mortality)									
Total	0	0	0	6	6	6	0	18	
St dev	--	--	--	±0.2	±0.2	±0.2	--		
Range	--	--	--	0-1	0-1	0-1	--		
<i>Porites lobata</i> (51-90% mortality)									
Total	0	0	0	0	0	6	0	6	
St dev	--	--	--	--	--	±0.2	--		
Range	--	--	--	--	--	0-1	--		
Total	3933	872	202	37	12	12	0	5068	

Table 23. Number of dead (90-100%) coral colonies in each size class for coral species at Sector E, as measured on 37 piles (543 m²).

Sector E, piles		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Cyphastrea ocellina</i>									
Total	25	0	0	0	0	0	0	25	
St dev	±0.3	--	--	--	--	--	--		
Range	0-1	--	--	--	--	--	--		
<i>Leptastrea</i> sp.									
Total	25	0	0	0	0	0	0	25	
St dev	±0.5	--	--	--	--	--	--		
Range	0-3	--	--	--	--	--	--		

Table 23 (continued).

Sector E, piles Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Montipora capitata</i>								
Total	0	0	0	12	25	12	6	55
St dev	--	--	--	±0.2	±0.3	±0.2	±0.2	
Range				0-1	0-1		0-1	
<i>Montipora patula</i>								
Total	0	0	0	6	0	12	0	18
St dev	--	--	--	±0.2	--	±0.2	--	
Range	--	--	--	0-1	--	0-1	--	
<i>Pocillopora damicornis</i>								
Total	31	135	221	12	0	6	0	405
St dev	±1	±1	±2	±0.2	--	±0.2	--	
Range	0-5	0-7	0-6	0-1	--	0-1	--	
<i>Porites compress</i>								
Total	0	0	0	0	0	12	0	12
St dev	--	--	--	--	--	±0.3	--	
Range	--	--	--	--	--	0-2	--	
<i>Porites lobata</i>								
Total	0	0	0	0	6	0	0	6
St dev	--	--	--	--	±0.2	--	--	
Range	0-	0-	0-	--	0-1	--	--	
Total	81	135	221	30	31	42	6	546

Table 24. Number of live total coral colonies in each size class for coral species on sea floor at Sector E, as measured using 20-m² transects (n=9).

Sector E, sea floor		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Cyphastrea ocellina</i>									
Total	14	0	0	0	0	0	0	14	
St dev	±1	--	--	--	--	--	--		
Range	0-2	--	--	--	--	--	--		
<i>Leptastrea sp.</i>									
Total	2194	56	0	0	0	0	0	2250	
St dev	±38	±1	--	--	--	--	--		
Range	1-120	0-4	--	--	--	--	--		
<i>Porites compressa</i>									
Total	14	0	0	0	0	0	0	14	
St dev	±0.4	--	--	--	--	--	--		
Range	0-1	--	--	--	--	--	--		
<i>Porites lobata</i>									
Total	4042	1049	111	0	7	0	0	5208	
St dev	±103	±19	±2	--	±0.3	--	--		
Range	4-314	052-	0-7	--	0-1	--	--		
Total	6264	1104	111	0	7	0	0	7486	

Table 25. Number of dead (90-100%) coral colonies in each size class for coral species on sea floor at Sector E, as measured using 20-m² transects (n=9).

Sector E, sea floor		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Leptastrea</i> sp.									
Total	14	0	0	0	0	0	0	14	
St dev	±1	--	--	--	--	--	--		
Range	0-2	--	--	--	--	--	--		
<i>Montipora capitata</i>									
Total	0	0	0	0	7	7	0	14	
St dev	--	--	--	--	±0.3	±0.3	--		
Range	--	--	--	--	0-1	0-1	--		
<i>Montipora patula</i>									
Total	0	0	0	0	7	0	0	7	
St dev	--	--	--	--	±0.3	0	--		
Range	--	--	--	--	0-1	--	--		
<i>Pocillopora damicornis</i>									
Total	160	97	90	21	7	0	0	375	
St dev	±3	±2	±3	±1	±0.3	--	--		
Range	0-9	0-7	0-9	0-2	0-2	--	--		
<i>Pocillopora meandrina</i>									
Total	0	0	0	7	0	0	0	7	
St dev	--	--	--	±0.3	--	--	--		
Range	--	--	--	0-1	--	--	--		
<i>Pavona varians</i>									
Total	0	7	0	0	0	0	0	7	
St dev	--	±0.3	--	--	0	--	--		
Range	0-	0-1	0-	--	--	--	--		
Total	174	104	90	28	21	7	0	424	

Table 26. Number of live total coral colonies in each size class for coral species at Sector F, as measured using 20-m² transects (n=3). Taxa without assigned mortality category are 0-10% mortality

Sector F Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>160	
<i>Leptastrea</i> sp.								
Total	998	14	0	0	0	0	0	1012
St dev	±25	±1	--	--	--	--	--	
Range	21-71	0-2	--	--	--	--	--	
<i>Porites lobata</i>								
Total	1455	219	14	0	0	0	0	1689
St dev	±23	±3	±1	--	--	--	--	
Range	56-97	7-13	0-q	--	--	--	--	
<i>Porites lobata</i> (51-90% mortality)								
Total	7	0	0	0	0	0	0	7
St dev	±1	--	--	--	--	--	--	
Range	0-1	--	--	--	--	--	--	
Total	2460	232	14	0	0	0	0	2706

Table 27. Number of dead (90-100%) coral colonies in each size class for coral species at Sector F, as measured using 20-m² transects (n=3).

Sector F Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Montipora capitata</i>								
Total	0	0	0	7	7	0	0	14
St dev	--	--	--	±1	±1	--	--	
Range	--	--	--	0-1	0-1	--	--	
<i>Montipora patula</i>								
Total	0	0	27	7	0	0	0	34
St dev	--	--	±2	±1	--	--	--	
Range	--	--	0-4	0-1	--	--	--	
<i>Pocillopora damicornis</i>								
Total	27	116	164	89	96	14	0	506
St dev	±2	±6	±4	±3	±7	±1	--	
Range	0-3	0-12	0-12	0-7	0-13	0-2	--	

Table 27 (continued).

Sector F Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Porites lobata</i>								
Total	7	0	0	0	0	0	0	7
St dev	±1	--	--	--	--	--	--	
Range	0-1	--	--	--	--	--	--	
Total	34	116	191	103	103	14	0	561

Table 28. Number of live total coral colonies in each size class for coral species on sea floor at Sector G, as measured using 20-m² transects (n=11). Taxa without assigned mortality category are 0-10% mortality

Sector G, sea floor Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Cyphastrea ocellina</i>								
Total	0	0	7	0	0	0	0	7
St dev	--	--	±0.3	--	--	--	--	
Range	--	--	0-1	--	--	--	--	
<i>Leptastrea sp.</i>								
Total	3982	77	0	0	0	0	0	4059
St dev	±44	±1	--	--	--	--	--	
Range	12-159	0-3	--	--	--	--	--	
<i>Porites lobata</i>								
Total	6158	1065	123	19	0	0	0	7365
St dev	±75	±13	±2	±1	--	--	--	
Range	8-260	0-39	0-5	0-3	--	--	--	
<i>Porites lobata</i> (51-90% mortality)								
Total	6	0	0	0	0	0	0	6
St dev	±0.3	--	--	--	--	--	--	
Range	0-1	--	--	--	--	--	--	
Total	10146	1142	130	19	0	0	0	11438

Table 29. Number of dead (90-100%) coral colonies in each size class for coral species on sea floor at Sector G, as measured using 20-m² transects (n=11).

Sector G, sea floor		Size class (cm)							Total
		1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Leptastrea</i> sp.									
	Total	6	0	0	0	0	0	0	6
	St dev	±0.3	--	--	--	--	--	--	
	Range	0-1	--	--	--	--	--	--	
<i>Montipora capitata</i>									
	Total	0	0	6	6	6	0	0	18
	St dev	--	--	±0.3	±0.3	±0.3	--	--	
	Range	--	--	0-1	0-1	0-1	--	--	
<i>Pocillopora damicornis</i>									
	Total	52	110	148	71	0	0	0	381
	St dev	±1	±3	±3	±2	--	--	--	
	Range	0-4	0-9	0-11	0-6	--	--	--	
<i>Porites compressa</i>									
	Total	26	32	13	0	0	0	0	71
	St dev	±1	±1	±1	--	--	--	--	
	Range	0-3	0-4	0-2	--	--	--	--	
Total		84	142	167	77	6	0	0	476

Table 30. Number of live total coral colonies in each size class for coral species at Sector G, measured on 3 piles. Taxa without assigned mortality category are 0-10% mortality

Sector G, piles		Size class (cm)							Total
		1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Leptastrea</i> sp.									
	Total	123	7	0	0	0	0	0	130
	St dev	±21	±1	--	--	--	--	--	
	Range	0-37	0-2	--	--	--	--	--	
<i>Porites lobata</i>									
	Total	37	0	3	0	0	0	0	40
	St dev	±4	--	±1	--	--	--	--	
	Range	0-7	--	0-1	--	--	--	--	
Total		160	7	3	0	0	0	0	170

Table 31. Number of dead (90-100%) coral colonies in each size class for coral species at Sector G, measured on 3 piles.

Sector G, piles Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
Total	0	0	0	0	0	0	0	0

Table 32. Number of live total coral colonies in each size class for coral species at Sector H, measured in 42 m² of sheet pile (n=7). Taxa without assigned mortality category are 0-10% mortality

Sector H Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Cyphastrea ocellina</i>								
Total	8	0	0	0	0	0	0	8
St dev	±0.4	--	--	--	--	--	--	
Range	0-1	--	--	--	--	--	--	
<i>Leptastrea sp.</i>								
Total	3623	23	0	0	0	0	0	3646
St dev	±18	±1	--	--	--	--	--	
Range	47-92	0-3	--	--	--	--	--	
<i>Pavona varians</i>								
Total	23	15	8	0	0	0	0	46
St dev	±1	±1	±1	--	--	--	--	
Range	0-2	0-2	0-1	--	--	--	--	
<i>Pavona varians (11-50% mortality)</i>								
Total	0	0	0	0	8	0	0	8
St dev	--	--	--	--	±0.4	--	--	
Range	--	--	--	--	0-1	--	--	
<i>Porites lobata</i>								
Total	483	121	38	23	8	0	0	673
St dev	±11	±2	±2	±1	±0.4	--	--	
Range	0-33	0-7	0-4	0-2	0-1	--	--	
Total	4136	159	45	23	15	0	0	4378

Table 33. Number of dead (90-100%) coral colonies in each size class for coral species at Sector H, measured in 42 m² of sheet pile (n=7).

Sector H		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Pocillopora damicornis</i>									
Total	23	30	0	0	0	0	0	53	
St dev	±1	±1	--	--	--	--	--		
Range	0-1	0-1	--	--	--	--	--		
Total	23	30	0	0	0	0	0	53	

Table 34. Number of live total coral colonies in each size class for coral species on sea floor at Sector I as measured using 20-m² transects (n=8). Taxa without assigned mortality category are 0-10% mortality

Sector I, sea floor		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Leptastrea</i> sp.									
Total	7049	856	13	0	0	0	0	7918	
St dev	±129	±24	±1	--	--	--	--		
Range	0-348	0-68	0-2	--	--	--	--		
<i>Leptastrea</i> sp.(11-50% mortality)									
Total	27	7	0	0	0	0	0	33	
St dev	±1	±0.4	--	--	--	--	--		
Range	0-4	0-1	--	--	--	--	--		
<i>Leptastrea</i> sp.(51-90% mortality)									
Total	7	13	0	0	0	0	0	20	
St dev	±2	±2	--	--	--	--	--		
Range	0-7	0-5	0-1	--	--	--	--		
<i>Porites compressa</i>									
Total	0	0	0	7	0	0	0	7	
St dev	--	--	--	±0.4	--	--	--		
Range	--	--	--	0-1	--	--	--		
<i>Porites compressa</i> (11-50% mortality)									
Total	0	0	0	0	0		0	7	
St dev	--	--	--	--	--	±0.4	--		
Range	--	--	--	--	--	0-1	--		

Table 34 (continued).

Sector I, sea floor		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Porites lobata</i>								
Total	14499	6581	3083	441	7	7	0	24618
St dev	±398	±152	±88	±18	±0.4	±0.4	--	
Range	0-936	0-330	0-242	0-52	0-1	0-1	--	
<i>Porites lobata</i> .(11-50% mortality)								
Total	33	27	20	47	40	0	0	167
St dev	±1	±1	±1	±1	±2	--	--	
Range	0-2	0-2	0-2	0-5	0-6	--	--	
<i>Porites lobata</i> .(51-90% mortality)								
Total	60	33	13	114	47	0	0	267
St dev	±2	±1	±1	±6	±2	--	--	
Range	0-5	0-1	0-2	0-16	0-7	--	--	
Total	21675	7517	3129	609	94	17	0	33036

Table 35. Number of dead (90-100%) coral colonies in each size class for coral species on sea floor at Sector I, as measured using 20-m² transects (n=8).

Sector I, sea floor		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Leptastrea</i> sp.								
Total	47	33	0	0	0	0	0	80
St dev	±2	±2	--	--	--	--	--	
Range								
<i>Montipora capitata</i>								
Total	0	0	0	0	0	7	7	14
St dev	--	--	--	--	--	±0.4	±0.4	
Range								
<i>Pocillopora damicornis</i>								
Total	7	0	0	0	0	0	0	7
St dev	±0.4	--	--	--	--	--	--	
Range								
<i>Porites lobata</i>								
Total	27	0	0	0	0	0	0	27
St dev	±1	--	--	--	--	--	--	
Range	0-1	0-1	--	--	--	--	--	
Total	81	33	0	0	0	7	7	128

Table 36. Number of live total coral colonies in each size class for coral species at Sector I as measured on 5 piles (80 m²).

Sector I, piles		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Leptastrea</i> sp.									
Total	2392	23	0	0	0	0	0	2415	
St dev	±131	±1	--	--	--	--	--		
Range	69-147	0-2	--	--	--	--	--		
<i>Porites lobata</i> .									
Total	1265	294	110	37	6	0	0	1712	
St dev	±25	±6	±1	±6	±2	--	--		
Range	27-84	2-19							
Total	3657	317	110	37	6	0	0	4127	

Table 37. Number of dead (90-100%) coral colonies in each size class for coral species at Sector I, as measured on 5 piles.

Sector I, piles		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Pocillopora damicornis</i>									
Total	0	12	0	0	0	0	0	12	
St dev	--	±1	--	--	--	--	--		
Range	--	0-2							
Total	0	12	0	0	0	0	0	12	

Table 38. Number of live total coral colonies in each size class for coral species at Sector J as measured on 6 piles.

Sector J		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Leptastrea</i> sp.									
Total	3460	110	0	0	0	0	0	3570	
St dev	±53	±5	--	--	--	--	--		
Range	67-196	0-11	--	--	--	--	--		

Table 38 (continued).

Sector J		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Porites lobata.</i>								
Total	226	121	28	0	0	0	0	375
St dev	±10	±5	±2	--	--	--	--	
Range	0-24	0-10	0-4	--	--	--	--	
Total	3686	231	28	0	0	0	0	3944

Table 39. Number of dead (90-100%) coral colonies in each size class for coral species at Sector J, as measured on 6 piles.

Sector J		Size class (cm)						
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Leptastrea sp.</i>								
Total	116	0	0	0	0	0	0	116
St dev	±9	--	--	--	--	--	--	
Range	0-21	--	--	--	--	--	--	
<i>Montipora capitata</i>								
Total	0	0	0	11	6	0	0	17
St dev	--	--	--	±0.5	±0.4	--	--	
Range	--	--	--	0-1	0-1	--	--	
<i>Montipora patula</i>								
Total	0	11	11	6	0	0	0	28
St dev	--	±1	±1	±0.4	--	--	--	
Range		0-2	0-1	0-1	--	--	--	
<i>Pocillopora damicornis</i>								
Total	11	0	0	0	0	0	0	11
St dev	±1	--	--	--	--	--	--	
Range	0-1	--	--	--	--	--	--	
<i>Porites lobata</i>								
Total	0	116	0	0	0	0	0	116
St dev	--	±2	--	--	--	--	--	
Range	--	0-21	--	--	--	--	--	
Total	127	127	11	17	6	0	0	288

Table 40. Number of live total coral colonies in each size class for coral species at Sector K-1 as measured in 144.3 m² of sheet pile (n=6). Taxa without assigned mortality category are 0-10% mortality

Sector K-1 Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Cyphastrea ocellina</i>								
Total	12	0	0	0	0	0	0	12
St dev		--	--	--	--	--	--	
Range		--	--	--	--	--	--	
<i>Leptastrea</i> sp.								
Total	20785	376	6	0	0	0	0	21167
St dev	±376	±7	±0.4	--	--	--	--	
Range	216-1269	0-23	0-1	--	--	--	--	
<i>Leptastrea</i> sp.(11-50% mortality)								
Total	29	0	0	0	0	0	0	29
St dev	±1	--	--	--	--	--	--	
Range	0-3	--	--	--	--	--	--	
<i>Leptastrea</i> sp.(51-90% mortality)								
Total	81	12	6	0	0	0	0	99
St dev	±5	±1	±0.4	--	--	--	--	
Range	0-13	0-2	0-1	--	--	--	--	
<i>Pavona varians</i> (50-90% mortality)								
Total	0	0	0	6	0	0	0	6
St dev	--	--	--	±0.4	--	--	--	
Range	--	--	--	0-1	--	--	--	
<i>Porites lobata</i>								
Total	14293	5943	1213	110	29	0	0	21588
St dev	±142	±79	±17	±3	±0.4	--	--	
Range	169-565	68-256	12-60	0-8	0-1	--	--	
<i>Porites lobata</i> .(11-50% mortality)								
Total	12	0	12	17	23	0	0	64
St dev	±1	--	±1	±1	±	--	--	
Range	0-1	--	0-2	0-3	0-3	--	--	
<i>Porites lobata</i> .(51-90% mortality)								
Total	6	0	0	0	0	0	0	6
St dev	±0.4	--	--	--	--	--	--	
Range	0-7	--	--	--	--	--	--	
Total	35218	6331	1237	133	52	0	0	42967

Table 41. Number of dead (90-100%) coral colonies in each size class for coral species at Sector K-1, as measured in 144.3 m² of sheet pile (n=6).

Sector K-1 Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Leptastrea</i> sp.								
Total	318	0	0	0	0	0	0	318
St dev	±10	--	--	--	--	--	--	
Range	0-28	--	--	--	--	--	--	
<i>Montipora capitata</i>								
Total	0	35	17	12	6	0	0	70
St dev	--	±1	±1	±1	±0.4	--	--	
Range	--	0-2	0-2	0-1	0-1	--	--	
<i>Montipora patula</i>								
Total	0	23	12	29	23	0	0	87
St dev	--	±1	±1	±1	±1	--	--	
Range	--	0-3	0-2	0-2	0-3	--	--	
<i>Pavona varians</i>								
Total	0	0	6	12	6	0	0	24
St dev	--	--	±0.4	±1	±0.4	--	--	
Range	--	--	0-1--	0-1	0-1	--	--	
<i>Pocillopora damicornis</i>								
Total	35	69	29	0	0	0	0	133
St dev	±2	±2	±1	--	--	--	--	
Range	0-4	0-5	0-2	--	--	--	--	
<i>Porites lobata</i>								
Total	58	0	0	0	0	0	0	58
St dev	±3	--	--	--	--	--	--	
Range	0-7	--	--	--	--	--	--	
Total	411	127	64	53	35	0	0	690

Table 42. Number of live total coral colonies in each size class for coral species at Sector K-2 as measured in 196.5 m² of sheet pile (n=8). Taxa without assigned mortality category are 0-10% mortality

Sector K-2 Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Leptastrea</i> sp.								
Total	12132	301	6	0	0	0	0	12439
St dev	±316	±12	±0.4	--	--	--	--	
Range	13-832	0-32	0-1	--	--	--	--	
<i>Leptastrea</i> sp.(11-50% mortality)								
Total	91	6	0	0	0	0	0	97
St dev	±3	±0.4	--	--	--	--	--	
Range	0-7	0-1	--	--	--	--	--	
<i>Leptastrea</i> sp.(51-90% mortality)								
Total	85	6	0	0	0	0	0	91
St dev	±2	±0.4	--	--	--	--	--	
Range	0-6	0-1	--	--	--	--	--	
<i>Porites lobata</i>								
Total	13341	4326	1300	403	51	0	11	19432
St dev	±390	±153	±50	±18	±2	--	±1	
Range	4-1047	2-380	0-1113	0-49	0-5	--	0-2	
<i>Porites lobata</i> .(11-50% mortality)								
Total	28	0	6	0	0	0	0	34
St dev	±1	--	±0.4	--	--	--	--	
Range	0-4	--	0-1	--	--	--	--	
<i>Porites lobata</i> .(51-90% mortality)								
Total	28	0	0	11	6	0	0	45
St dev	±2	--	--	±0.5	±0.4	--	--	
Range	0-5	--	--	0-1	0-1	--	--	
Total	25705	4369	1312	414	57	0	11	32138

Table 43. Number of dead (90-100%) coral colonies in each size class for coral species at Sector K-2, as measured in 196.5 m² of sheet pile (n=8).

Sector K-2		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Leptastrea</i> sp.									
Total	1561	40	0	0	0	0	0	0	1601
St dev	±25	±1	--	--	--	--	--	--	
Range	2-67	0-4	--	--	--	--	--	--	
<i>Montipora capitata</i>									
Total	11	11	6	23	17	0	0	0	68
St dev	±1	±1	±0.4	±1	±1	--	--	--	
Range	0-2	0-2	0-1	0-2	0-2	--	--	--	
<i>Montipora patula</i>									
Total	0	6	11	6	0	0	6	6	29
St dev	--	±0.4	±1	±0.4	--	--	±0.4	±0.4	
Range	--	0-1	0-2	0-1	--	--	0-1	0-1	
<i>Pavona varians</i>									
Total	0	0	6	0	0	0	0	0	6
St dev	--	--	±0.4	--	--	--	--	--	
Range	--	--	0-1	--	--	--	--	--	
<i>Pocillopora damicornis</i>									
Total	68	45	57	23	0	0	0	0	193
St dev	±3	±2	±3	±1	--	--	--	--	
Range	0-8	0-6	0-9	0-4	--	--	--	--	
<i>Porites lobata</i>									
Total	11	0	6	17	17	6	0	0	57
St dev	±0.4	--	±0.4	±1	±1	±0.4	--	--	
Range	0-1	--	0-1	0-1	0-2	0-1	--	--	
Total	1651	102	86	69	34	6	6	6	1954

Table 44. Number of live total coral colonies in each size class for coral species at Sector K-3 as measured in 174.7 m² of sheet pile (n=8). Taxa without assigned mortality category are 0-10% mortality

Sector K-3		Size class (cm)							
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161	Total	
<i>Leptastrea</i> sp.									
Total	16180	193	6	0	0	0	0	16379	
St dev	±135	±7	±0.4	--	--	--	--		
Range	202-633	0-21	0-1	--	--	--	--		
<i>Leptastrea</i> sp.(11-50% mortality)									
Total	6	0	0	0	0	0	0	6	
St dev	±0.4	--	--	--	--	--	--		
Range	0-1	--	--	--	--	--	--		
<i>Porites lobata</i>									
Total	11297	5643	772	108	6	0	0	17826	
St dev	±103	±87	±11	±4	±0.4	--	--		
Range	112-428	22-240	5-40	0-12	0-1	--	--		
<i>Porites lobata</i> .(11-50% mortality)									
Total	0	6	49	68	28	0	6	148	
St dev	--	±0.4	±1	±1	±1	--	±0.4		
Range	--	0-1	0-2	0-3	0-2	--	0-1		
<i>Porites lobata</i> .(51-90% mortality)									
Total	0	0	17	17	28	0	0	62	
St dev	--	--	±1	±15	±1	--	--		
Range	--	--	0-1	0-1	0-2	--	--		
<i>Porites monticulosa</i> .(11-50% mortality)									
Total	0	0	0	11	0	0	0	11	
St dev	--	--	--	±0.5	--	--	--		
Range	--	--	--	0-1	--	--	--		
<i>Porites monticulosa</i> (51-90% mortality)									
Total	0	0	0	0	0	11	0	11	
St dev	--	--	--	--	--	±0.5	--		
Range	--	--	--	--	--	0-1	--		
Total	27483	5842	835	204	62	11	6	34443	

Table 45. Number of dead (90-100%) coral colonies in each size class for coral species at Sector K-3, as measured in 174.7 m² of sheet pile (n=8).

Sector K-3 Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Leptastrea</i> sp.								
Total	--	6	6	0	0	0	0	12
St dev	--	±0.4	±0.4	--	--	--	--	
Range	--	0-1	--	--	--	--	--	
<i>Montipora capitata</i>								
Total	6	11	45	79	85	17	0	243
St dev	±0.4	±0.5	±1	±2	±2	±1	--	
Range	0-1	0-1	0-4	0-5	0-6	0-1	--	
<i>Montipora patula</i>								
Total	6	23	17	102	40	11	0	199
St dev	±0.4	±1	±0.5	±3	±1	±0.5	--	
Range	0-1	0-3	0-1	0-8	0-2	0-1	--	
<i>Pavona varians</i>								
Total	0	0	11	17	6	0	0	34
St dev	--	--	±1	±1	±0.4	--	--	
Range	--	--	0-2	0-3	0-1	--	--	
<i>Pocillopora damicornis</i>								
Total	136	74	34	0	0	0	0	244
St dev	±3	±2	±1	--	--	--	--	
Range	0-7	0-6	0-3	--	--	--	--	
<i>Porites lobata</i>								
Total	0	0	6	6	0	0	0	57
St dev	--	--	±0.4	±0.4	--	--	--	
Range	--	--	0-1	0-1	--	--	--	
Total	148	125	125	193	125	28	0	744

Table 46. Number of live total coral colonies in each size class for coral species at Sector L as measured in 154.1 m² of sheet pile (n=6). Taxa without assigned mortality category are 0-10% mortality

Sector L		Size class (cm)							
Taxa		1-5	6-10	11-20	21-40	41-80	81-160	>161	Total
<i>Leptastrea</i> sp.									
	Total	3561	86	0	0	0	0	0	3647
	St dev	±52	±3	--	--	--	--	--	
	Range	47-170	0-7	--	--	--	--	--	
<i>Cyphastrea ocellina</i>									
	Total	32	0	0	0	0	0	0	32
	St dev	±2	--	--	--	--	--	--	
	Range	0-4	--	--	--	--	--	--	
<i>Pavona varians</i>									
	Total	21	0	0	0	0	0	0	21
	St dev	±2	--	--	--	--	--	--	
	Range	0-4	--	--	--	--	--	--	
<i>Porites lobata</i> .									
	Total	1208	342	86	16	0	0	0	1652
	St dev	±37	±7	±3	±1	--	--	--	
	Range	8-107	1-20	1-9	0-1	--	--	--	
<i>Porites lobata</i> .(51-90% mortality)									
	Total	5	0	0	0	0	0	0	5
	St dev	±0.4	--	--	--	--	--	--	
	Range	0-1	--	--	--	--	--	--	
Total		4827	428	86	16	0	0		5358

Table 47. Number of dead (90-100%) coral colonies in each size class for coral species at Sector L, measured in 154.1 m² of sheet pile (n=6).

Sector L		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
<i>Cyphastrea ocellina</i>									
Total	5	0	0	0	0	0	0	5	
St dev	±2	--	--	--	--	--	--		
Range	0-4	--	--	--	--	--	--		
<i>Leptastrea sp.</i>									
Total	636	16	0	0	0	0	0	652	
St dev	±31	±1	--	--	--	--	--		
Range	3-170	0-3	--	--	--	--	--		
<i>Montipora capitata</i>									
Total	5	16	27	5	5	0	0	58	
St dev	±0.4	±1	±1	±0.4	±0.4	--	--		
Range	0-1	0-2	0-2	0-1	0-1	--	--		
<i>Montipora patula</i>									
Total	0	0	0	0	11	0	0	11	
St dev	--	--	--	--	±1	--	--		
Range	--	--	--	--	0-1	--	--		
<i>Pocillopora damicornis</i>									
Total	0	5	5	0	0	0	0	10	
St dev	--	±0.4	±0.4	--	--	--	--		
Range	--	0-1	0-1	--	--	--	--		
<i>Porites lobata</i>									
Total	96	37	21	0	0	0	0	154	
St dev	±7	±3	±2	--	--	--	--		
Range	0-18	0-7	0-4	--	--	--	--		
Total	742	74	53	5	16	0	0	890	

Table 48. Number of live and dead (90-100% mortality) coral colonies in each size class for coral species at harbor bottom locations, 20 m² transects (n=9).

Sector Harbor bottom		Size class (cm)							Total
Taxa	1-5	6-10	11-20	21-40	41-80	81-160	>161		
Total	0	0	0	0	0	0	0	0	

Table 49. Summary of total live (<90% mortality) coral colonies of all species by size class distribution in each survey sector.

Sector	Size class (cm)							Total	Sector Total	%
	1-5	6-10	11-20	21-40	41-80	81-160	>161			
A-1	4871	625	92	7	0	0	0	5595		
A-2	2463	597	45	0	0	0	0	3106	8701	4.
B-1	2064	552	12	0	0	0	0	2628		
B-2	1125	142	0	0	0	0	0	1268		
B-3	732	210	6	0	0	0	0	948		
B-4	380	107	7	0	0	0	0	493	5337	2.
C-1	0	0	0	0	0	0	0	0		
C-2	4432	148	15	0	7	0	0	4602	4602	2.
D	520	6	0	0	0	0	0	526	526	0.
E piles	3933	871	202	38	12	12	0	5068		
E shoreline	6264	1104	111	0	7	0	0	7486	12554	6.
F	2460	232	14	0	0	0	0	2706	2706	1.
G piles	160	7	3	0	0	0	0	170		
G shoreline	10146	1142	130	19	0	0	0	11438	11608	5.
H	4136	159	45	23	15	0	0	4378	4378	2.
I piles	3657	317	110	37	6	0	0	4127		
I shoreline	21674	7517	3129	609	94	14	0	33036	37163	18.
J	3686	231	28	0	0	0	0	3944	3944	1.
K-1	35216	6329	1237	133	52	0	0	42967		
K-2	25705	4326	1311	414	57	0	11	32138		
K-3	27483	5842	835	204	62	11	6	34443	109548	53.
L	4829	428	86	16	0	0		5358	5358	2.
Total	165936	30891	7418	1500	312	37	17	206423		100.

Table 50. Summary of total live (<90% mortality) coral colonies by species across all survey sectors.

Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Cyphastrea ocellina</i>	194	0	7	0	0	0	0	200
<i>Leptastrea</i> sp.	87571	2572	36	0	0	0	0	90179
<i>Pavona varians</i>	44	15	8	6	8	0	0	80
<i>Porites compressa</i>	14	0	0	7	0	7	0	27
<i>Porites lobata</i>	78113	28616	7366	1475	305	19	17	115905
<i>Porites monticulosa</i>	0	0	0	11	0	11	0	23
Total	165936	31205	7417	1499	312	37	17	206407

Table 51. Summary of total dead (90-100% mortality) coral colonies by species across all survey sectors.

Taxa	Size class (cm)							Total
	1-5	6-10	11-20	21-40	41-80	81-160	>161	
<i>Cyphastrea ocellina</i>	38	0	0	0	0	0	0	38
<i>Leptastrea</i>	2730	95	6	0	0	0	0	2831
<i>M. capitata</i>	50	73	101	155	164	43	13	600
<i>M. patula</i>	6	63	78	156	81	23	6	413
<i>Pavona varians</i>	0	18	29	18	6	0	0	71
<i>Poc. damicornis</i>	706	1632	1600	620	290	20	0	4869
<i>Poc. meandrina</i>	0	0	0	7	0	0	0	7
<i>P. compressa</i>	26	32	13	0	0	12	0	83
<i>P. lobata</i>	199	159	33	23	23	6	0	443
Total	3756	2072	1860	979	564	104	19	9354

Table 52. Summary of total dead (90-100% mortality) coral colonies of all species by size class distribution in each survey sector.

Sector	1-5	6-10	11-20	21-40	41-80	81-160	>160	Total	Total	% total
A-1	36	0	0	0	0	0	0	36		
A-2	8	8	15	22	0	0	0	53	89	0.95%
B-1	54	198	84	30	0	0	0	366		
B-2	82	615	682	352	188	0	0	1920		
B-3	0	36	30	0	0	0	0	66		
B-4	20	60	40	0	0	0	0	120	2472	26.42%
C-1	0	0	0	0	0	0	0	0		
C-2	0	0	0	0	0	0	0	0	0	0.24%
D	0	6	0	0	0	0	0	6	6	0.06%
E piles	80	135	221	31	31	43	6	547		
E shoreline	174	104	90	28	21	7	0	424	971	10.37%
F	34	116	191	103	103	14	0	561	561	6.00%
G piles	0	0	0	0	0	0	0	0		
G shoreline	84	142	167	77	6	0	0	476	476	5.09%
H	23	30	0	0	0	0	0	53	53	0.57%
I piles	0	12	0	0	0	0	0	12		
I shoreline	81	33	0	0	0	7	7	128	140	1.50%
J	127	127	11	17	6	0	0	288	288	3.08%
K-1	318	0	0	0	0	0	0	318		
K-2	1651	102	86	69	34	6	6	1954		
K-3	148	125	125	193	125	28	0	744	3016	36.22%
L	742	74	53	5	16	0	0	890	890	9.51%
TOTAL	3756	2072	1859	979	565	105	19	9355	9355	100.00%

Benthic community composition

Mean percent community, by sector composition from line-intercept point method, is provided in Tables 53 through 56. The dominant bottom types in the shoreline sectors are silt and rubble. At shoreline sectors A-2 and I, coral makes up 13 and 14% of the bottom, respectively. Macroalgae and CCA are 0% cover across all shallow water sectors.

Table 53. Shoreline sectors mean percent benthic community composition.

	Concrete	Silt	Rubble	Invert†	Macroalgae	Turf	CCA	Coral‡	Sand
Sector A-1									
Mean %	3	38	48	0	0	5	0	8	0
St dev	±0.5	±3.2	±2.6	---	---	±0.6	---	±1.0	---
Sector A-2									
%Mean	0	33	53	0	0	0	0	13	0
St dev	---	±2.5	±2.1	---	---	---	---	±1.5	---
Sector B-1									
Mean %	0	10	73	0	0	3	0	3	13
St dev		±1.4	±2.1	---	---	±0.5	---	±0.5	±1.3
Sector B-2									
Mean %	0	23	53	0	0	20	0	3	3
St dev	--	±2.1	±2.4	--	--	±3.4	--	±0.5	±0.5
Sector B-3									
Mean %	0	55	33	8	0	0	0	0	5
St dev	--	±3.7	±2.5	±1.5	--	--	---	--	±1
Sector B-4									
Mean %	0	62	34	4	0	0	0	0	0
St dev	--	±1.1	±0.9	±0.5	--	--	--	--	--
Sector E									
Mean %	0	74	23	0	0	0	0	3	0
St dev	--	±2.7	±2.5	--	--	--	--	±0.5	--
Sector F									
Mean %	13	20	60	8	0	0	0	7	0
St dev	±1.5	±1.7	±1	±1.0-	--	--	--	±1.2	--
Sector G									
Mean %	24	25	35	8	0	0	3	5	0
St dev	2.4	2.4	2.7	1	--	--	0.6	0.7	--
Sector I									
Mean %	0	71	9	4	0	1	0	14	0
St dev	--	±2.4	±1.2	±0.8	--	±0.4	--	±1.5	--

† Includes dead invertebrates

‡ Includes dead coral

Pile and sheet pile sectors are dominated by invertebrates, mostly shells of dead bivalves (*Dendrostroma sandvicensis*) and tunicates (*Phallusia nigra*). Fine-grained silt covers nearly all surfaces. Coral makes up a small fraction at sector C-2, and 10-14% at sectors E, I and J, respectively. Coral cover was 0% at sectors G and C-1. The two dominant bottom types at sector K are invertebrates (including dead bivalves) and coral. Invertebrates make up the majority of the assemblages at sectors H and L.

Table 54. Pile sectors mean percent community composition.

	Concrete	Silt	Rubble	Invert†	Macroalgae	Turf	CCA	Coral‡
Sector C-1								
Mean %	17	0	0	83	0	0	0	0
St dev	±1.4	--	--	±1.4	---	--	---	--
Sector C-2								
%Mean	14	0	0	80	0	0	2	4
St dev	±2.1	--	--	±2.2	---	---	±0.7	±0.9
Sector D								
Mean %	44	0	0	47	3	0	6	0
St dev	±1.6	--	--	±1.5	±0.6	--	±0.6	---
Sector E								
Mean %	17	<1	0	52	12	3	4	13
St dev	±1.8	±0.2	--	±3.1	±1.8	±0.8	±1.0	±1.6
Sector G								
Mean %	22	3	0	72	3	0	0	0
St dev	±1.5	±0.6	--	±1.5	±0.6	--	---	--
Sector I								
Mean %	7	2	0	75	0	0	2	14
St dev	±1.7	±0.7	--	±2	--	--	±0.5	±1.7
Sector J								
Mean %	3	0	0	77	2	3	5	10
St dev	±0.8	--	--	±2.6	±0.4	±0.5	±0.5	±1.1
† Includes dead invertebrates								
‡ Includes dead coral								

Table 55. Sheet pile sectors mean percent community composition.

	Concrete	Silt	Rubble	Invert†	Macroalgae	Turf	CCA	Coral‡
Sector H								
Mean %	5	23	0	59	0	0	5	7
St dev	±1.8	±2.7	--	±1.5	---	--	±0.9	±1.7
Sector K-1								
%Mean	0	0	0	81	0	0	0	19
St dev	--	--	--	±1.2	---	---	--	±1.2
Sector K-2								
Mean %	1	0	0	68	0	0	0	31
St dev	±0.3	--	--	±4.5	--	--	--	±4.5
Sector K-3								
Mean %	1	0	0	74	0	0	0	25
St dev	±0.4	--	--	±4.1	--	--	--	±4.1
Sector L								
Mean %	17	1	0	68	11	0	3	0
St dev	±0.6	±0.4	--	±1.0	±1.2	--	±0.8	--

† Includes dead invertebrates
‡ Includes dead coral

Table 56. Harbor bottom mean percent benthic community composition.

	Concrete	Silt	Rubble	Invert†	Macroalgae	Turf	CCA	Coral‡	Sand
Sector HB-1									
Mean %	0	100	0	0	0	0	0	0	0
St dev	--	0	--	---	---	--	---	--	---
Sector HB-2									
%Mean	0	100	0	0	0	0	0	0	0
St dev	--	0	--	---	---	--	---	--	---
Sector HB-3									
Mean %	0	100	0	0	0	0	0	--	0
St dev	--	0	--	---	---	--	---	--	---
Sector HB-4									
Mean %	0	100	0	0	0	0	0	0	0
St dev	--	0	--	---	---	--	---	--	---

Table 56 (continued).

	Concrete	Silt	Rubble	Invert†	Macroalgae	Turf	CCA	Coral‡	Sand
Sector HB-5									
Mean %	0	100	0	0	0	0	0	0	0
St dev	--	0	--	---	---	--	---	--	---
Sector HB-6									
Mean %	0	100	0	0	0	0	0	0	0
St dev	--	0	--	---	---	--	---	--	---
Sector HB-8									
Mean %	0	100	0	0	0	0	0	0	0
St dev	--	0	--	---	---	--	---	--	---
Sector HB-9									
Mean %	0	100	0	0	0	0	0	0	0
St dev	--	0	--	---	---	--	---	--	---
Sector HB-10									
Mean %	0	100	0	0	0	0	0	0	0
St dev	--	0	--	---	---	--	---	--	---

Algae

Algae abundance (less than or more than common) across sectors is provided in Tables 57 through 61 below. In general, algae are not common throughout the survey area. When encountered, algae were nearly always “less than common” on a transect. A total of 29 algal taxa were observed in the survey area. Four species of green algae (Chlorophyta) were observed: *Bryopsis* sp., *Cladophora* sp., *Dictyosphaeria versluysii*, and *Neomeris* sp. Of these, *Bryopsis* sp. and *Neomeris* sp. were observed to be more than common at sectors B and L. Brown algae (Phaeophyta) were represented by *Lobophora variegata*, *Lobophora* sp., *Ralfisia pangoensis*, and *Padina* sp. *Lobophora* sp. was “more than common” at pile sectors D and I, and sheet pile sectors H and L. Cyanobacteria (blue-green ‘algae’) were seen across the sectors, including one “whispy red stringy” variety, which was found to be “more than common” in shoreline sector B and pile sectors D and E. Red algae (Rhodophyta) were represented by the most species, with *Dichotomeria marginata* “more than common” at sectors C-2, D, and J. An encrusting coralline alga, *Hydrolithion* sp., was “more than common” at shallow water sectors B-2 and B-4, and piles at sector E.

Table 57. Fraction of times green algae were observed ("less than common" or "more than common") in each sector.

Sector	Green algae									
	<i>Bryopsis</i> sp.		<i>Pseudo Bryopsis</i> (?)		<i>Cladophora</i> sp.		<i>Dictyosphaeria versluysii</i>		<i>Neomeris</i> sp.	
	Less	More	Less	More	Less	More	Less	More	Less	More
A-1, n=4	--	--	--	--	--	--	0.25	0	--	--
A-2, n=3	--	--	--	--	--	--	--	--	--	--
B-1, n=4	--	--	--	--	--	--	--	--	--	--
B-2, n=4	0.25	0	--	--	--	--	0.25	0	--	--
B-3, n=4	--	--	--	--	--	--	--	--	--	--
B-4, n=5	0.20	0.20	--	--	--	--	--	--	--	--
C-1, n=2	--	--	--	--	--	--	--	--	--	--
C-2, n=8	--	--	0.13	0	--	--	--	--	0.13	0
D, n=3	--	--	--	--	--	--	--	--	--	--
pE, n=35	--	--	--	--	0.03	0	0.34	0	--	--
F, n=3	--	--	--	--	--	--	--	--	--	--
G, n=11	--	--	--	--	--	--	--	--	--	--
pG, n=3	--	--	--	--	--	--	--	--	1	0
H, n=7	--	--	--	--	--	--	--	--	0.14	0
I, n=8	--	--	--	--	--	--	--	--	--	--
pI, n=5	--	--	--	--	--	--	--	--	--	--
J, n=6	--	--	--	--	--	--	--	--	--	--
K-1, n=6	--	--	--	--	--	--	--	--	--	--
K-2, n=9	--	--	--	--	--	--	0.11	0	--	--
K-3, n=8	--	--	--	--	--	--	0.75	0	--	--
L, n=6	--	--	--	--	--	--	0.67	0	--	0.67

Table 58. Fraction of times brown algae were observed (“less than common” or “more than common”) in each sector.

Sector	Brown algae							
	<i>Lobophora variegata</i>		<i>Lobophora sp.</i>		<i>Ralfisia pangoensis</i>		<i>Padina sp.</i>	
	Less	More	Less	More	Less	More	Less	More
A-1, n=4	--	--	--	--	--	--	--	--
A-2, n=3	--	--	--	--	--	--	--	--
B-1, n=4	--	--	--	--	--	--	--	--
B-2, n=4	--	--	--	--	--	--	--	--
B-3, n=4	--	--	--	--	--	--	--	--
B-4, n=5	--	--	--	--	--	--	--	--
C-1, n=2	0.5	0	--	--	--	--	--	--
C-2, n=8	0.63	0	--	--	--	--	--	--
D, n=3	0	0.33	--	--	--	--	--	--
pE, n=35	0.43	0	0.26	0.15	--	--	--	--
F, n=3	--	--	--	--	--	--	--	--
G, n=11	--	--	--	--	--	--	--	--
pG, n=3	--	--	0.4	0.4	--	--	--	--
H, n=7	--	--	0.57	0.14	--	--	--	--
I, n=8	--	--	--	--	--	--	--	--
pI, n=5	0.4	0.2	--	--	--	--	--	--
J, n=6	1	0	--	--	--	--	--	--
K-1, n=6	--	--	--	--	0.17	0	--	--
K-2, n=9	0.33	0	--	--	--	--	--	--
K-3, n=8	0.88	0	0.25	0	--	--	--	--
L, n=6	--	--	0	0.83	--	--	0.17	0

Table 59. Fraction of times blue-green algae were observed (“less than common” or “more than common”) in each sector.

Sector	Blue-green algae							
	<i>Lyngbya majuscula</i>		<i>Symploca hynoides</i>		Whispy/stringy red cyanobacteria		Brown stringy cyanobacteria	
	Less	More	Less	More	Less	More	Less	More
A-1, n=4	--	--	0.25	0	--	--	--	--
A-2, n=3	--	--	0.67	0	--	--	--	--
B-1, n=4	--	--	--	--	0.5	0.25	--	--
B-2, n=4	--	--	0.25	0	0.25	0	--	--
B-3, n=4	--	--	--	---	--	--	--	--
B-4, n=5	--	--	--	--	0.6	0.2	--	--
C-1, n=2	--	--	--	--	--	--	--	--
C-2, n=8	--	--	--	--	0.38	0	--	--
D, n=3	--	--	--	--	0.67	0.33	--	--
pE, n=35	0.06	0	--	--	0	0.17	--	--
F, n=3	--	--	--	--	--	--	--	--
G, n=11	--	--	--	--	--	--	--	--
pG, n=3	--	--	--	--	--	--	--	--
H, n=7	--	--	--	--	--	--	--	--
I, n=8	--	--	--	--	--	--	--	--
pI, n=5	--	--	--	--	0.6	0	--	--
J, n=6	--	--	--	--	--	--	--	--
K-1, n=6	--	--	--	--	--	--	0.5	0
K-2, n=9	--	--	--	--	--	--	--	--
K-3, n=8	--	--	--	--	--	--	--	--
L, n=6	--	--	--	--	--	--	--	--

Table 60. Fraction of times red algae were observed (“less than common” or “more than common”) in each sector.

Sector	Red algae									
	<i>Acanthophora spicifera</i>		<i>Dichotomeria marginata</i>		<i>Dichotomeria sp.</i>		<i>Galaxaura rugosa</i>		<i>Hydrolithon onkodes</i>	
	Less	More	Less	More	Less	More	Less	More	Less	More
A-1, n=4	--	--	--	--	--	--	--	--	0.5	0
A-2, n=3	--	--	--	--	--	--	--	--	0.67	0
B-1, n=4	--	--	--	--	--	--	--	--	1	0
B-2, n=4	--	--	--	--	--	--	--	--	0.75	0.25
B-3, n=4	--	--	--	--	--	--	--	--	1	0
B-4, n=5	--	--	--	--	--	--	--	--	0	0.4
C-1, n=2	--	--	--	--	--	--	--	--	--	--
C-2, n=8	--	--	0	0.13	--	--	--	--	0.375	0
D, n=3	--	--	0	0.33	--	--	0.02	0	1	0
pE, n=35	0.03	0	0.03	0	--	--	--	--	0.4	0.06
F, n=3	--	--	--	--	--	--	--	--	0.05	0
G, n=11	--	--	--	--	--	--	0.09	0	0.18	0
pG, n=3	--	--	--	--	--	--	--	--	1	0
H, n=7	--	--	--	--	--	--	--	--	0.43	0
I, n=8	--	--	--	--	--	--	--	--	0.25	0
pI, n=5	--	--	--	--	--	--	--	--	0.8	0
J, n=6	--	--	0	0.17	--	--	--	--	--	--
K-1, n=6	--	--	--	--	--	--	--	--	--	--
K-2, n=9	--	--	--	--	--	--	--	--	0.89	0
K-3, n=8	--	--	--	--	0.13	0	--	--	0.88	0
L, n=6	--	--	--	--	--	--	--	--	--	--
Sector	<i>Hydrolithon reinboldii</i>		<i>Hydrolithon sp.</i>		<i>Mesophyllum mesomorphum</i>		<i>Peyssonnelia rubra</i>		<i>Sciniaia(?) sp.</i>	
	Less	More	Less	More	Less	More	Less	More	Less	More
A-1, n=4	0.5	0	--	--	--	--	--	--	--	--
A-2, n=3	0.33	0	--	--	--	--	--	--	--	--
B-1, n=4	--	--	--	--	--	--	--	--	--	--
B-2, n=4	0.5	0	--	--	--	--	--	--	0.25	0
B-3, n=4	1	0	--	--	--	--	--	--	--	--
B-4, n=5	0	0.4	--	--	--	--	--	--	--	--
C-1, n=2	--	--	--	--	--	--	--	--	--	--
C-2, n=8	0.125	0	0.25	0	--	--	--	--	--	--
D, n=3	1	0	--	--	--	--	0.33	0	--	--
pE, n=35	0.23	0.06	--	--	--	--	--	--	--	--
F, n=3	0.02	0	--	--	--	--	--	--	--	--

Sector	<i>Hydrolithon reinboldii</i>		<i>Hydrolithon sp.</i>		<i>Mesophyllum mesomorphum</i>		<i>Peyssonnelia rubra</i>		<i>Scinaia(?) sp.</i>	
	Less	More	Less	More	Less	More	Less	More	Less	More
G, n=11	--	--	--	--	--	--	--	--	--	--
pG, n=3	1	0	--	--	--	--	--	--	--	--
H, n=7	0.43	0	--	--	--	--	--	--	--	--
I, n=8	0.25	0	--	--	--	--	--	--	--	--
pI, n=5	0.6	0	--	--	--	--	--	--	--	--
J, n=6	--	--	--	--	--	--	--	--	--	--
K-1, n=6	0.17	0	--	--	0.17	0	--	--	--	--
K-2, n=9	0.22	0	--	--	--	--	--	--	--	--
K-3, n=8	0.25	0	--	--	0.13	0	--	--	--	--
L, n=6	--	--	0.67	--	--	--	--	--	--	--

Table 61. Fraction of times unidentified algae were observed (“less than common” or “more than common”) in each sector.

Sector	unidentified sp. 1		unidentified sp. 2		unidentified sp. 3		unidentified CCA		unid. Green filamentous		unid. yellowish green fine	
	Less	More	Less	More	Less	More	Less	More	Less	More	Less	More
A-1, n=4	--	--	--	--	--	--	--	--	--	--	--	--
A-2, n=3	--	--	--	--	--	--	--	--	--	--	--	--
B-1, n=4	--	--	--	--	--	--	--	--	--	--	--	--
B-2, n=4	--	--	--	--	--	--	--	--	--	--	--	--
B-3, n=4	--	--	--	--	--	--	--	--	--	--	--	--
B-4, n=5	--	--	--	--	--	--	--	--	--	--	--	--
C-1, n=2	--	--	--	--	--	--	--	--	--	--	--	--
C-2, n=8	--	--	--	--	--	--	--	--	--	--	--	--
D, n=3	--	--	--	--	--	--	--	--	--	--	--	--
pE, n=35	0.03	0	0.03	0	--	--	--	--	0.03	0	--	--
F, n=3	--	--	--	--	--	--	--	--	--	--	--	--
G, n=11	--	--	--	--	--	--	--	--	--	--	--	--
pG, n=3	--	--	--	--	--	--	--	--	--	--	--	--
H, n=7	--	--	--	--	--	--	--	--	--	--	--	--
I, n=8	--	--	--	--	--	--	--	--	--	--	--	--
pI, n=5	--	--	--	--	--	--	--	--	--	--	--	--
J, n=6	--	--	--	--	--	--	0.83	0	--	--	--	--
K-1, n=6	--	--	--	--	--	--	--	--	--	--	--	--
K-2, n=9	--	--	--	--	--	--	--	--	--	--	--	--
K-3, n=8	--	--	--	--	--	--	--	--	--	--	--	--
L, n=6	--	--	--	--	0.17	0	--	--	--	--	--	--

Macro-invertebrates

The survey area is characterized by high densities of tunicates, sponges, bryozoans, and bivalves. Over 64 taxa were identified throughout the survey area, with tunicates and several species of sponges (grouped as Porifera for data analysis) making up the majority of the community and observed in every sector. Of the species encountered, 11 are identified as introduced (not native) species (see Appendix A). Tunicates are the most abundant group of invertebrates (Fig 6), with the black sea squirt (*Phallusia nigra*) and solitary ascidan (*Herdmania momus*) occurring in large numbers throughout the sectors with piles and sheet piles. Nearly all surfaces of the concrete piles and sheet piles that make up the piers in Kapālama Basin are encrusted with remnant mollusk shells (primarily *Dendostrea sandvichensis*), with few live mollusks. Tables 62 through 73 show estimated invertebrate abundance for each sub-sector or sector, as applicable. One unidentified tube worm was observed across all harbor bottom survey locations. Burrows in the silt substratum were also observed, indicating the presence of infaunal invertebrates.

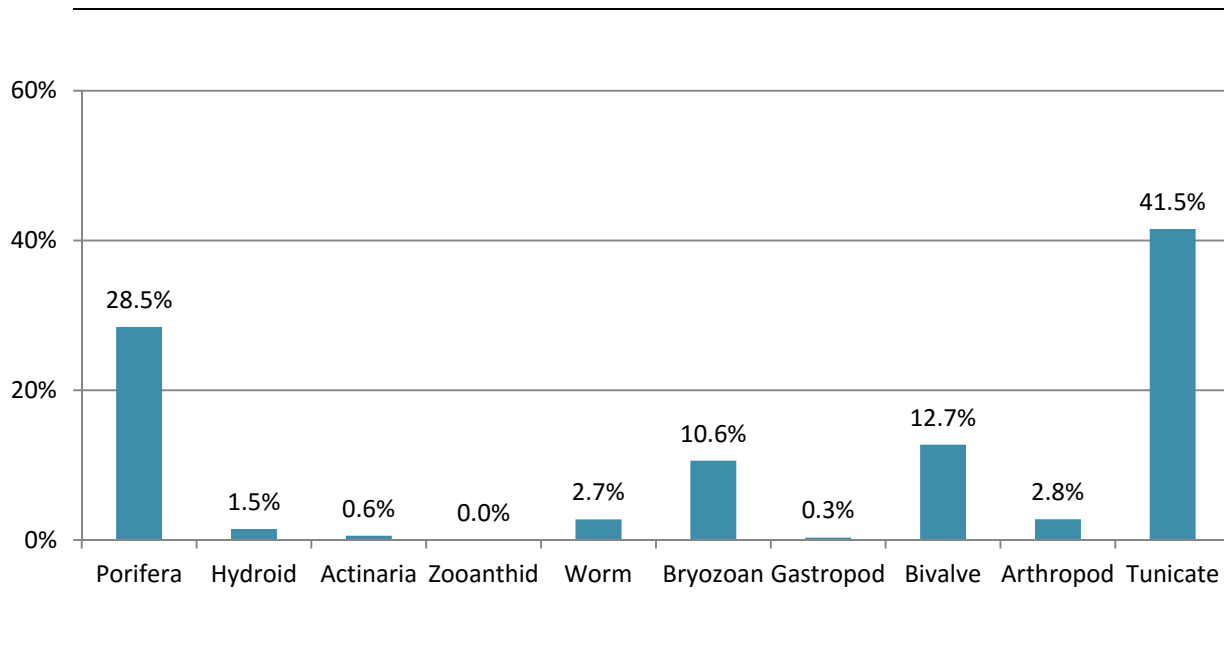


Figure 6. Percent of invertebrates in major groups, all sectors combined.

Table 62. Invertebrate abundance at Sector A-1, as measured using 20-m² transects (n=7) and Sector A-2, as measured using 20-m² transects (n=3).

Sector A-1			Sector A-2		
Taxon	Total	St dev	Taxon	Total	St dev
<i>Alpheus sp</i>	28.4	2.00	<i>Ascidea sydneyensis</i>	14.93	1.15
<i>Aplysia sp</i>	21.3	1.50	<i>Chromodoris vibrata</i>	7.47	0.71
<i>Chromodoris vibrata</i>	14.2	1.00	<i>Dendostrea sandvicensis</i>	134.4	1.73
<i>Dendostrea sandvicensis</i>	56.8	2.45	<i>Gonodactylaceus falcatus</i>	7.47	0.58
<i>Iotrochota protea</i>	14.2	0.50	<i>Herdmania momus</i>	7.47	0.58
<i>Isognomon perna</i>	7.1	0.58	<i>Isognomon perna</i>	14.93	1.15
<i>Pennaria disticha</i>	63.9	3.86	<i>Loimia medusa</i>	14.93	0.58
<i>Plakobranthus ocellatus</i>	28.4	0.82	<i>Phallusia nigra</i>	29.87	2.31
<i>Podphthalmus vigil</i>	49.7	0.50	<i>Podphthalmus vigil</i>	14.93	1.15
<i>Pseudoquilla ciliata</i>	14.2	0.58	<i>Portunidae sp</i>	59.73	2.52
<i>Sabellastarte spectabilis</i>	7.1	0.50	<i>Sabellastarte spectabilis</i>	14.93	1.15
<i>Stomatopoda sp</i>	14.2	1.00	White colonial tunicate	7.47	0.58
<i>Porifera</i>	28.4	0.82	<i>Porifera</i>	89.6	3.21

Table 63. Invertebrate abundance at Sector B-1, as measured using 20-m² transects (n=4) and Sector B-2, as measured using 20-m² transects (n=4) Sector B-3, as measured using 20-m² transects (n=4) and Sector B-4, as measured using 20-m² transects (n=5).

Sector B-1			Sector B-2		
Taxon	Total	St dev	Taxon	Total	St dev
<i>Amathia distans</i>	48	1.15	<i>Amathia distans</i>	30	2
<i>Chaetopterus sp.</i>	72	6.00	<i>Bugula dentate</i>	0	1
<i>Dendostrea sandvichensis</i>	726	23.87	<i>Bugula neritina</i>	0	0.5
<i>Herdmania momus</i>	66	2.87	<i>Calcinus latens</i>	0	1
<i>Phallusia nigra</i>	78	1.15	<i>Dendostrea sandvichensis</i>	14	46.8
<i>Pseudosquilla ciliata</i>	6	0.50	<i>Herdmania momus</i>	0.43	0.96
<i>Schizoporella errata</i>	6	0.50	<i>Phallusia nigra</i>	46.3	6.76
Unid. Sabellidae	48	2.31	<i>Plankobranthus ocellatus</i>	0.05	0.5
Porifera	1314	71.53	<i>Sabellastarte spectabilis</i>	0.04	1.5
			<i>Schizoporella errata</i>	0.04	0.96
			Unid. tunicate	0.04	0.5

Table 63 (continued).

Sector B-3			Sector B-2		
Taxon	Total	St dev	Taxon	Total	St dev
<i>Amathia distans</i>	216	13.44	Unid. Sabellidae	0.28	4.86
<i>Botryllus</i> sp.	6	0.50	Unid. Portunidae	0.08	1.5
<i>Bugula dentate</i>	126	8.06	Porifera	4.6	14.1
<i>Bugula neritina</i>	6	0.50			
<i>Dendostrea sandvichensis</i>	1212	38.14	Sector B-4		
<i>Herdmania momus</i>	84	3.42	Taxon	Total	St dev
<i>Hypselodoris infucata</i>	6	0.50	<i>Amathia distans</i>	59.94	1.92
<i>Phallusia nigra</i>	228	5.20	<i>Bugula dentate</i>	26.64	1.30
Portunidae	6	0.50	<i>Bugula neritina c.f.</i>	26.64	1.30
<i>Reteporellina denticulata</i>	6	0.50	<i>Dendostrea sandvichensis</i>	1238.76	20.49
<i>Sabellastarte spectabilis</i>	6	0.50	<i>Herdmania momus</i>	246.42	11.26
<i>Schizoporella errata</i>	30	1.50	<i>Pennaria disticha</i>	26.64	1.10
<i>Stenopus hispidus</i>	12	1.00	<i>Phallusia nigra</i>	959.04	26.72
<i>Thelepus setosus</i>	30	1.50	<i>Sabellastarte spectabilis</i>	6.66	0.45
Unid. Didemnidae	6	0.50	<i>Schizoporella errata</i>	226.44	5.40
Unid. Sabellidae	66	2.06	Unknown Portunidae	19.98	0.89
Porifera	522	9.36	Unid. Sabellidae	86.58	1.79
			Unid. Stomatopoda	26.64	0.84
			Porifera	499.5	12.15

Table 64. Invertebrate abundance at Sector C-1, as measured on 2 piles and Sector C-2, as measured on 8 piles.

Sector C-1			Sector C-2		
Taxon	Total	St dev	Taxon	Total	St dev
<i>Amathia distans</i>	285	16.97	<i>Aiptasia pulchella</i>	95.875	3.54
<i>Chama</i> sp.	7.5	0.71	<i>Amathia distans</i>	789.125	11.38
<i>Dendostrea sandvicensis</i>	157.5	14.85	black <i>Didemnum</i>	14.75	0.35
<i>Didemnum</i> sp.	127.5	12.02	<i>Botryllus</i> sp.	132.75	4.69
<i>Hermania momus</i>	480	1.41	<i>Bugula dentate</i>	1010.375	13.67
<i>Isognomon perna</i>	22.5	2.12	camouflage <i>alpheidae</i>	7.375	0.35
<i>Pennaria disticha</i>	15	1.41	<i>Chaetopterus</i> sp.	22.125	0.52
<i>Phallusia nigra</i>	420	14.14	<i>Chama</i> sp.	14.75	0.46
colonial tunicate	15	1.41	<i>Dendostrea sandvicensis</i>	243.375	5.94
<i>Reteporellina denticulata</i>	90	5.66	<i>Didemnum</i> sp.	206.5	3.93

Table 64 (continued).

Sector C-1			Sector C-2		
Taxon	Total	St dev	Taxon	Total	St dev
<i>Schizoporella errata</i>	142.5	6.36	<i>Hermania momus</i>	1792.125	13.15
<i>Sabellastarte spectabilis</i>	120	0.00	<i>Isognomon californicum</i>	73.75	4.13
<i>Thamita sp.</i>	7.5	0.71	<i>Isognomon perna</i>	958.75	29.86
Unid. tunicate	90	8.49	<i>Loimiamedusa</i>	7.375	0.35
white colonial tunicate	60	5.66	<i>Metograpsus thukahar</i>	14.75	0.46
<i>Porifera</i>	427.5	17.68	<i>Pennaria disticha</i>	66.375	2.80
			<i>Phallusia nigra</i>	3363	34.93
			purple colonial tunicate	95.875	2.51
			<i>Reteporellina denticulata</i>	272.875	4.50
			<i>Schizoporella errata</i>	516.25	4.27
			<i>Sabellastarte spectabilis</i>	221.25	4.41
			<i>S.dysteri</i>	81.125	1.85
			<i>S.giganteus</i>	51.625	1.64
			<i>Serpulorbis variabilis</i>	309.75	0.35
			<i>Stenopus hispidus</i>	7.375	0.46
			<i>Thalamita sp.</i>	14.75	0.76
			Unid. colonial tunicate	44.25	0.74
			Unid. tunicate	7.375	2.10
			Vermetidae	51.625	0.46
			<i>Porifera</i>	14.75	15.21

Table 65. Invertebrate abundance at Sector D as counted on 3 piles.

Taxon	Total	St dev
<i>A.sydneyensis</i>	12.67	0.58
<i>Bugula dentata</i>	19.00	1.73
<i>Chaetopterus sp.</i>	12.67	0.58
<i>Dendostrea sandvicensis</i>	31.67	1.53
<i>Hermania momus</i>	145.67	2.52
<i>Isognomon perna</i>	253.33	8.14
<i>Metopograpsus sp.</i>	12.67	1.15
<i>Parahyotissa numisma</i>	25.33	0.58
<i>Phallusia nigra</i>	316.67	14.22

Table 65 (continued).

Taxon	Total	St dev
<i>Schizoporella errata</i>	25.33	1.53
<i>Sabellastarte spectabilis</i>	12.67	1.15
<i>Thamita sp.</i>	19.00	1.00
white didemnum	6.33	0.58
<i>Zoobotryon verticillatum</i>	12.67	1.15
<i>Porifera</i>	316.67	14.01

Table 66. Invertebrate abundance at Sector E, as counted on 34 piles (499 m²).

Taxon	Sector E		Taxon	Total	St dev
	Total	St dev			
<i>Aiptasia pulchella</i>	38.91	0.53	<i>Pinctada margaritifera</i>	38.91	0.87
<i>Amathia distans</i>	168.63	2.63	Portunidae	6.49	0.17
			<i>Reteporellina</i>		
<i>Botryllus sp.</i>	479.94	5.87	<i>denticulata</i>	6.49	0.17
<i>Bugula dentate</i>	12.97	0.24	<i>Schizoporella errata</i>	38.91	1.74
<i>Chaetopterus sp.</i>	64.86	0.97	<i>Sabellastarte spectabilis</i>	343.74	2.23
<i>Chama sp.</i>	6.49	0.17	<i>S.dysteri</i>	38.91	0.72
colonial tunicate	12.97	0.34	Sabellidae	25.94	0.65
<i>Crassostrea gigas?</i>	32.43	0.86	<i>Schizoporella sp.</i>	706.94	4.61
<i>Dendostrea sandvicensis</i>	603.17	48.06	Serpulid worm	38.91	0.63
Didemnum sp.	188.09	2.40	<i>Siphonaria normalis</i>	84.31	2.23
<i>Grapsus sp.</i>	188.09	1.82	<i>Thalamita crenata</i>	6.49	0.42
<i>Herdmania momus</i>	2373.77	14.43	<i>Thalamita edwardsi</i>	19.46	0.41
<i>Iotrochota protea</i>	6.49	0.17	Unid colonial tunicate	19.46	0.24
<i>Isognomon perna</i>	214.03	4.38	Unid sol. Anemone	129.71	0.70
<i>Littoraria pintado</i>	25.94	0.48	Unid <i>Stomatopoda</i>	6.49	0.17
<i>Metopograpsus</i>					
<i>thukuhar</i>	71.34	0.79	Unid. clear tunicate	6.49	0.29
<i>Palythoa caesia</i>	12.97	0.34	Unid. Sabellidae	181.60	3.18
<i>Parahyotissa sp</i>	25.94	0.50	Unid. Portunidae	6.49	0.17
<i>Pennaria disticha</i>	655.06	10.96	<i>Porifera</i>	5506.37	32.02
<i>Phallusia nigra</i>	7335.34	46.35			

Table 67. Invertebrate abundance at Sector F as counted using 20-m² transects (n=3).

Taxon	Total	St dev
<i>Alpheus sp</i>	68.33	1.15
<i>Dendostrea sandvicensis</i>	164.00	3.46
<i>Herdmania momus</i>	20.50	0.00
<i>Isognomon perna</i>	27.33	2.31
<i>Phallusia nigra</i>	68.33	3.21
<i>Podphthalmus vigil</i>	27.33	0.58
<i>Portunidae sp</i>	68.33	0.58
<i>Pseudoquilla ciliata</i>	6.83	0.58
Purple colonial tunicate	6.83	0.58
<i>Sabellastarte spectabilis</i>	102.50	4.04
<i>Stomatopoda sp</i>	6.83	0.58
<i>Porifera</i>	116.17	1.15

Table 68. Invertebrate abundance at Sector G, as counted on 3 piles, and using 20-m² transects (n=11).

Sector G, piles			Sector G, shoreline		
Taxon	Total	St dev	Taxon	Total	St dev
<i>Aiptasia pulchella</i>	56.67	8.96	<i>Alpheus sp.</i>	116.18	1.32
<i>Amathia distans</i>	20.00	1.73	<i>Amathia distans</i>	38.73	1.35
<i>Botryllus sp.</i>	6.67	1.15	<i>Dendostrea sandvicensis</i>	484.09	3.82
<i>Bugula dentate</i>	26.67	3.06	<i>Herdmania momus</i>	83.91	1.25
Colonial tunicate	6.67	0.58	<i>Iotrochota protea</i>	12.91	0.60
Didemnum sp	20.00	2.65	<i>Isognomon perna</i>	148.45	3.31
<i>Herdmania momus</i>	216.67	10.12	<i>Pennaria disticha</i>	32.27	1.04
<i>Isognomon californicum</i>	3.33	0.58	<i>Phallusia nigra</i>	296.91	3.95
<i>Pennaria disticha</i>	3.33	0.58	<i>Podphthalmus vigil</i>	51.64	1.08
<i>Phallusia nigra</i>	76.67	5.86	<i>Portunidae sp.</i>	438.91	3.92
Pinctada margaritifera	3.33	0.58	<i>Pseudoquilla ciliata</i>	6.45	0.30
<i>Portunidae sp.</i>	6.67	0.58	<i>Schizoporella errata</i>	6.45	0.30
Purple colonial tunicate	13.33	2.65	<i>Sabellastarte spectabilis</i>	167.82	2.42
<i>Reteporellina denticulata</i>	26.67	3.79	<i>Salmacina dysteri</i>	83.91	1.42
<i>Sabellastarte spectabilis</i>	6.67	0.58	<i>Stomatopoda sp.</i>	12.91	0.40
<i>Schizoporella errata</i>	6.67	0.58	<i>Porifera</i>	1555.55	7.35
<i>Porifera</i>	260.00	26.63			

Table 69. Invertebrate abundance at Sector H, as counted in 42 m² of sheet pile (n=7).

Taxon	Total	St dev
<i>Amathia distans</i>	15.10	0.49
<i>Botryllus</i> sp.	7.55	0.38
<i>Bugula dentate</i>	30.19	1.13
Colonial tunicate	7.55	0.38
<i>Dendostrea sandvicensis</i>	181.14	4.16
<i>Grapsus</i> sp.	7.55	0.38
<i>Herdmania momus</i>	626.45	5.19
<i>Isognomon perna</i>	45.29	1.57
<i>Loimia medusa</i>	7.55	0.38
<i>Phallusia nigra</i>	113.21	2.12
Purple colonial tunicate	7.55	0.38
<i>Sabellastarte spectabilis</i>	22.64	1.13
<i>Schizoporella errata</i>	22.64	0.53
Unid. Sabellidae	15.10	0.49
<i>Porifera</i>	898.17	9.90

Table 70. Invertebrate abundance at Sector I, measured on 5 piles (80 m²), and using 20-m² transects (n=8).

Sector I, piles			Sector I, shoreline		
Taxon	Total	St dev	Taxon	Total	St dev
<i>Amathia distans</i>	4.6	0.45	<i>Amathia distans</i>	93.63	3.18
<i>Ascidia sydneyensis</i>	4.6	0.45	<i>Bugula dentate</i>	40.13	1.49
<i>Bugula dentate</i>	13.8	0.89	<i>Bugula neritina</i>	33.44	1.77
<i>Chama sp.</i>	9.2	0.55	<i>Dendostrea</i>		
colonial tunicate	4.6	0.45	<i>sandvichensis</i>	621.94	24.85
<i>Dendostrea</i>			<i>Herdmania momus</i>	6.69	0.35
<i>sandvicensis</i>	105.8	1.82	<i>Isarachnathus</i>		
<i>Herdmania momus</i>	179.4	2.28	<i>bandanensis</i>	214.00	0.35
<i>Isognomon perna</i>	78.2	2.79	<i>Phallusia nigra</i>	407.94	4.50
<i>Loimia medusa</i>	4.6	0.45	<i>Sabellastarte specatbilis</i>	80.25	2.51
<i>Metopograpsus</i>			<i>Schizoporella errata</i>	13.38	0.71
<i>thukuhar</i>	27.6	2.17	Unid. Sabellidae	33.44	1.77
<i>Parahyotissa sp.</i>	13.8	0.55	Unid. Portunidae	6.69	2.19
<i>Phallusia nigra</i>	409.4	9.63	Porifera	856.00	16.03
<i>Salmacina dysteri</i>	64.4	4.82			
<i>Schizoporella errata</i>	55.2	2.70			
<i>Sabellastarte</i>					
<i>specatbilis</i>	13.8	0.55			
<i>Thalamita sp.</i>	9.2	0.55			
unid Vermetidae	9.2	0.58			
porifera	906.2	12.68			

Table 71. Invertebrate abundance at Sector J as counted on 6 piles.

Taxon	Total	St dev
<i>Amathia distans</i>	5.5	0.41
<i>Dendostrea sandvichensis</i>	33	2.45
<i>Herdmania momus</i>	11	0.82
<i>Iotrochota protea</i>	22	0.41
<i>Isognomon californicum</i>	16.5	12.42
<i>Isognomon perna</i>	363	3.27
<i>Metopograpsus messor</i>	5.5	0.41
<i>Parahyotissa inermis</i>	27.5	2.04
<i>Phallusia nigra</i>	1237.5	19.18
Pinnidae	11	0.82
<i>Schizoporella errrata</i>	5.5	0.41
<i>Serpulorbis varaibilis</i>	5.5	0.41
<i>Thalamita crenata</i>	11	0.52
Unid. limpet	5.5	0.41
Unid. Hydrozoa	27.5	2.04
Porifera	572	7.33

Table 72. Invertebrate abundance within 833m² at Sector K-1, as counted in 144.3 m² of sheet pile (n=6), 991.9 m² of Sector K-2, as counted in 196.5 m² of sheet pile (n=8), and 991.9 m² of Sector K-3, as counted in 174.7 m² of sheet pile (n=8).

Sector K-1			Sector K-2		
Taxon	Total	St dev	Taxon	Total	St dev
<i>Amathia distans</i>	11.55	0.82	<i>Bugula dentata</i>	1337.27	34.96
<i>Chaetopterus</i>	5.77	0.41	<i>Chaetopterus sp.</i>	201.85	4.07
<i>Dendostrea sandvicensis</i>	1,218.43	37.59	<i>Chama sp.</i>	10.09	0.71
<i>Hermania momus</i>	161.69	4.16	<i>Dendostrea sandvicensis</i>	201.85	1.88
<i>Isognomon perna</i>	5.77	0.41	<i>Grapsus tenuicrustatus</i>	5.05	0.33
<i>Metopograpsus thukuhar</i>	23.10	1.21	<i>Herdmania momus</i>	857.87	8.98
<i>Phallusia nigra</i>	1,986.44	36.45	<i>Istrochota protea</i>	90.83	1.64
<i>P.numisma</i>	57.75	1.58	<i>Isognomon perna</i>	80.74	1.56
<i>Pennaria disticha</i>	202.11	14.29	<i>P. vigil</i>	5.05	0.33
purple <i>Didemnum</i>	17.32	1.22	<i>Pennaria disticha</i>	105.97	1.60
<i>Schizoporella errata</i>	17.32	0.55	<i>Phallusia nigra</i>	1670.32	11.17
<i>S. giganteus</i>	69.29	2.90	<i>Schizoporella errata</i>	10.09	0.44
<i>Sabellastarte spectabilis</i>	11.55	0.82	<i>Sabellastarte spectabilis</i>	111.02	3.41
<i>Serpulorbis variabilis</i>	17.32	0.84	<i>S.dysteri</i>	151.39	2.14
<i>Thalamita crenata</i>	80.84	2.88	<i>Thamita sp.</i>	186.71	3.06
<i>Thalamita sp.</i>	150.14	5.75	<i>Porifera</i>	1539.12	19.98
unid. <i>Portunidae</i>	5.77	0.41			
<i>Porifera</i>	1,050.97	26.14			
Sector K-3					
Taxon	Total	St dev	Taxon	Total	St dev
<i>Amathia distans</i>	5.68	0.35	Unid. tunicate	11.35	0.46
<i>Botryllus sp.</i>	5.68	0.35	<i>Sabellastarte spectabilis</i>	147.60	5.50
<i>Bugula dentata</i>	5.68	0.35	<i>Schizoporella errata</i>	28.39	0.95
<i>Grapsus tenuicrustatus</i>	11.35	0.46	<i>Thalamita sp.</i>	136.25	2.33
<i>Herdmania momus</i>	783.44	11.18	Unid. Sabellidae	397.40	11.07
<i>Phallusia nigra</i>	1424.95	14.35	<i>Porifera</i>	1101.35	7.30

Table 73. Invertebrate abundance at Sector L as counted in 154.1 m² of sheet pile (n=6).

Taxon	Total	St dev
<i>Amathia distans</i>	5.68	0.35
<i>Botryllus</i> sp.	5.68	0.35
<i>Bugula dentata</i>	5.68	0.35
<i>Grapsus tenuicrustatus</i>	11.35	0.46
<i>Herdmania momus</i>	783.44	11.18
<i>Phallusia nigra</i>	1424.95	14.35
Unid. tunicate	11.35	0.46
<i>Sabellastarte spectabilis</i>	147.60	5.50
<i>Schizoporella</i> sp.	28.39	0.95
<i>Thalamita</i> sp.	136.25	2.33
Unid. Sabellidae	397.40	11.07
<i>Porifera</i>	1101.35	7.30

Fish abundance, biomass, and functional groups

A total of 6,334 individual fish, comprising 68 species were counted in our survey (Table 74). Fishes are most abundant in the shallow water at Sector B, where 4,148 individuals were observed. This high count is attributable to a school of goldspot sardine (*Herklotsichthys quadrimaculatus*) present in this sector. Sectors G and E were next highest in numbers of fishes, with 663 and 576 observed, respectively. The sectors with the lowest fish counts were J (9 fishes) and D (12 fishes). Based on individual fishes observed during the surveys, total biomass across all sectors was 490.1 kg.

Biomass of fishes, by species, across all sectors is presented in Table 75. The large tiger shark (*Galeocerdo cuvier*) observed during the harbor bottom survey near sectors I and K accounts for the highest biomass. Excluding the shark, yellowfin surgeonfish (*Acanthurus xanthopterus*) and blacktail snapper (*Lutjanus fulvus*) contribute the most towards total biomass. Fish biomass (Table 76), normalized to kilograms per hectare, ranged from 5.9 to 187.8 kg/ha, at Sector A and Sector L, respectively. Sector E had the next highest biomass (169.3 kg/ha) recorded.

Table 74. Number of fish counted and total biomass (kg) for each sector.

Sector	No. of Fish Counted	Total Biomass (kg)
A	283	10.6
B	4148†	67.2
C	148	17.6
D	12	0.8
E	576	74.3
F	81	5.9
G	663	54.5
H	101	12.2
HB	13	218.3‡
I	115	10.5
J	11	1.5
K	96	12.2
L	87	4.9
Total	6334	490.5

† Data are skewed by large schools of goldspot sardine (*Herklotsichthys quadrimaculatus*).

‡ Data are skewed by a large tiger shark (*Galeocerdo cuvier*).

Table 75. Biomass (kg) by taxa for all sectors.

Taxon	Biomass (kg)
<i>Abudefduf abdominalis</i>	4.11
<i>Abudefduf sordidus</i>	0.02
<i>Abudefduf vaigiensis</i>	0.07
<i>Acanthurus achilles</i>	0.20
<i>Acanthurus blochii</i>	5.36
<i>Acanthurus leucopareius</i>	0.01
<i>Acanthurus nigrofuscus</i>	0.14
<i>Acanthurus nigroris</i>	0.34
<i>Acanthurus</i> sp.	0.00
<i>Acanthurus triostegus</i>	0.51
<i>Acanthurus xanthopterus</i>	58.30

Table 75 (continued).

Taxon	Biomass (kg)
<i>Apogon</i> sp.	0.00
<i>Arothron hispidus</i>	2.71
<i>Asterropteryx semipunctata</i>	0.78
<i>Aulostomus chinensis</i>	1.08
<i>Blenniidae</i> sp.	0.00
<i>Calotomus carolinus</i>	0.01
<i>Canthigaster jactator</i>	0.51
<i>Caranx melampygus</i>	22.23
<i>Apogonidae</i> sp.	0.00
<i>Chaetodon auriga</i>	3.76
<i>Chaetodon ephippium</i>	0.95
<i>Chaetodon lunula</i>	0.46
<i>Chaetodon ornatissimus</i>	0.42
<i>Chaetodon unimaculatus</i>	0.06
<i>Coryphopterus</i> sp.	0.00
<i>Fistulariidae</i> sp.	0.09
<i>Ctenochaetus hawaiiensis</i>	0.32
<i>Ctenochaetus strigosus</i>	0.18
<i>Dascyllus albisella</i>	0.63
<i>Dendrochirus barberi</i>	0.07
<i>Diodon hystrix</i>	2.36
<i>Encrasicholina purpurea</i>	0.11
<i>Foa brachygramma</i>	0.23
<i>Galeocerdo cuvier</i>	217.04
<i>Mullidae</i> sp.	0.00
<i>Gobiidae</i> sp.	0.08
<i>Heteropriacanthus cruentatus</i>	0.25
<i>Herklotsichthys quadrimaculatus</i>	31.43
<i>Kuhlia sandvicensis</i>	6.15
<i>Synodontidae</i> sp.	2.15
<i>Lutjanus fulvus</i>	43.66
<i>Lutjanus gibbus</i>	0.22
<i>Muraenidae</i> sp.	0.03
<i>Mugil cephalus</i>	6.76
<i>Mulloidichthys flavolineatus</i>	10.56
<i>Mulloidichthys vanicolensis</i>	0.08
<i>Myripristinae</i> sp.	0.07
<i>Naso brevirostris</i>	0.27
<i>Naso lituratus</i>	0.83
<i>Naso unicornis</i>	3.77

Table 75 (continued).

Taxon	Biomass (kg)
<i>Ostracion meleagris</i>	0.02
<i>Parupeneus insularis</i>	0.00
<i>Parupeneus multifasciatus</i>	2.31
<i>Scaridae</i> sp.	0.00
<i>Plectroglyphidodon imparipennis</i>	0.20
<i>Psilogobius mainlandi</i>	0.45
<i>Scarus psittacus</i>	0.26
<i>Scarus rubroviolaceus</i>	0.65
<i>Lutjanidae</i> sp.	0.25
<i>Sphyraena barracuda</i>	3.84
<i>Synodus dermatogenys</i>	0.00
<i>Thalassoma duperrey</i>	0.01
<i>Thalassoma trilobatum</i>	0.00
<i>Upeneus taeniopterus</i>	19.36
<i>Zanclus cornutus</i>	27.86
<i>Zebrasoma flavescens</i>	0.39
<i>Zebrasoma veliferum</i>	1.72
Total	486.72

Table 76. Mean (\pm SD) fish biomass (kg/ha) by sector.

Sector	Mean + SD
A	72.0 \pm 19.9
B	379.8 \pm 67.0
C	839.7 \pm 94.7
D	68.3 \pm 15.1
E	1293.2 \pm 227.0
F	121.5 \pm 16.5
G	519.4 \pm 88.9
H	300.7 \pm 91.6
I	239.8 \pm 44.6
J	151.6 \pm 36.6
K	727.0 \pm 97.2
L	364.7 \pm 61.9
HB	14562.0 \pm 5503.8 ‡

‡ Data are skewed by a large tiger shark (*Galeocerdo cuvier*).

Belt transect and SPC survey areas and corresponding extrapolated total count of individuals and biomass by sector is provided in table 77, below. A total of 22,457 individual fish are estimated to occur in Honolulu Harbor, with a total biomass of 4525452.88 kg. The one large shark observed in the harbor bottom survey accounts of a large portion of the biomass. Excluding the shark, total biomass is 1377.48 kg. .

Table 77. Fish survey areas (belt transects and SPC) for each sector, total number of individuals, and total biomass (kg).

Sector	Survey area (m2)	Total number of individuals	Total biomass (kg)
A-1			
Belt transect (n=4)	537.5	219	8.2
SPC (n=1)	28.3	40	1.9
Total	565.8	259	10.1
A-2			
Belt transect (n=3)	297.5	73	4.4
SPC (n=1)	28.3	0	0
Total	325.8	110	4.4
B-1			
Belt transect (n=4)	552.5	197	11.8
SPC (n=1)	43	324	16.5
Total	595.5	521	28.3
B-2			
Belt transect (n=4)	445	1077	17.9
SPC (n=1)	28.3	2459	44.8
Total	473.3	3536	62.7
B-3			
Belt transect (n=4)	392.5	256	1
SPC (n=0)	--	--	--
Total	392.5	256	1
B-4			
Belt transect (n=5)	517.5	3562	46
SPC (n=0)	--	--	--
Total	517.5	3562	46

Table 77 (continued).

Sector	Survey area (m2)	Total number of individuals	Total biomass (kg)
C-1			
Belt transect (n=2)	25.2	0	0
SPC (n=4)	57.3	497	55.3
Total	82.5	497	55.3
C-2			
Belt transect (n=6)	67.2	366	43.5
SPC (n=4)	32.2	2052	133.5
Total	99.4	2418	177
D			
Belt transect (n=3)	23.5	59	0.03
SPC (n=3)	58.9	38	3.8
Total	82.4	97	3.83
E			
Belt transect (n=22)	176.3	4135	499.2
SPC (n=34)	600.8	2028	212.4
Total	777.1	6163	711.6
F			
Belt transect (n=3)	407.5	67	5.5
SPC (n=1)	40.7	141	4.5
Total	448.2	208	10
G shoreline			
Belt transect (n=11)	1397.5	630	5.8
SPC (n=1)	40.7	384	5
Total	1438.2	1014	10.8
G piles			
Belt transect (n=0)		--	
SPC (n=3)	97.3	59	8.6
Total	97.3	59	8.6
H			
Belt transect (n=4)	68.1	177	1.2
SPC (n=7)	216.3	103	15.2
Total	284.4	280	16.4
HB			
Belt transect (n=9)	337.5	1346	4524075.4
SPC (n=0)		--	
Total	337.5	1346	4524075.4‡

‡ Data are skewed by a large tiger shark (*Galeocerdo cuvier*).

Table 77 (continued).

Sector	Survey area (m²)	Total number of individuals	Total biomass (kg)
I shoreline			
Belt transect (n=7)	560	174	39.9
SPC (n=1)	28.3	0	0
Total	588.3	174	39.9
I piles			
Belt transect (n=4)	32	127	10.1
SPC (n=5)	63.6	116	12.4
Total	95.6	243	22.5
J			
Belt transect (n=6)	44.9	97	11.8
SPC (n=6)	75.4	19	2.8
Total	120.3	116	14.6
K-1			
Belt transect (n=6)	120	125	15.1
SPC (n=6)	85.6	107	16.6
Total	205.6	232	31.7
K-2			
Belt transect (n=7)	169.8	210	35.9
SPC (n=7)	193.9	10	2.1
Total	363.7	220	38
K-3			
Belt transect (n=7)	108	46	0.3
SPC (n=8)	18.1	252	24.3
Total	126.1	298	24.6
L			
Belt transect (n=6)	101.6	567	20.1
SPC (n=6)	49.8	281	40
Total	151.4	848	60.1
TOTAL	8168.4	22457	4525452.8

Trophic Groups – Seven fish trophic groups were observed in the survey area: corallivore, detritivore, herbivore, mobile-invertebrate feeder, piscivore, planktivores, and sessile invertebrate feeder (Table 78 and Fig. 7). Piscivores made up 70.4% of the total biomass, attributed to the one large tiger shark observed at a harbor bottom location. Across the sectors, mobile invertebrate feeders (e.g., *Lutjanus fulvus*), herbivores (e.g., *Acanthurus xanthopterus*), sessile invertebrate feeders (e.g., *Chaetodon lunula*), and planktivores (e.g., *Abudefduf*)

abdominalis and *Dascyllus albisella*), made up between 6.3% and 9% of the total community biomass (Table 75 and Fig. 7). Detritivores and corallivores, combined made up 0.3% of the total biomass. Corallivores were only encountered at Sector B.

Protected species

For each survey area, an inventory was made of protected species, including any species proposed for listing (DLNR, 1998, 2007; NOAA-NMFS, 2012 and 2013; USFWS, 2012). No seagrasses or protected species were encountered. Colonies of the proposed to be listed coral, *Montipora patula*, were observed throughout the sectors, but all observed colonies were no longer alive.

Conditions and safety issues

Turbid conditions underwater in the harbor produced typically low visibility (1-2 ft). Constant barge and boat traffic in the survey sectors were also a safety issue. Several dives ended early or were aborted altogether to avoid being in the vicinity of barge activity. Dangerous marine life, including stinging organisms and sharks, were also safety issues that arose during the three-month dive survey.

Summary

This report presents data collected in KCT project area for corals, macroinvertebrates, fish, and algae. These data will be used to populate an HEA and conduct an EFH assessment.

Table 78. Mean (\pm SD) fish biomass (kg/ha) by trophic group for each sector.

Sector	Corallivore	Detritivore	Herbivore	Mobile invert. Feeder	Piscivore	Planktivore	Sessile invert. Feeder
A	0	0.6 + 0.6	20.3 + 18	57.1 + 82.7	48.5 + 60.4	12.6 + 10.9	10.3 + 12.2
B	1.9 + 2.7	1.7 + 2.2	125.5 + 115.1	46.4 + 53.9	14.1 + 6.1	170.4 + 169.9	19.7 + 6.1
C	0	0.3 + 0.4	255.1 + 201.7	117.2 + 163.2	127.3 + 119.9	200.1 + 31.6	139.8 + 196.6
D	0	0.6 + 0.9	6.3 + 8.9	23.2 + 32.8	38.2 + 54.0	0	0
E	0	0.4 + 0.4	546.0 + 520.6	400.9 + 209.4	45.9 + 14.1	5.1 + 5.4	294.8 + 133.4
F	0	0.4 + 0.5	31.8 + 3.6	35.7 + 50.4	24.6 + 10.2	0	29.1 + 40.6
G	0	2.8 + 2.6	158.1 + 66.9	72.1 + 95.7	11.4 + 8.3	43.0 + 34.7	232.0 + 283.1
H	0	0.7	249.7 + 224.0	24.1 + 1.9	17.1 + 24.1	7.5 + 10.6	1.6 + 2.0
I	0	0	74.7 + 65.0	46.6 + 38.9	111.2 + 35.2	2.7 + 3.9	4.6 + 3.7
J	0	0.1 + 0.1	8.9 + 12.6	45.9 + 64.9	95.6 + 77.9	0	1.1 + 1.6
K	0	0.4 + 0.1	72.9 + 81.2	241.4 + 285.7	172 + 104.8	49.1 + 77.5	191.2 + 142.3
L	0	0.4 + 0.5	81.3 + 47.2	159.1 + 199.4	96.7 + 55.7	27.2 + 38.5	0
HB	0	0	0	0.2 + 0.2	14561.8 + 24982	0	0
Total	1.9	8.2	1610.4	1212.8	15364.5	517.7	924.2

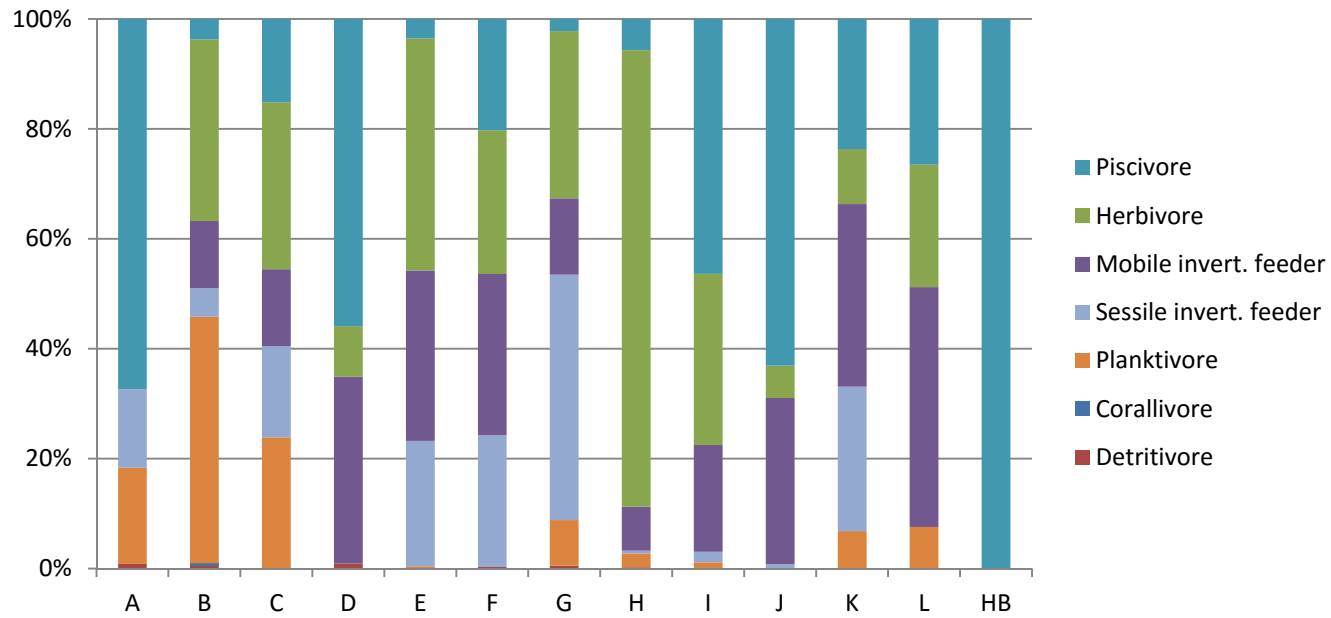


Figure 7. Percent of total fish biomass (kg) for each trophic category by sector.

References

- AECOS, Inc. 2014. Assessment methodology for baseline surveys Kapālama Container Terminal Improvements, Honolulu Harbor, Honolulu, O'ahu. AECOS No. 1354A. 14 pp.
- Dollar, S. 2012. Letter to Carter Luke, PE., Department of Transportation, Harbors Division, from Marine Research Consultants: RE: Marine Surveys of Pacific Shipyards Dock Areas. Dated December 2, 2012.
- Hawai'i Department of Land and Natural Resources (DLNR). 1998. Indigenous wildlife, endangered and threatened wildlife and plants, and introduced wild birds. Department of Land and Natural Resources. State of Hawaii. Administrative Rule §13-124-1 through §13-124-10, with Exhibits.
- _____. 2002. Hawai'i Administrative Rules, Title 13, Department of Land and Natural Resources, Chapter 99, Protected Marine Fisheries Resources, Rules Regulating the Taking and Selling of Certain Marine Resources. 14 pp.
- _____. 2007. Hawai'i Administrative Rules. Department of Land and Natural Resources. Title 12. Conservation and Resources. Chapter 188. Fishing Rights and Regulations. 5 pp.
- _____. 2009. Hawai'i Administrative Rules. Title 13. Department of Land and Natural Resources. Chapter 4. Protected Marine Fisheries. 15 pp.
- National Oceanic and Atmospheric Administration (NOAA). 2008. Ecological assessment of coral. National Marine Fisheries Service - Pacific Islands Fisheries Science Center. Available online at URL: <http://www.pifsc.noaa.gov/cred/coral.php>; last accessed January 24, 2014.
- National Oceanic and Atmospheric Administration – National Marine Fisheries Service (NOAA-NMFS). 2002. Department of Commerce. Essential Fish Habitat. *Federal Register*, 67 (2376; January 17, 2002):98-111.
- _____. 2010. Department of Commerce. 50 CFR 75. Endangered and Threatened Wildlife: Notice of 90-Day Finding on a Petition to List 83 Species of Corals as Threatened or Endangered Under the Endangered Species Act (ESA). *Federal Register*, 75 (27; February 10, 2010): 6616-6621.
- _____. 2012. Department of Commerce. 50 CFR Parts 223 and 224. Endangered and Threatened Wildlife and Plants: Proposed Listing Determination for

82 Reef-building Coral Species; Proposed Reclassification of *Acropora palmata* and *Acropora cervicornis* from Threatened to Endangered. *Federal Register*, 77 (236; December 7, 2012): 73220-73262.

_____. 2013. Corals proposed for listing under the ESA. NOAA proposes listing 66 reef-building coral species under the Endangered Species Act. Available online at URL: <http://www.nmfs.noaa.gov/pr/species/invertebrates/corals.htm>; last accessed July 2, 2013.

Schneider, J.C., Laarman, W. and H. Gowing. 2000. Length-Weight Relationships. Chapter 17 in Schneider, J.C. (ed.) 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

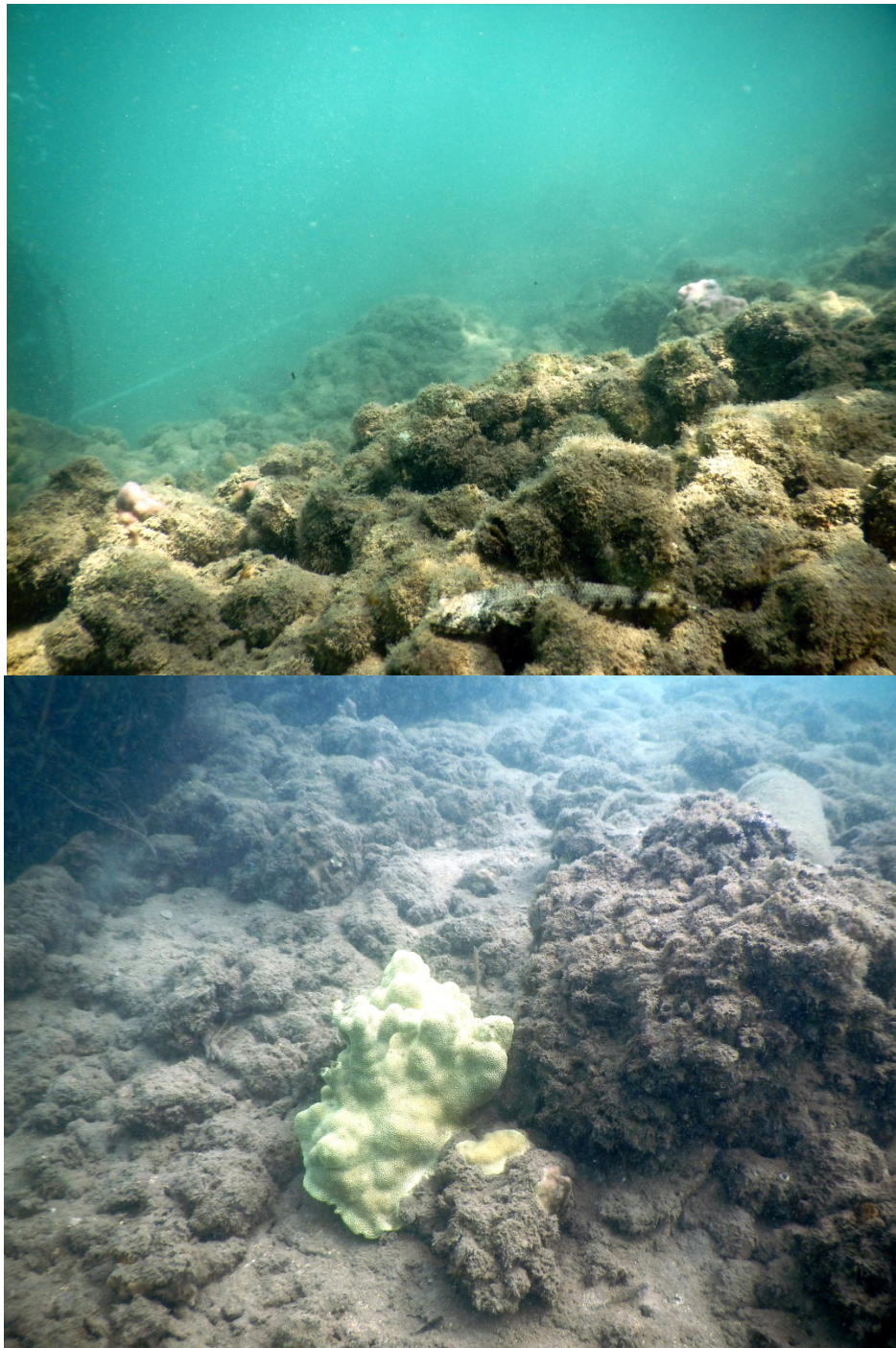
State of Hawai'i Department of Transportation – Harbors Division (DOT-H). 2012. An Assessment of the Marine Biological Community Structure in the Vicinity of the Proposed Kapālama Container Terminal Honolulu Hawai'i. Prepared by Marine Research Consultants, Inc. Available online at URL: <http://www.Kapālamaeis.com/wp-content/uploads/2012/12/App-E-opt-Marine-Biological-Structure-Report.pdf>; ; last accessed January 26, 2014.

_____. 2013. Kapālama Container Terminal and Tenant Relocations. Second Draft Environmental Impact Statement. Prepared by Belt Collins Hawai'i, LLC.. Available online at URL: http://oeqc.doh.hawaii.gov/Shared%20Documents/Forms/DispForm.aspx?ID=12084&RootFolder=%2fShared%20Documents%2fEA_and_EIS_Online_Library%2fOahu%2f2010s&Source=http%3a%2f%2foeqc%2edoh%2ehawaii%2egov%2fShared%20ocuments%2fEA_and_EIS_Online_Library%2fOahu%2f2010s; last accessed January 26, 2014.

US Fish and Wildlife Service and National Marine Fisheries Service (USFWS and NMFS). 2011. Draft planning aid report: marine biological survey protocols. Prep. for USACE Honolulu District: 39 pp.

APPENDIX A

Representative photos of sectors A-L and harbor bottom locations, Honolulu Harbor, taken March through June, 2014.



Rubble and silt are the dominant bottom types at Sector A-1 and A-2. Many small colonies of *Porites* sp. and *Leptastrea* sp. are common here.



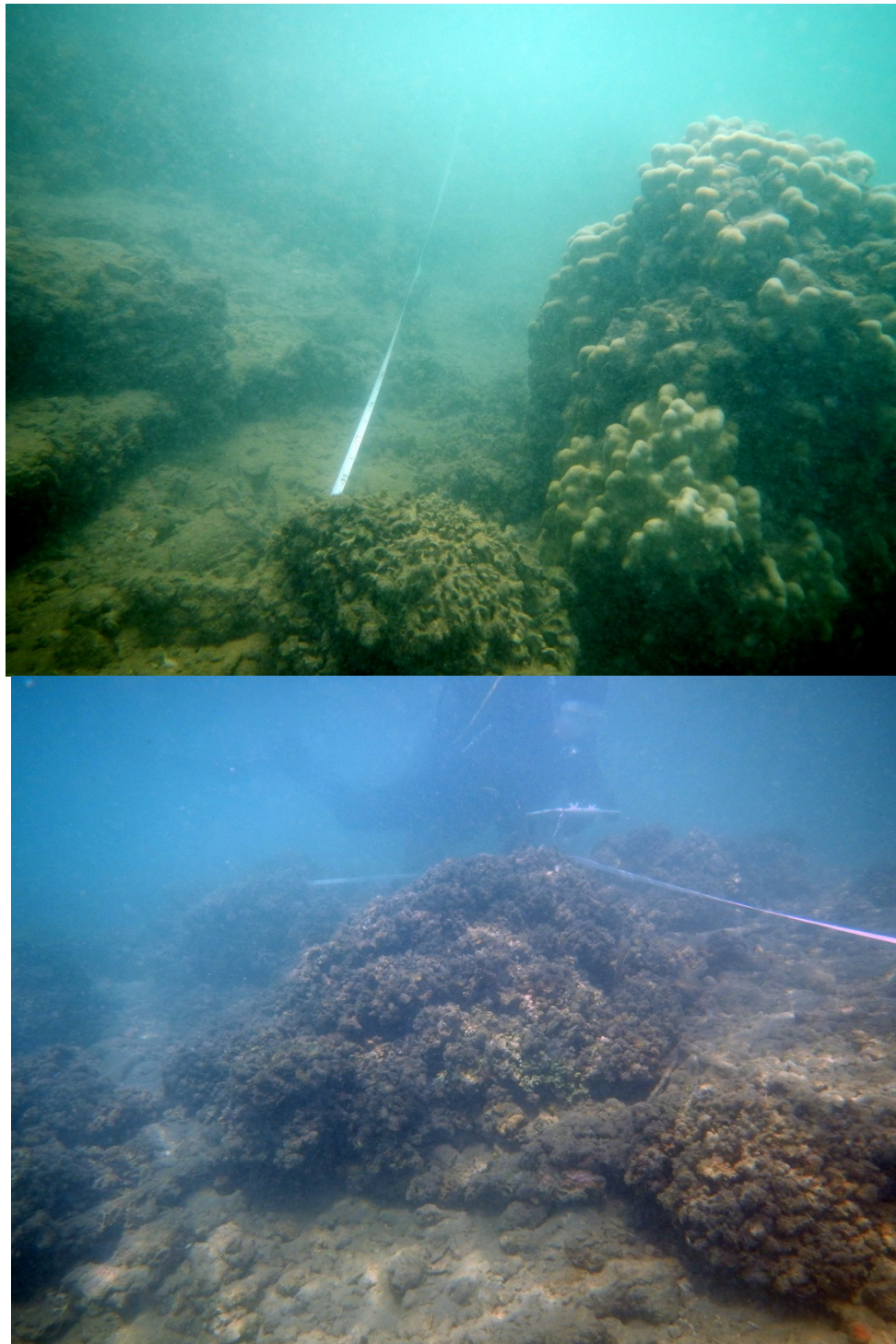
At Sector B, a large school of Bluestripe herring (*Herklotsichthys quadrimaculatus*) was observed (top photo). Silt and rubble are the dominant benthos across Sector B. Small colonies of *Porites* sp. are common (bottom photo).



Sector C and D piles host invertebrates, including many dead Hawaiian oysters (*Dendostrea sandvicensis*), tunicates (*Phallusia nigra*) and small *Leptastrea* sp. colonies.



Piles at sector E host partially dead *Porites* sp. colonies (top photo). The corner of Sector E, by the main channel hosts many dead *Poc. damicornis* colonies (bottom photo).



Shoreline at sector F hosts several large *Porites* spp (top photo) and dead *Poc. damicornis* colonies (bottom photo).



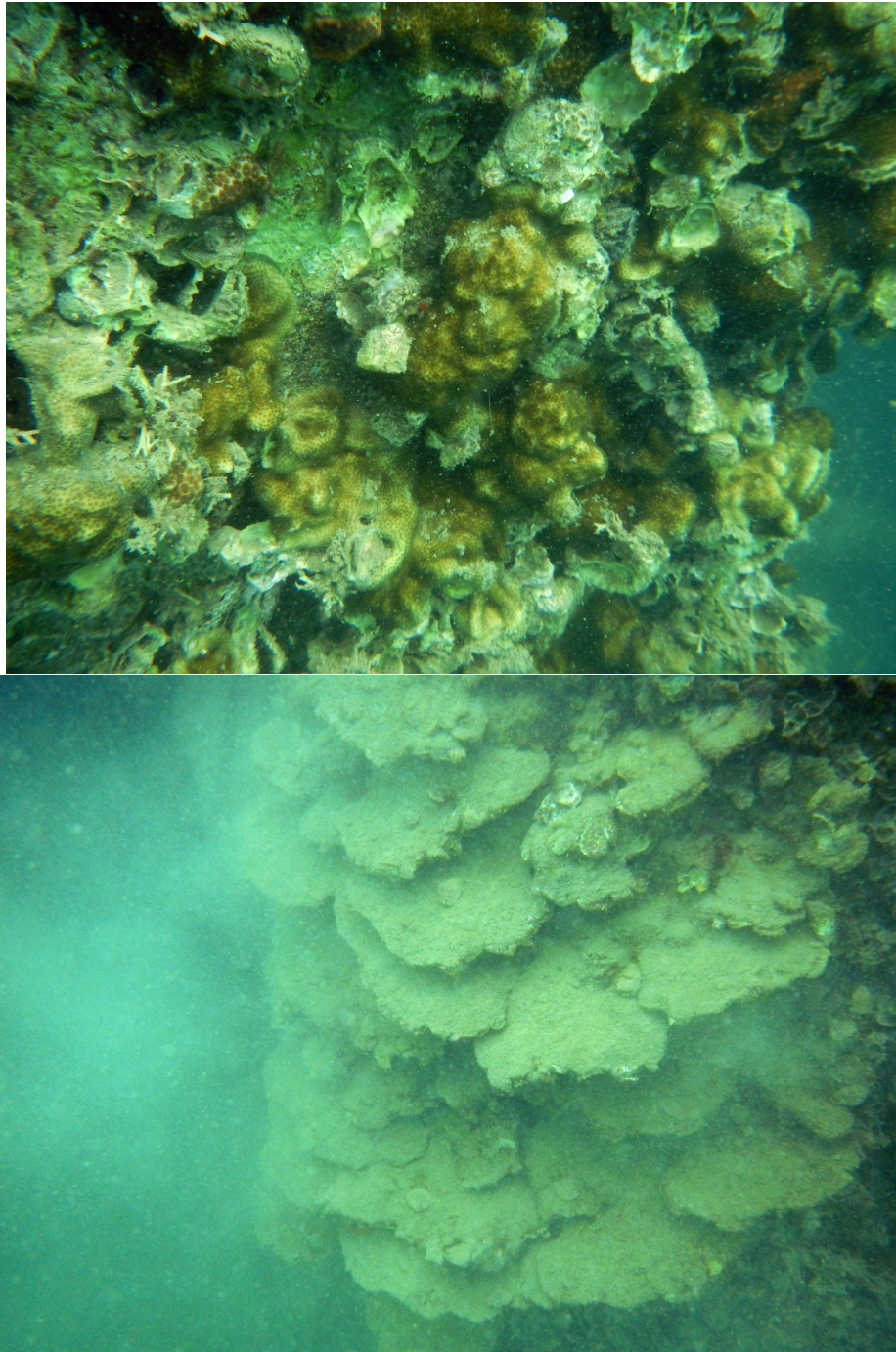
At sector G, silt, rubble and large debris are dominant bottom types. Small (<10 cm) colonies of *Porites* sp. and *Leptastrea* spp. are found on the rubble and debris.



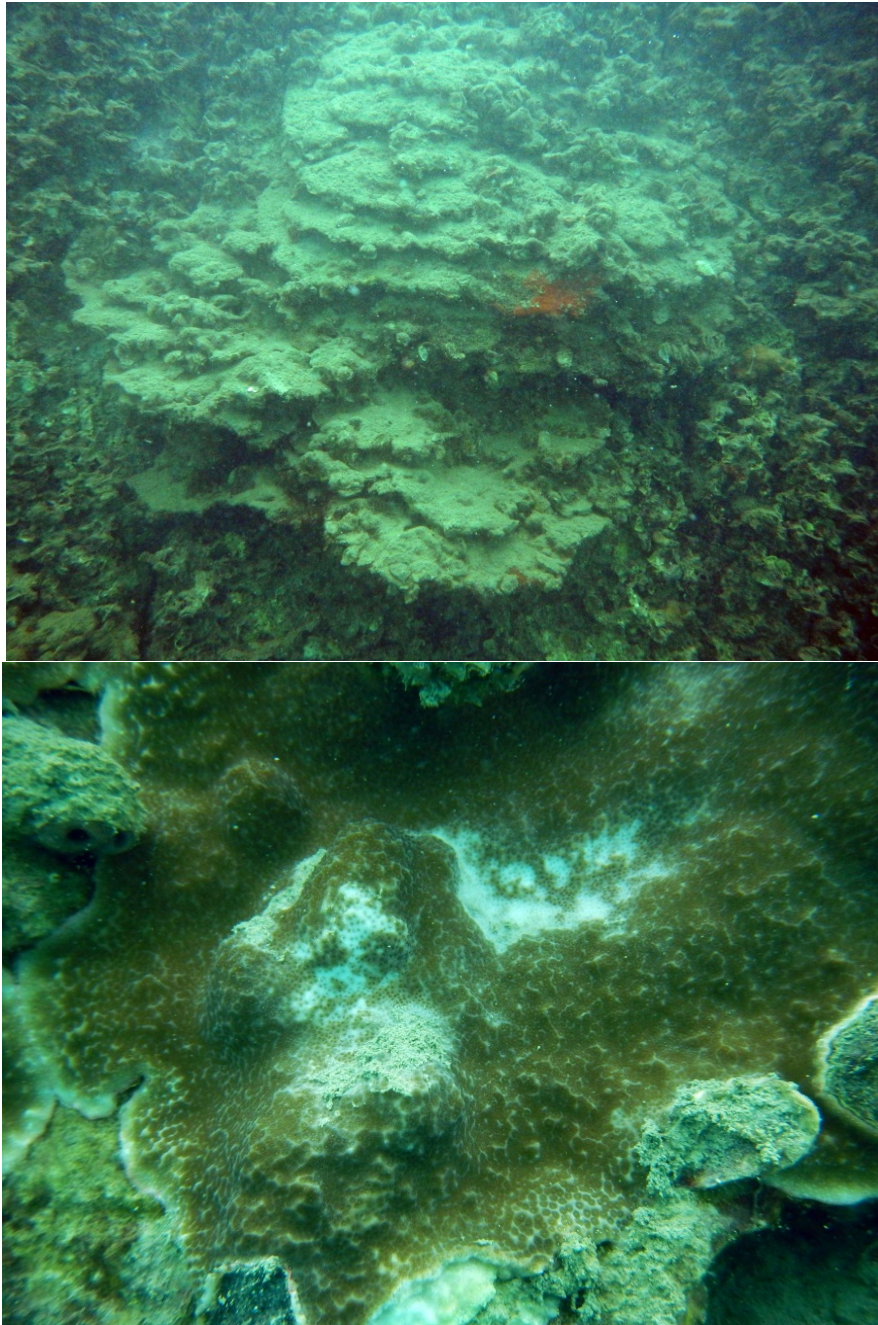
Sheet pile at sector H hosts small (<10 cm) live *Leptastrea* spp. and *Porites lobata* encrusting coral (top photo). Ringtail surgeonfish (*Acanthurus blochii*) and blacktail snapper (*Lutjanus fulvus*) are seen here (bottom photo).



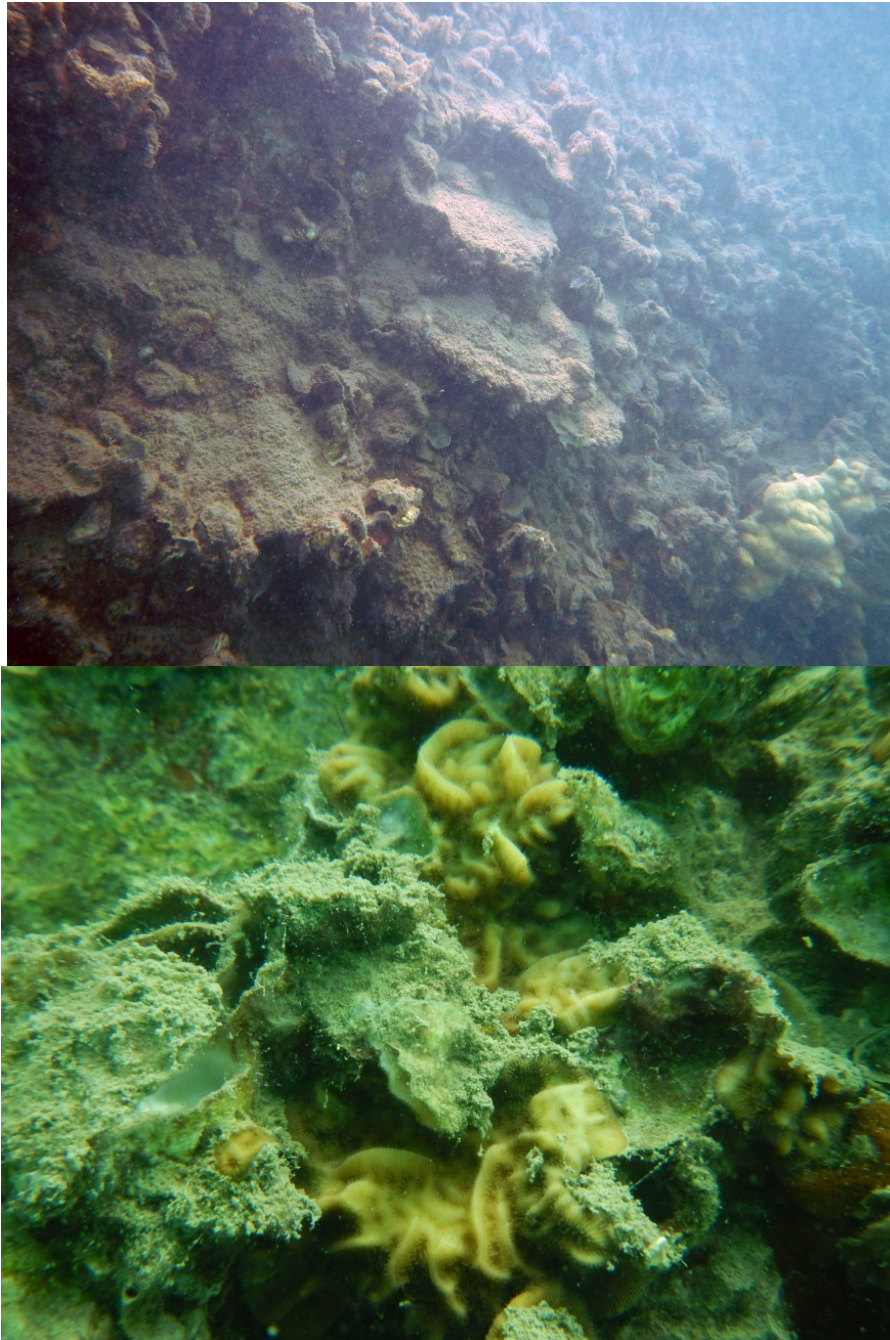
At the shoreline of sector I, many small (<10 cm) live *Leptastrea* spp. and *Porites lobata* encrusting corals occur (left column). Large (>40 cm) dead *Montipora patula* and *M. capitata* and very large (>80 cm) partially dead *Porites* spp. occur (right column).



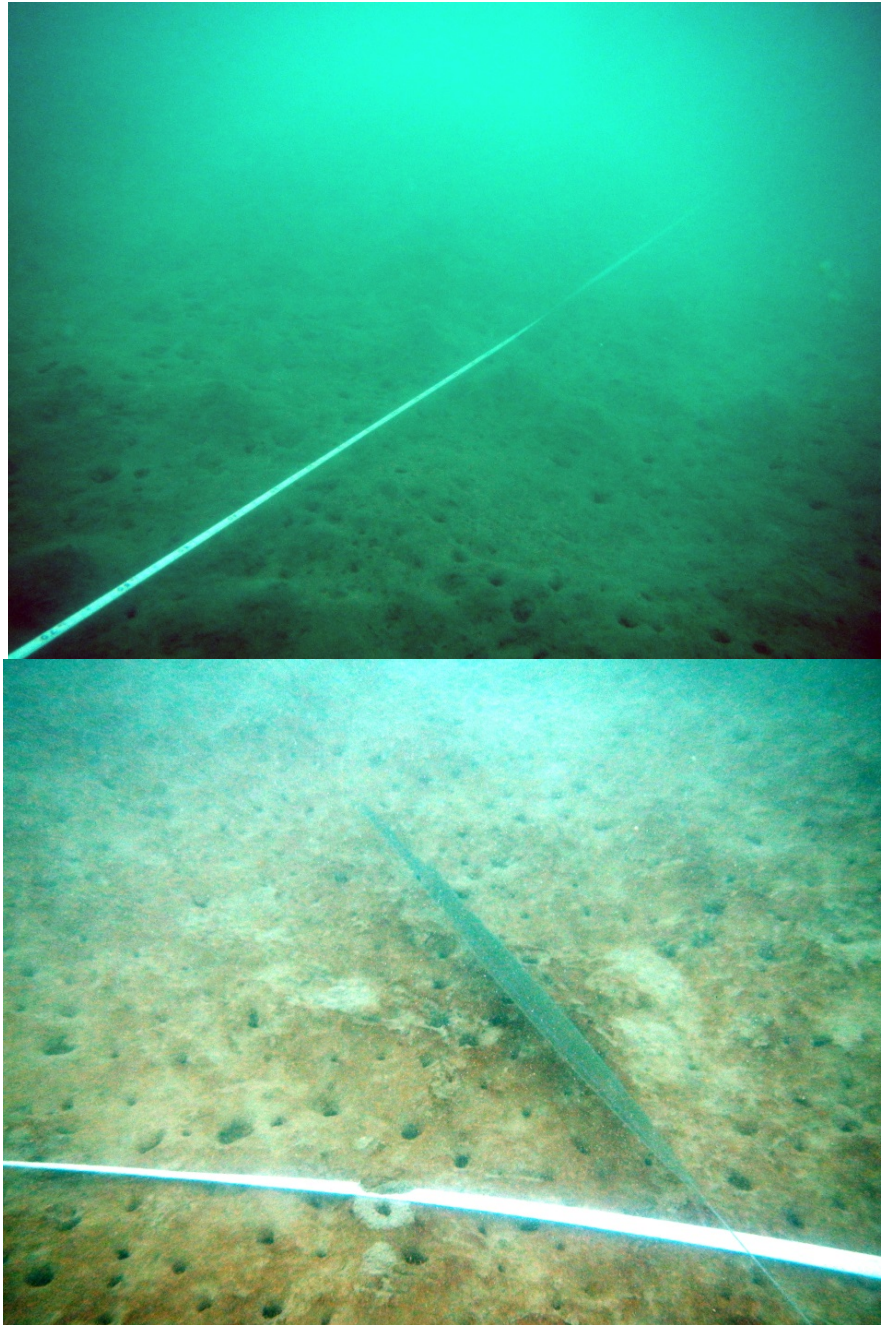
Piles at sector J host small (<10 cm) live *Leptastrea* spp. and *Porites lobata* encrusting corals (top photo). Large (>40 cm) dead *Montipora patula* and *M. capitata* and partially dead *Porites* spp. occur (bottom photo).



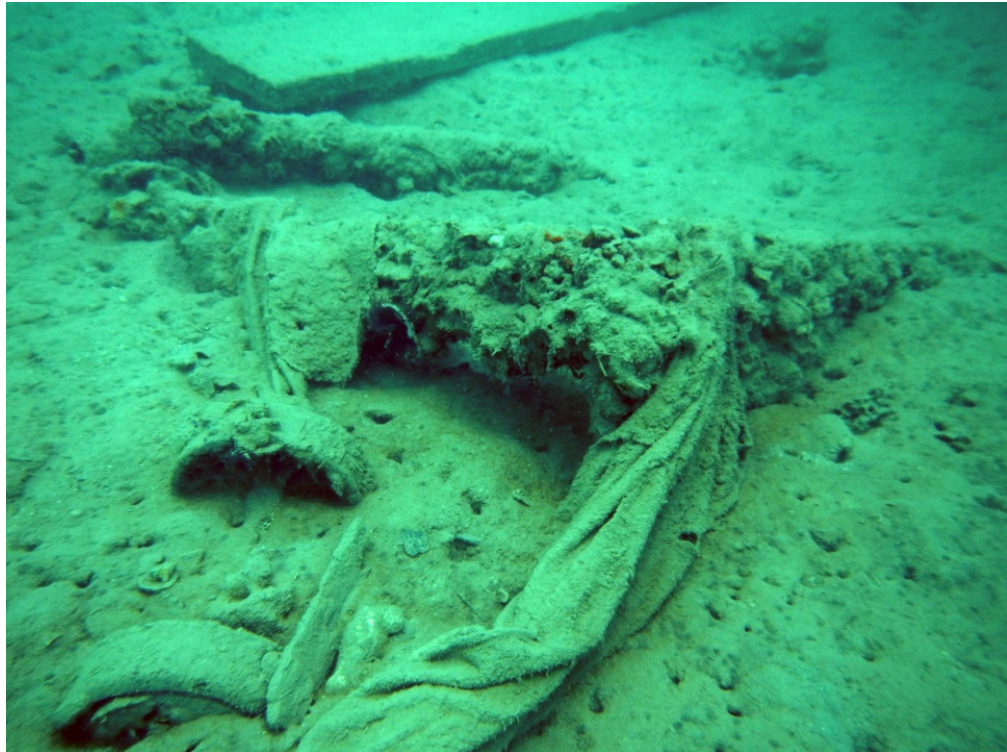
Piles at sector K-3, surveyed May 6, 2014. The shallow sections of the piles host large (> 40 cm) coral colonies -- dead *Montipora* spp. and alive/partially dead *Porites* sp. (top photo). Several large, partially dead *Porites monticulosa* were observed in K-3 (bottom photo).



Piles at sector L surveyed May 7, 2014. The piles host large (> 40 cm) coral colonies -- dead *Montipora* spp. (top photo). Several live *Pavona varians* colonies were observed to be growing over old dead coral (bottom photo).



At depth of 30-39 ft, the harbor bottom, surveyed Tuesday, May 13, 2014. In all harbor bottom transects, the substrata is thick silt. The top photo shows bottom survey off sector B. Few fishes were encountered, including bluespotted cornetfish (*Fistularia commersonii*; bottom photo), in the area between sectors K and I.



All harbor bottom transects are silt bottom and no coral. Debris was encountered in the back of Snug Harbor, shown in photo.

APPENDIX B

Relative abundance of taxa observed at Project and reference stations at Honolulu Harbor O'ahu, March through May, 2014.

Abundance categories:

D = Dominant - observed in large numbers and widely distributed.

A = Abundant - observed everywhere, although generally not in large numbers.

C = Common - seen irregularly in small numbers.

O = Occasional - several to a dozen individuals observed.

R = Rare - only one or two individuals observed.

Status (distributional status for the Hawaiian Islands):

End = endemic - native to Hawai'i, and not occurring naturally elsewhere.

Ind = indigenous - native to Hawai'i, but not unique to the Hawaiian Islands.

Alien = alien - non-native species introduced to the Hawaiian Islands intentionally or accidentally.

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
CHLOROPHYTA,	GREEN ALGAE		
BRYOPSISIDOPHYCEAE, BRYOPSIDALES, BRYOPSISIDACEAE <i>Bryopsis pennata</i>		R	Ind
DASYCLADOPHYCEAE, DASYCLADALES, DASYCLADACEAE <i>Neomeris sp.</i>		C	Ind
SIPHONOCLADOPHYCEAE, SIPHONOCLADALES, SIPHONOCLADACEAE <i>Dictyosphaeria versluysii</i>	hard bubble algae	R	Ind
RHODOPHYTA,	RED ALGAE		
RHODYMENIOPHYCIDAE, CERAMIALES, DASYACEAE <i>Dasya iridescens</i>	iridescent seaweed	O	End
DELESSERIACEAE <i>Martensia fragilis</i>	fragile martensia	O	Ind
RHODOMELACEAE <i>Acanthophora spicifera</i>	spiny seaweed	A	Alien
RHODOMELACEAE <i>Tolypocladia/ Neosiphonia / Polysiphonia unk.</i>	red fuzz	C	Ind or End
CORALLINALES, CORALLINACEAE <i>Hydrolithon gardineri</i>	branching coralline algae	R	Ind
<i>Hydrolithon onkodes</i>	encrusting coralline algae	C	Ind
<i>Hydrolithon reinboldii</i>	encrusting coralline algae	C	Ind

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
<i>Pneophyllum conicum</i>		C	Ind
GRACILARIALES, GRACILARIACEAE			
<i>Gracilaria salicornia</i>	gorilla seaweed, <i>ogo</i>	O	Alien
NEMALIALES, GALAXAURACEAE			
<i>Dichotomaria marginata</i>	flat galaxaura	O	Ind
PEYSSONNELIALES PEYSSONNELIACEAE			
<i>Peyssonnelia rubra</i>		O	Ind
SPOROLITHALES, SPOROLITHACEAE			
<i>Sporolithon</i> sp.		C	Ind
CYANOBACTERIA	BLUEGREEN ALGAE		
<i>Lyngbya majuscula</i>	stinging limu	O	Ind
<i>Symploca hydroides</i>		O	Ind
unidentified	red stringy	C	---

CORAL			
PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
CNIDARIA, ANTHOZOA, SCLERACTINIA, POCILLOPORIDAE	STONY CORALS		
<i>Pocillopora damicornis</i>	lace coral	O	Ind
<i>Pocillopora meandrina</i>	cauliflower coral	R	Ind
PORITIDAE			
<i>Porites compressa</i>	finger coral	C	End
<i>Porites lobata</i>	lobe coral, <i>pōhaku</i> <i>puna</i>	A	Ind
<i>Porites monticulosa</i>	<i>pōhaku puna</i>	R	Ind
AGARICIIDAE			
<i>Pavona varians</i>	variegated coral	O	Ind
FAVIIDAE			
<i>Leptastrea sp</i>		A	Ind
ACROPORIDAE			
<i>Montipora capitata</i>	rice coral	C	Ind
<i>Montipora patula</i>	sand paper coral	O	End

MACROINVERTEBRATES

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
PORIFERA	SPONGES		
unidentified	black sponge	C	---
unidentified	blue sponge	C	---
unidentified	blue/purple sponge	C	---
unidentified	orange sponge	C	---
unidentified	red sponge	C	---
DEMOSPONGIAE, POECILOSCLERIDA, HYMEDESMIIDAE			
<i>Hamigera sp.</i>		C	---
IOTROCHOTIDAE			
<i>Iotrochota protea</i>	black staining sponge	C	End
MYCALIDAE			
<i>Mycale sp.</i>		C	---
<i>Stylinos sp.</i>		C	---
CNIDARIA, HYDROZOA, ANTHOATHECATA	HYDROIDS		
<i>Pennaria disticha</i>	Christmas tree hydroid	C	Alien
ACTINIARIA, ACTINIIDAE	SEA ANEMONES		
Unidentified	solitary anemone	C	---
AIPTISIIDAE			
<i>Aiptasia pulchella</i>	glass anemone	C	Ind
ZOANTHINARIA, SPHENOPIIDAE	ZOANTHIDS		
<i>Palythoa caesia</i>	blue-gray zoanthid	R	Ind
<i>Palythoa sp.</i>	green zoanthid	R	---
ZOANTHIDAE			
<i>Zoanthus sp.</i>	solitary zonthid	R	---
ANNELIDA, POLYCHAETA	WORMS		

MACROINVERTEBRATES

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
SABELLIDAE			
<i>Sabellastarte spectabilis</i>	feather duster worm	O	Ind
TEREBELLIDAE			
<i>Loimia medusa</i>	Medusa spaghetti worm, <i>kauna'oa</i>	O	Ind
<i>Thelepus setosus</i>	Spaghetti worm, shell binder worm	O	Ind
CHAETOPTERIDAE			
<i>Chaetopterus</i> spp.	parchment worm	O	?
SERPULIDAE			
<i>Salmacina dysteri</i>	sea frost	C	Ind
<i>Spirobranchus giganteus</i>	Christmas tree worm	C	Ind
ECTOPROCTA, GYMNOLOEMATA, CHEILOSTOMATA, RETEPORIDAE	BRYOZOANS		
<i>Reteporellina denticulata</i>	lace bryozoan	C	Ind
SCHIZOPORELLIDAE			
<i>Schizoporella errata</i>	erratic bryozoan	C	Ind
BRYOZOA, VESICULARIIDAE			
<i>Amathia distans</i>	bushy bryozoan	C	Alien
<i>Zoobotryon verticillatum</i>		O	Alien
BUGULIDAE			
<i>Bugula dentata</i>	blue fan bryozoan	C	Alien
MOLLUSCA, GASTROPODA,	SNAILS AND SLUGS		
LITTORINIDAE			
<i>Littoraria pintado</i>	dotted periwinkle	O	Ind
VERMETIDAE			
<i>Serpulorbis variabilis</i>	variable worm snail	C	Ind
PATELLIDAE			
<i>Siphonaria normalis</i>	false 'opihī-awa	R	Ind
unidentified	limpet	R	---
ANASPIDEA,	SEA HARES		

MACROINVERTEBRATES

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
APLYSIIDAE <i>Aplysia sp.</i>	sea hare	C	---
SACOGLOSSA, ELYSIIDAE <i>Plakobranthus ocellatus</i>	SAP-SUCKING SLUGS ringed sap-sucking slug	O	Ind
NUDIBRANCHIA, CHROMODORIDAE <i>Hypselodoris infucata</i> <i>Chromodoris vibrata</i>	NUDIBRANCHS dorid nudibranch trembling nudibranch	R O	Ind End(?)
MOLLUSCA, BIVALVIA, ISOGNOMONIDAE <i>Isognomon californicum</i> <i>Isognomon perna</i>	BIVALVES PURSE SHELLS black purse shell, <i>nahawele</i> brown purse shell, <i>nahawele</i>	C O	End Ind
VENEROIDA, CHAMIDAE <i>Chama macerophylla</i>	leafy jewelbox clam	C	Alien
GRYPHAEIDAE <i>Parahyotissa numisma</i> <i>Parahyotissa inermis</i>	coin oyster	C C	Ind Alien
PTERIOIDA, PTERIIDAE <i>Pinctada margaritifera</i>	black-lipped pearl oyster	O	Ind
OSTREIDAE <i>Crassostrea gigas</i> <i>Dendostrea sandvichensis</i>	true oyster Hawaiian oyster	O A	Alien End
ARTHROPODA, MALACOSTRACA, ISPODOA Unidentified	SHRIMPS, LOBSTERS, CRABS isopod	A	---
STOMATOPODA,	MANTIS SHRIMP		

MACROINVERTEBRATES

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
unidentified	mantis shrimp	O	---
PSEUDOSQUILLIDAE			
<i>Pseudosquilla ciliata</i>	ciliated mantis shrimp	O	Ind
GONODACTYLIDAE			
<i>Gonodactylaceus falcatus</i>	Philippine mantis shrimp	O	Ind
DECAPODA, ALPHEIDAE	SNAPPING SHRIMPS		
<i>Alpheus sp.</i>	snapping shrimp	R	---
STENOPODIDAE			
<i>Stenopus hispidus</i>	banded coral shrimp	O	Ind
DIOGENIDAE	LEFTHANDED HERMIT CRABS		
<i>Calcinus latens</i>	hidden hermit	R	Ind
PORTUNIDAE	SWIMMING CRABS		
<i>Podphthalmus vigil</i>	long-eyed swimming crab	O	Ind
<i>Thalamita edwardsi</i>	Edward's swimming crab	R	Ind
<i>Thalamita crenata</i>	mangrove swimming crab	R	Ind
unidentified	swimming crab	R	---
GRAPSIDAE	ROCK CRABS		
<i>Percnon planissum</i>	flat rock crab, <i>pāpā</i>	O	Ind
<i>Grapsus tenuicrustatus</i>	thin-shelled rock crab, <i>'ama'ama</i>	R	Ind
<i>Metopograpsus thukuhar</i>		R	Ind
CHORDATA, UROCHORDATA, ASCIDIACEA	ASCIDIAN		
unidentified	tunicate	O	---
<i>Ascidea sydneyensis</i>	yellow sea squirt	A	Alien?

MACROINVERTEBRATES

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
<i>Phallusia nigra</i>	black sea squirt	A	Alien?
PYURIDAE			
<i>Herdmania momus</i>	Herdman's sea squirt	A	Alien?
DIDEMNUM			
<i>Didemnum sp.</i>		A	---
STYELIDAE	LADDER TUNICATES		
<i>Botryllus sp.1</i>		A	---
<i>Botryllus sp.2</i>		A	---

FISHES			
PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
CHORDATA, OSTEICHTHYES, PERCIFORMES SYNODONTIDAE	BONEY FISHES LIZARDFISHES		
<i>Synodus</i> sp.	lizardfish, <i>'ulae</i>	O	---
<i>Synodus dermatogenys</i>	sand lizardfish	O	Ind
<i>Synodus ulae</i>	Hawaiian lizardfish, <i>'ulae</i>	R	Ind
FISTULARIIDAE	CORNETFISHES		
<i>Fistularia commersonii</i>	bluespotted cornetfish, <i>nūnū</i>	R	Ind
SCORPAENIDAE	SCORPIONFISHES		
<i>Dendrochirus barberi</i>	Hawaiian lionfish, <i>nohu</i>	R	End
HOLOCENTRIDAE	SOLDIERFISH		
<i>Myripristis</i> sp.		R	---
KHULIDAE	FLAGTAILS		
<i>Kuhlia xenura</i>	Hawaiian flagtail, <i>āholehole</i>	C	End
APOGONIDAE	CARDINALFISHES		
<i>Foa brachygramma</i>	weed cardinalfish		End
CARANGIDAE	JACKS	O	
<i>Caranx melampygus</i>	bluefin trevally, <i>pāpio</i>	O	Ind
LUTJANIDAE	SNAPPERS		
<i>Lutjanus fulvus</i>	blacktail snapper, <i>to'au</i>	A	Alien
MULLIDAE	GOATFISHES		
<i>Mulloidichthys flavolineatus</i>	yellow stripe goatfish, <i>weke 'a, 'oama</i>	C	Ind
<i>Parupeneus porphyreus</i>	white-saddle goatfish, <i>kūmū</i>		End
<i>Parupeneus multifasciatus</i>	many bar goatfish, <i>moano</i>	R	Ind
<i>Upeneus arge</i>	bandtail goatfish, <i>weke pueo</i>	R	Ind
CHAETODONTIDAE	BUTTERFLYFISHES		
<i>Chaetodon auriga</i>	threadfin, <i>kīkākāpu</i>	R	Ind
<i>Chaetodon ephippium</i>	saddle, <i>kīkākāpu</i>	R	Ind

FISHES

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
<i>Chaetodon lunula</i>	raccoon, <i>kikākapu</i>	R	Ind
<i>Chaetodon ornatissimus</i>	ornate <i>kikākapu</i>	R	Ind
<i>Chaetodon unimaculatus</i>	tear drop <i>kikākapu</i>	R	Ind
POMACENTRIDAE	DAMSELFISHES		
<i>Abudefduf abdominalis</i>	Hawaiian sergeant, <i>mamo</i>	C	End
<i>Abudefduf sordidus</i>	blackspot sergeant, <i>kūpīpī</i>	C	Ind
<i>Abudefduf vaigiensis</i>	Indo-Pacific sergeant	C	Ind
<i>Dascyllus albisella</i>	Hawaiian dascyllus, <i>'ālo'ilo'i</i>	O	End
<i>Plectroglyphidodon imparipennis</i>	brighteye damselfish	O	Ind
LABRIDAE	WRASSES		
<i>Thalassoma duperrey</i>	saddle wrasse, <i>hīnālea lau-wili</i>	O	End
SCARIDAE	PARROTFISHES		
<i>Calotomus carolinus</i>	stareye parrotfish, <i>pōnuhunuhunu</i>	R	Ind
<i>Scarus psittacus</i>	palenose parrotfish, <i>uhu</i>	R	Ind
<i>Scarus rubroviolaceus</i>	redlip parrotfish, <i>uhu</i>	R	Ind
GOBIIDAE	GOBIES		
<i>Asterropteryx semipunctatus</i>	half-spotted goby	O	Ind
<i>Gnatholepis anjerensis</i>	eye-bar goby	O	Ind
<i>Coryphopterus duospilus</i>	twospot sand goby	O	Ind
<i>Psilogobius mainlandi</i>	mainland's goby	O	End
unidentified	goby	O	---
ZANCLIDAE	MOORISH IDOL		
<i>Zanclus cornutus</i>	Moorish idol, <i>kihikihi</i>	O	Ind
ACANTHURIDAE	SURGEONFISHES		
<i>Acanthurus achilles</i>	achilles tang	O	Ind
<i>Acanthurus blochii</i>	ringtail surgeonfish, <i>pualu</i>	C	Ind
<i>Acanthurus leucopareius</i>	whitebar surgeonfish, <i>māikoiko</i>	O	Ind

FISHES

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
<i>Acanthurus nigrofuscus</i>	lavender tang, <i>mā'i'i'i</i>	O	Ind
<i>Acanthurus triostegus</i>	convict tang, <i>manini</i>	C	Ind
<i>Acanthurus nigroris</i>	bluelined surgeonfish	R	Ind
<i>Acanthurus xanthopterus</i>	yellowfin surgeonfish, <i>pualu</i>	C	Ind
<i>Ctenochaetus strigosus</i>	goldring surgeonfish, <i>kole</i>	O	End
<i>Zebrasoma flavescens</i>	yellow tang	R	Ind
<i>Naso unicornis</i>	bluespine unicornfish, <i>kala</i>	R	Ind
<i>Naso lituratus</i>	orangespine unicornfish	O	Ind
<i>Naso brevirostris</i>	spotted unicornfish	R	Ind
TETRAODONTIDAE	PUFFERFISHES		
<i>Arothron hispidus</i>	stripebelly puffer	O	Ind
<i>Canthigastor jactator</i>	Hawaiian whitespotted toby	A	End
AULOSTOMIDAE			
<i>Aulostomus chinensis</i>	trumpet fish	O	Ind
BLENNIDAE	BLENNY		
<i>Entomacrodus marmoratus</i>	marbled blenny	O	End
<i>Omobranchus ferox</i>	gossamer blenny	O	Alien
CLUPEIDAE			
<i>Herklotsichthys quadrimaculatus</i>	goldspot herring	A	Alien
SPHYRENIDAE			
<i>Sphyraena barracuda</i>	great barracuda	R	Ind
DIODONTIDAE			
<i>Diodon hystrix</i>	spotted porcupinefish	O	Ind
ANTENNARIIDAE			
<i>Antennarius commerson</i>	Commerson's frogfish	R	Ind

FISHES

PHYLUM, CLASS, ORDER, FAMILY <i>Genus species</i>	Common name, <i>Hawaiian name</i>	Abundance	Status
CHORDATA, CHONDRICHTHYES, CARCHARHINIFORMES, CARCHARHINIDAE <i>Galeocerdo cuvier</i>	tiger shark	R	Ind

**The New Kapalama Container Terminal
Wharf and Dredging Project
(H.C. 10498)
Coral Transplantation Plan**

**State of Hawaii Department
Of Transportation**

Harbors Division

Honolulu Harbor, Kapalama Basin, Oahu, Hawaii

Department of the Army File No. POH-2012-00081

Prepared for:
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Prepared by:
State of Hawaii, Department of Transportation
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TABLE OF CONTENTS

1. INTRODUCTION	1
1.1 Need for Coral Transplantation	1
1.2 Objectives of the Plan	1
1.3 Project Description	2
2. REVIEW OF CORAL TRANSPLANTATION EFFORTS IN HAWAII.....	6
3. PHASE I: PRE-CONSTRUCTION CORAL SURVEYS.....	9
3.1 General	9
3.2 Coral Survey Findings.....	10
3.3 Description of Corals to be Transplanted	14
3.4 Coral Recipient Site Alternatives.....	15
4. PHASE II: TRANSPLANTATION PLAN.....	17
4.1 Timeframe for Harvesting.....	17
4.2 Coral Selection and Harvesting.....	17
4.3 Preparation of Recipient Site	18
4.4 Coral Specimen Holding and Transportation	19
4.5 Coral Transplant Attachment.....	19
4.6 Transplant Reporting and Success Criteria.....	20
5. PHASE III: POST-TRANSPLANTATION MONITORING.....	20
5.1 Control Corals	20
5.2 Transplanted Corals.....	21
5.3 Post Transplantation Monitoring Schedule.....	21
5.4 Post Transplantation Monitoring Methodology	21
5.5 Success Criteria.....	21
5.6 Reporting Criteria	21
6. IMPLEMENTATION AND MANAGEMENT.....	22
7. REFERENCES	23

List of Figures

Figure 1. Location Map.....	4
Figure 2. Project Waters.....	5
Figure 3. Marine Survey Sectors	9
Figure 4. Distribution of all live coral Species across the existing Project site and adjacent Shoreline	11
Figure 5. Location of Corals Greater than 40 cm in diameter.....	12
Figure 6. Candidate Coral Recipient Sites in Honolulu Harbor.....	16

List of Tables

Table 1. Recent Coral Mitigation Efforts.....	8
Table 2. Size and Area Distribution of Live Coral Species in Project Area	10
Table 3. Colony Area of Coral Species Selected for Transplanting.....	12

1. INTRODUCTION

1.1 Need for Coral Transplantation

Coral transplantation is one strategy to minimize impacts to corals from coastal development projects. Coral transplantation will be used to minimize adverse impacts to coral colonies potentially affected by the New Kapalama Container Terminal Wharf and Dredging Project (Project).

It is important to note that based on the textual description of Essential Fish Habitat for Coral Reef Ecosystem Management Unit Species (CREMUS) provided in the Final Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region, Chapter 2 (WPRFMC, 2001) and the Fishery Ecosystem Plan for the Hawaii Archipelago, Chapter 3 (WPRFMC, 2009), individual coral colonies do not constitute Essential Fish Habitat (EFH) that is afforded protection under the Magnusson-Stevens Fishery Conservation and Management Act (MSA). In addition Coral reefs are described in the CREMUS FMP as “patchworks of hard and sediment bottoms” and in the Hawaii FEP as “carbonate rock structures at or near sea level that support viable populations of scleractinian or reef-building corals”. Furthermore, the Western Pacific Region Fishery Management Council, in designating EFH for CREMUS, considered designating individual reef building corals as EFH, but rejected that specific alternative in favor of a habitat composite approach. While coral reefs are considered EFH, individual corals are not. The Corps interprets coral reef/hard substrate habitat composite designated EFH for CREMUS to mean, naturally occurring, hard bottom and not individual coral colonies or artificial vertical structures such as pilings or bulkheads that support coral growth.

The proposed minimization measure to transplant corals is based on the presumption that coral colonies growing on manmade structures within the Project area, although not EFH, do provide habitat and other ecological support for MUS’ and accordingly impacts to such a resource should be minimized to the greatest extent practical. The Project intends to realign the entire 4,190 foot long shoreline that presently provides substrate for an estimated 82,324 corals (+/- 14,632 standard error of mean). The purpose of the Plan is to identify the methods for transplanting high-value corals from the Project area to a recipient site and for post-transplantation monitoring.

1.2 Objectives of the Plan

The main objectives of the Plan are to move select corals out of the direct physical impact footprint of the Project and maximize the survival of transplanted corals at a carefully selected recipient site. The Plan includes selection of appropriate species and optimal sizes for transplantation, protocols for harvesting from the area of impact, examination for and control of invasive species, transportation to the recipient site, preparation of the recipient site, planting on new substrate, prescribed monitoring to assess transplantation success, and reporting to document the overall findings of the transplantation effort. This coral transplantation plan is organized into the following three phases:

Phase I

- Evaluate construction activities that impact corals and identify the geographic areas of impact.
- Characterize the distribution of coral species and sizes at the impacted sites in the Project area.
- Identify the species, sizes, health characteristics (including associated invasive species), and distribution of corals to be transplanted that will minimize impact.
- Identify biologically, chemically and physically suitable recipient sites that are ecologically appropriate to foster future growth of the corals.

Phase II

- Identify the coral harvesting schedule relative to the construction schedule.
- Describe the method of field identification of corals, cleaning and temporary storage of specimens.
- Describe methods and conditions for transportation to the recipient site.
- Describe the method of preparing the recipient site, spacing between corals, and method of affixing the corals to the recipient site substrate.

Phase III

- Describe the post-transplantation monitoring method.
- Define long-term success criteria and reporting requirements.

1.3 Project Description

The Project is located at the Kapalama Basin in the western part of Honolulu Harbor, Oahu, Hawaii. The Project covers about 18.8 acres of upland and 8.13 acres of water within Kapalama Basin in the western portion of Honolulu Harbor, Oahu, Hawaii (Figure 1). The Project area extends from Pier 43 at the base of the Sand Island Bridge and Kalihi Channel through Snug Harbor, Pier 42, and to the foot of Piers 41 and 40F (Figure 2). The shoreline will be transformed to create docks, a container wharf, and infrastructure capable of simultaneously loading, offloading, distributing and storing containerized cargo from two container ships and two interisland barges. This transformation will essentially straighten the existing shoreline resulting in the loss of 2.49 acres of waters of the U.S. by fill, and a gain of 2.78 acres of waters of the U.S. by excavation of existing fast land. The result is a slight gain (0.29 acres) of waters of the U.S. During the initial demolition phase of the Project, all fouling community and benthic community organisms (including corals) in the Project area that have not been transplanted away from the site will be lost. Corals intended for transplantation must be removed from the Project area prior to initiation of any in-water demolition work.

Demolition will include removal of piles, sheet piles, debris and other subsurface utilities. All existing artificial structures along the shoreline, including concrete piles, sheet pile bulkheads, in-water concrete debris, rail-slip hardware and foundations,

wharf pavement and concrete foundations and subsurface utilities, will be physically removed from the existing 4,190-foot long shoreline. Approximately 417,900 cubic yards will be excavated and dredged within the Project area (Figure 2).



Figure 1. Location Map

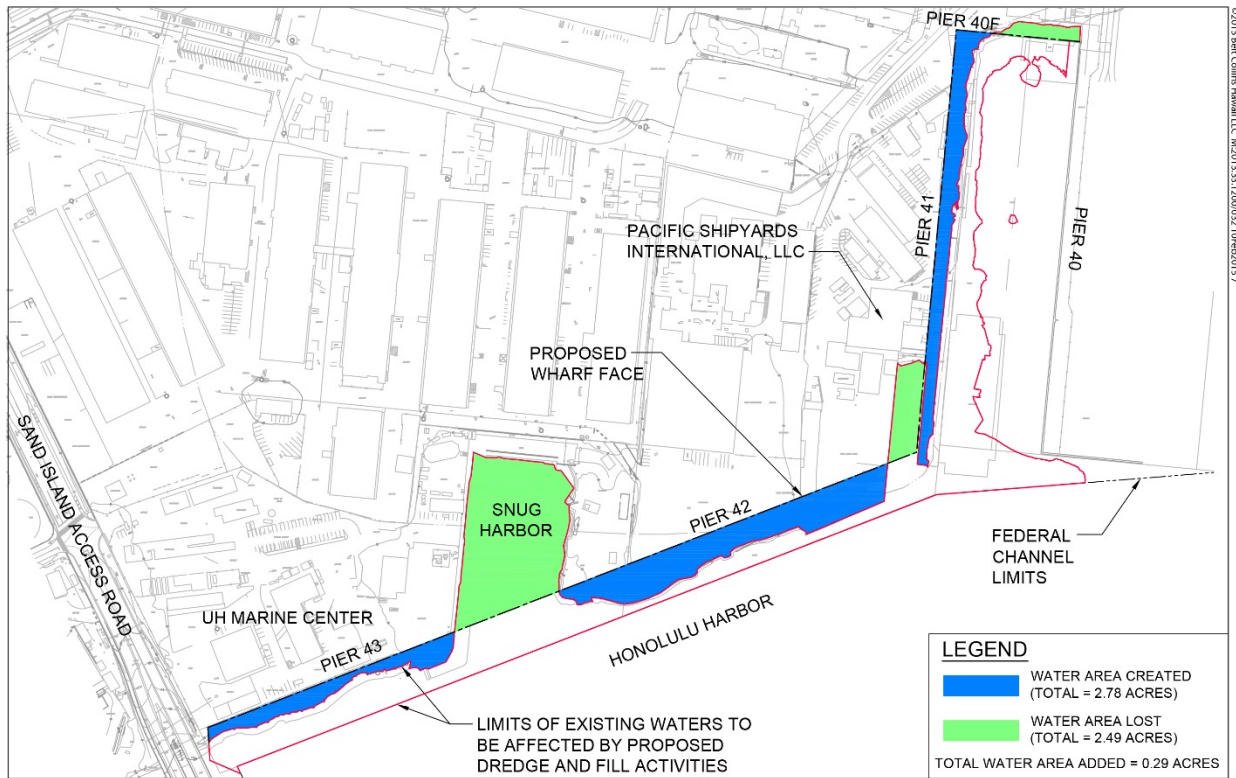


Figure 2. Project Waters

2. REVIEW OF CORAL TRANSPLANTATION EFFORTS IN HAWAII

Coral transplantation projects have developed rapidly over the past four decades in response to the need for improved coral reef management and preservation. The intentional transplantation of corals to preserve and manage coral reefs was initiated in Hawaii (Maragos, 1974) and quickly found its way to the field of professional public aquariums (Carlson, 1978), and from there into the realm of the aquarium hobbyist (Neilson and Fossa, 1991; Coral Reef Magazine, 1999). The first application of coral transplantation as mitigation to offset adverse impacts was reported in 1979 (Birkeland, et al.) to reestablish corals adversely impacted by a thermal plume in Guam. Coral transplantation, husbandry and artificial reef construction as mitigation are all much more commonly used in Florida and the U.S. Caribbean as compared to in the Pacific (Sathe, et al., 2012; Neidimeyer, et al., 2012).

A review of coral reef restoration and mitigation efforts in the Pacific (Jokiel, et al., 2006) reached a number of important conclusions. The more applicable of these include:

- Reef protection is much more cost-effective than reef mitigation and restoration efforts which tend to be expensive and ineffective.
- Watershed management is inseparable from coral reef management.
- There is no point in expending effort to restore a reef that will subsequently be destroyed by chronic anthropogenic stress.
- Mitigation should focus on coral reef habitat, not merely the simple transplanting of coral colonies.
- Transplantation of corals into marginal habitats leads to their eventual demise.
- Token restoration efforts should never be a basis to justify proposed negative environmental actions under the guise of “improving” the environment.
- Restoration can be justified as a means to enhance fisheries production, tourism, recreation, aesthetics, research, conservation, or other activities and may allow natural restoration on otherwise pristine or sparsely inhabited reefs.

Since 2011, at least seven projects in Hawaii have used coral transplantation to minimize adverse impacts to corals from planned harbor construction activities. These projects include improvements at six small State of Hawaii Department of Land and Natural Resources (DLNR) boat harbors on Maui, Molokai, Lanai, and Hawaii Island and a boat ramp at the Kaneohe Marine Corps Base Hawaii on Oahu. Additional coral transplantation experience has been gained in response to several ship groundings that have occurred in the past decade. Information regarding the degree of success of these projects has been partially documented in individual monitoring reports, but no documents have been found that collates this material. Information readily available concerning these efforts is assembled in Table 1.

In discussions with individuals involved with several of the coral transplantation activities listed in Table 1, the following lessons emerge:

- Corals transplanted into a different light regime relative to the harvesting site display reduced survival.
- Transplanted corals must be stabilized against unusual currents or large swell events.
- The use of “volunteer” corals, broken from natural reefs following swell events, is a viable option to supplying coral plantings, as opposed to spending the time and effort to grow starter corals.
- Coral specimens should be planted separately to minimize the allelopathic effect (the production of metabolites that can have both beneficial and detrimental effects on another coral) of one coral against another.
- If corals are absent or sparse at the intended recipient site, the reason for this low prevalence must be understood prior to transplantation.

Project	Year	Agency	Ref.	# or Area of Corals Impacted	# Trans planted	1-Year % Survival	Other Mitigation Offset Measures / Comments
Port Royal	2009	DOD		4 hectares	5,400	N/A	
Voge Trader	2010	NOAA	NOAA 2015	103,027	643	89	Used corals dislodged from natural reef in 2012 to re-populated sea bottom scoured by vessel grounding
Hilo Pier 4	2009	DOT-HARBOR	Oceanit 2011	461	0	N/A	Day-use Mooring Buoys (not yet installed)
Lahaina SBH	2011	DOBOR	AECOS 2011	52	61	N/A	Harbor users SOPs education, Fishing restrictions, Invasive species monitoring. Debris monitoring, Water quality monitoring. Partial removal of S/V Dolphin
Lahaina SBH	2011	DOBOR	MOC 2013	12 coral (253 CFG)	21 CFG 232 CFG	100% 54%	232 CFG removed & cultured at MOC for 1 year, then 123 survivors transplanted to wild with no data after transplant
Kaunakakai SBH	2012	DOBOR	MOC, 2014	315	8 coral 5 CFG	54%	MOC also removed and cultured 81 fragments for 21 months at the aquarium, then transplanted back to wild.
Kawaihae SBH	2012	DOBOR	AECOS 2012	40	9	N/A	
Maalaea SBH	2013	DOBOR	AECOS 2013	98	34	N/A	Aquarium stewardship of 70 corals for 6 months followed by transplant to site outside of harbor.
Manele SBH	2013	DOBOR	AECOS 2013	43	43	64	Surveys by USFWS & AECOS, Transplant by MOC
Kona Wharf & Boat Ramp	2013	DOBOR	AECOS 2013	80	90	61	Of 10 control corals, 5 not found and 2 show tissues loss at re-survey
Keauhou	2013	DOBOR	MOC 2015	58	90	56	26% of corals not found or dead. Documented damage from anchor chain
MCBH Boat Ramp	2016?	DOD	MRC 2012	160	80 (?)	N/A	Transplantation not yet conducted
Pier 11-12	2015	DOT-Harbors	AECOS Pers Com	2.5 m ²	2.5 m ²	N/A	Recipient site scoured by prop wash

NOAA: National Oceanographic and Atmospheric Administration N/A = Data not available CFG: Coral Fragment
DOD: Department of Defense MOC: Maui Ocean Aquarium SBH: Small Boat Harbor
DOBOR: State Division of Boating and Ocean Resources MRC: Marine Research Consultants
MOC: Maui Ocean Center USFWS: United States Fish and Wildlife Service
MCBH: Marine Corps Base Hawaii

Table 1. Recent Coral Mitigation Efforts

3. PHASE I: PRE-CONSTRUCTION CORAL SURVEYS

3.1 General

The Project area extends from Pier 43 at the base of the bridge at Kalihi Channel through Snug Harbor, Pier 42 and to the foot of Piers 41 and 40F (Figure 3).

Phase I of the coral transplantation consists of the following steps:

- Evaluate construction activities that impact corals and identify the extent and geographic areas of impact.
- Characterize the distribution of coral species and sizes at the impacted sites in the Project area.
- Identify the species, sizes, health characteristics (including associated invasive species), and distribution of corals to be transplanted that will minimize impact.
- Identify biologically suitable recipient sites with appropriate substrate that may be ecologically appropriate to foster future growth of the corals.



Figure 3. Marine Survey Sectors

Two marine surveys were conducted in the affected Project area to identify and document marine biota. The first (MRC, 2012) occurred prior to a September 2013 molasses spill event (unrelated to the Project), the second survey was conducted after the spill event (AECOS 2014). The MRC survey report is retained for its general

observations concerning the harbor ecosystem, but only the AECOS dataset is used for quantification of the Project’s environmental baseline. The AECOS survey is attached to the EFH assessment report as Appendix B. The survey sectors used are shown in Figure 3. Sector A, the portion of sector from the Sand Island Bridge towards Keehi Lagoon, sector K, and sector L are outside the Project area. This coral transplantation plan is developed from the survey data collected after the molasses spill (AECOS 2014) and only from the sectors surveyed within the Project area.

3.2 Coral Survey Findings

Coral species, sizes, and quantities in the project area are presented in Table 2. These data include a total of 82,324 coral colonies representing five live species of corals found within the project site with a combined colony area of 275 square meters. About 30% (25,520/82,324) of the corals in the Project area were attached to artificial structures (concrete and sheet piles) and 70% (56,804/82,324) were affixed to hard substrate exposed at the base of piles and the edges of dredge slopes.

Project Area Only (B1, B2, B3, C1, C2, D, Epile, Eshore, F, Gshore, Gpile, H, Ishore, Ipile, J)									
Size class ->	1-5cm	6-10cm	11-20cm	21-40cm	41-80cm	81-160 cm	>160cm	Total #	Coral m^2
<i>Cyphastrea ocellina</i>	21	0	7	0	0	0	0	29	0
<i>Leptastrea</i>	32444	1560	13	0	0	0	0	34017	23
<i>Pavona varians</i>	23	15	8	0	8	0	0	53	2
<i>Porites compressa</i>	14	0	0	7	0	7	0	27	8
<i>Porites lobata</i>	32486	11064	3778	717	134	19	0	48198	241
Total Count	64988	12639	3806	724	141	26	0	82324	
Area m^2	32	55	67	51	40	29			275
			205			69			

Seafloor (B1, B2, B3, Eshore, Gshore, Ishore)									
Size class ->	1-5cm	6-10cm	11-20cm	21-40cm	41-80cm	81-160 cm	>160cm	Total #	Coral m^2
<i>Cyphastrea ocellina</i>	14	0	7	0	0	0	0	21	0
<i>Leptastrea</i>	13943	1059	13	0	0	0	0	15015	12
<i>Pavona varians</i>	0	0	0	0	0	0	0	0	0
<i>Porites compressa</i>	14	0	0	7	0	7	0	27	8
<i>Porites lobata</i>	28035	9609	3368	621	101	7	0	41741	196
Total Count	42006	10668	3389	628	101	13	0	56804	
Area m^2	20	47	60	44	28	15			216
			171			43			

Piles and Sheetpiles (C1, C2, D, Epile, F, Gpile, H, Ipile, J)									
Size class ->	1-5cm	6-10cm	11-20cm	21-40cm	41-80cm	81-160 cm	>160cm	Total #	Coral m^2
<i>Cyphastrea ocellina</i>	8	0	0	0	0	0	0	8	0
<i>Leptastrea</i>	18501	501	0	0	0	0	0	19002	11
<i>Pavona varians</i>	23	15	8	0	8	0	0	53	2
<i>Porites compressa</i>	0	0	0	0	0	0	0	0	0
<i>Porites lobata</i>	4451	1455	410	96	33	12	0	6457	46
Total Count	22982	1971	417	96	40	12	0	25520	
Area m^2	11	9	7	7	11	14			59
			34			25			

Table 2. Size and Area Distribution of Live Coral Species in Project Area

More than 99% of the corals within the Project area consist of only two common species (*Porites lobata* and *Leptastrea sp.*). *P. lobata* accounts for 58% (48,198 / 82,324) of the total coral colony count, but, most are generally less than 10 cm in diameter and

represent 88% (241m²/275m²) of total area of living corals. The combined distribution of all live coral species along the Project and adjacent shoreline is shown in Figure 4.

Sectors adjacent to but outside the Project area (A, B4, K, and L) were found to contain a greater population of corals (124,099) with similar size and species distribution to those found within the Project area.

Larger corals (greater than 40 cm. in diameter) have a higher ecological value than smaller corals. Their size provides greater habitat cover for fish and invertebrates, greater wave and current resistance, and produces more efficient spawning. Corals 5 to 20 cm in diameter provide limited structure, which in turn limits the amount of habitat provided to other organisms as well as the capacity of the coral to sustain the surrounding ecosystem or provide significant resilience capacity. Corals 1 to 5 cm. in diameter provide minimal ecosystem habitat provision, primary or secondary production, or ecosystem resilience capacity. For this coral transplantation effort, corals greater than 40 cm. in diameter will be targeted, as described below. This size criterion to identify corals to be transplanted effectively eliminates two species (*C. ocellina*, *Leptastrea* sp.) from consideration

The colony areas, by size class, of the two remaining species meeting the size criterion are shown in Table 3. These corals have a total geometrically calculated area of 69 square meters. Should some of the corals larger than 40 cm diameter not be acceptable for transplantation, then corals as small as 21 cm. in diameter may need to be selected to achieve transplantation of at least 25 percent (69/275) of the total Project area coral cover.

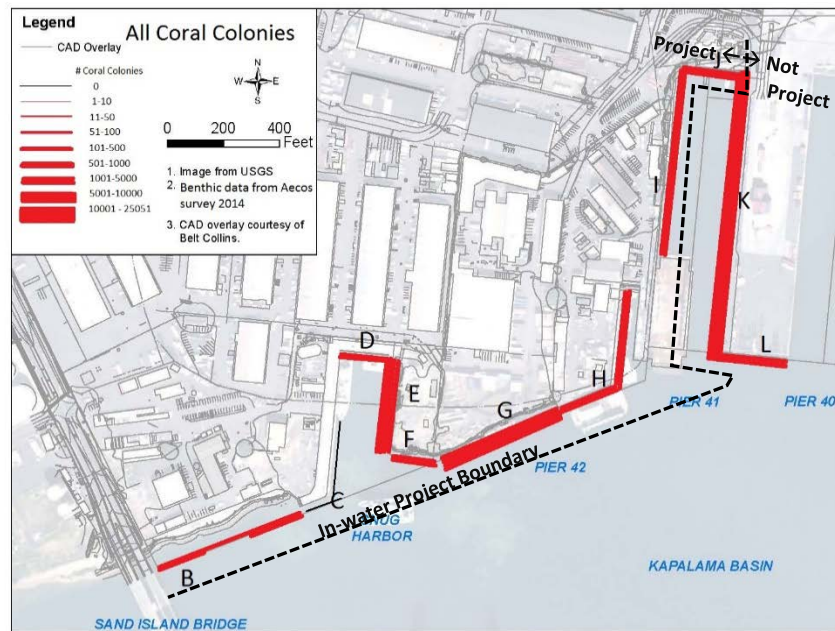


Figure 4. Distribution of all live coral Species across the existing Project site and adjacent Shoreline



Figure 5. Distribution of live corals >40 cm displayed as red lines within Project area.

Coral Species	Area (m ²) per Size Class		
	41-80 cm	81-160 cm	Total area
<i>Porites lobata</i>	37.7	21.4	59.1
<i>Porites compressa</i>	0	7.6	7.6
<i>Pavona varians</i>	2.1	0	2.1
Total Coral Colony Area	39.8	29.0	68.8
% Total (275 m ²) Coral Area	14.4%	10.6%	25.0%

Table 3. Colony area of Coral Species Selected for Transplanting

In early coordination meetings between DLNR-Division of Aquatic Resources (DLNR-DAR) and DOT-H, DLNR-DAR biologists recommended transplantation of corals >40 cm for the Project. The following reasons justify DLNR-DAR’s recommendations to support transplantation of large (>40 cm) colonies:

- Ecological value of larger corals: The larger size class (>40 cm) is selected because theoretically and historically, larger coral colonies have been assigned more ecological value in terms of habitat, rugosity, shelter and volume of food they may provide. Larger colonies have been found to be more fecund, and thereby, capable of producing more gametes and contributing more reproductively to the ecosystem than smaller colonies (Hall and Hughes, 1996; Babcock, 1991).
- Reduce Risk of Alien Invasive Species (AIS) Introduction: Biologists from DLNR-DAR have expressed concern that the corals within the Project Area could be contaminated with non-native, invasive species and/or chemical

pollutants due to their source from within the commercial harbor and based on prior surveys. The more colonies that are transplanted from this site (smaller colony size = more colonies transplanted), the higher the probability of introducing AIS to the recipient site. Therefore, limiting the number of coral colonies transplanted would reduce risk of introducing AIS to the recipient site. Divers can more accurately identify larger corals by their morphology and also more extensively assess presence of AIS attached to 167 large (>40 cm) colonies as opposed to >800 small (<40 cm) colonies.

- Suspected Non-Native Coral Species: Biologists from DLNR-DAR have expressed concern that the corals listed as *Porites lobata* in the 2014 AECOS survey are potentially an introduced or hybrid species, potentially only existing within Honolulu Harbor and introduced through ballast water or vessel hulls. This theory introduced the possibility that some of the corals described as *Porites lobata* may actually be an introduced *Porites* species, tentatively termed “Harbor *Porites*”. The “Harbor *Porites*” coral seems remarkably hardy; there are colonies that are of a certain size that suggest they may have survived the 2013 Matson molasses spill. Biologists at the DLNR-DAR coral nursery have observed “Harbor *Porites*” exhibiting monthly asexual reproduction, which is uncharacteristic for *Porites lobata*. DLNR-DAR consulted with three coral experts¹, who helped to discern this species from the species already present in Hawaii by examining morphological features and genetics. Genetic testing could not confirm that the “Harbor *Porites*” is *Porites lobata* (pacific) or *Porites compressa* (endemic) or related to the various other *Porites* spp. present in Hawaii. DLNR-DAR biologists have observed that this coral is present in certain areas but not present in other areas of Honolulu Harbor. The original populations of “Harbor *Porites*” discovered were located on the Makai side of the Sand Island Access Road Bridge by the fuel tanks, thus in close proximity to the proposed development area (“donor site”), which extends between Pier 43 at the base of the Sand Island Bridge and Kalihi Channel and Piers 41 and 40F. At this time, no *Porites* colonies within the development area have been re-surveyed to verify their species; these individual coral colonies need to be visually inspected to confirm they are actually *Porites lobata* and then the recipient site (Piers 5 and 6) needs to be re-surveyed to see if “Harbor *Porites*” is prevalent at the site. DLNR-DAR biologists express concern about transplantation of this “Harbor *Porites*” species to the recipient site if it is not already populated with this species (to minimize the potential spread of a non-native coral throughout the harbor).
- Long-Term Ecological Benefit: DLNR-DAR is in favor of supporting actions that offer high potential value and chance of success for long-term ecological gain. To achieve long term ecological benefits for Hawaii’s resources, DLNR-DAR biologists recommend focusing transplantation efforts on the larger (>40 cm) colonies, with low AIS risk, and utilizing additional offset

¹ Robert Richmond, Ph.D.; Douglas Fenner, Ph.D.; and Cynthia Hunter

measures (out-planting corals produced by DLNR-DAR's coral nursery and the control of invasive algae at the Waikiki MLCD (or other suitable locations) via urchin biocontrol), as described in the EFHA for this Project. DLNR-DAR believes that the combination of offset measure efforts are expected to provide greater ecological benefits to marine resources in Hawaii than relocating all corals colonies in the Project area to another site within the harbor.

3.3 Description of Corals to be transplanted

Coral species to be transplanted were selected only from the live species documented by the AECOS survey within the project area.

Porites lobata

Lobe coral (*Porites lobata*) is the most common and widespread coral in Hawaii and is also the most prevalent within the Project area, encompassing 58% (48198/82324) of the colony count and 88% (241/275) of the total coral area. Over 92% of the coral colonies in the Project area that are greater than 40 cm in diameter are Lobe coral. The growth form is most commonly massive but can be encrusting in high wave energy environments or plate-forming on steep calm slopes or concrete pilings. Lobe coral spawns from July to August two to three days after the full moon and has a moderate 11.4 millimeters (mm) per year growth rate.

Transplanting large lobe coral colonies can be relatively easy if they are not tightly attached to hard substrate. However, lobe corals that present a squamous morphology, adhering tightly to hard substrates, such as pier columns, can be very difficult to transplant.

Porites compressa

Finger coral (*Porites compressa*) is often the most common coral in low wave energy environments; it has a rapid growth rate (28 mm per year: Minton, 2013) but tends to be very fragile. Finger coral is not prevalent in the Project area (< 1% of corals), but a small number of observed colonies were larger than 40 cm in diameter. The upright morphology of this coral would be conducive to transplantation. Finger coral spawns from June through September on the new moon's first quarter.

The fragility of this species makes it difficult to transplant as a whole colony, but relatively easy to transplant as individual, but very small, branches.

Pavona varians

Corrugated coral (*Pavona varians*) grows in encrusting brown lumpy masses and receives its name from the curling ridges that make up the edges of the coral calices. This species is relatively common in shallow waters, often found where it is exposed to moderate to strong wave action in the holes or cracks between other corals. Colonies are typically small often encrusting and rarely larger than 60 cm in diameter. This coral

has a reported radial growth rate of 15.1 mm per year (Minton, 2013) and spawns in June during the full moon's third quarter.

Corrugated coral makes up less than 1% of the coral within the Project area; each of the eight colonies observed greater than 40 cm in diameter was located on pier piles or bulkheads. The encrusting morphology of this coral will not lend itself well to transplantation as a whole colony.

3.4 Coral Recipient Site Alternatives

Transplantation recipient sites for corals harvested from the Project area should satisfy multiple criteria including:

- Sites closer to the Project area are preferred to those more distant. Recipient sites within 1-mile of an impact site are generally considered to constitute "on-site" mitigation. More distant sites require more logistics in transportation and may result in greater mortality.
- The site selected to receive corals should remain undisturbed by development activity into the foreseeable future to promote growth and stabilization. It does not make sense to transplant corals to a site that might not be left intact for the future.
- Coral colonies in Honolulu Harbor likely support alien flora and fauna (AECOS, 2014). Minimizing contamination from source to any recipient site should be an important factor in recipient site selection.
- The water dynamics at the recipient site should be similar to the low surge, low energy regime under which the corals grew in the Project area.
- The water quality at the recipient site should equal or exceed the water quality at the Project area.
- The depth of water available at the recipient site should allow for a similar depth range as that of the Project area.
- Sufficient space should be available to provide an optimum separation between transplanted specimens to avoid detrimental interactions.

Site options for coral transplantation were limited by the ownership of the transplantation site, time and other conditions that may be required to obtain permission for transplantation, and the presence of invasive species at the harvesting site within Honolulu Harbor. The invasive species requirement limits the potential transplantation sites to those within the harbor. The sites discussed below generally meet the above criteria. Further biological evaluation is needed to determine whether the sites have appropriate water quality, acceptable levels of wave action, and have sufficient space. Other than a general knowledge of site conditions and casual underwater observations, the sites have not been analyzed for substrate suitability, stability or invasive species characterization.

Two candidate recipient sites are identified to receive corals from the Project area. The sites are located within Honolulu Harbor and are located along the Sand Island shoreline adjacent to the Anuenue Fisheries Research Center (AFRC) and the Sand Island State Recreation Area Park, and along the small public park fronting the Pier 5

and 6 between the Coast Guard station and the Maritime Museum off of Nimitz Highway.

AFRC Revetment

The AFRC recipient site consists of approximately 1,000 feet of shoreline, extending from the AFRC to the shoreline observation deck located in the Sand Island State Recreation Area (Figure 6). This revetment is outside of the Federal project line and might not be impacted by future dredging activities. The revetment is a USACE designed structure and would therefore require a Section 408 permit to authorize the addition of coral to the structure. The smooth surface and basaltic nature of these boulders are not conducive to larval settlement, but once established, corals along this shoreline appear to grow well. The proximity of the recipient site to the State's coral culture laboratory at the AFRC should simplify the post-transplantation monitoring at this site. A marine biota census and detailed investigation of this 1,000-foot shoreline will need to be conducted prior to transplanting any corals. USACE Section 408 permitting process will have to be completed before transplanting is implemented. In addition, input from the USACE (civil) branch should be obtained for use of this site for coral transplanting.

Pier 5-6 Area

The Pier 5 - 6 area is similarly located within Honolulu Harbor and outside the Federal project line (Figure 6). The sizes of revetment rocks along the slope are smaller than those located along the Anuenue revetment, but do support the growth of corals as observed during casual in-water observation. No preliminary survey has yet been conducted at this site. A marine biota census and detailed investigation of this shoreline will need to be conducted prior to transplanting any corals.

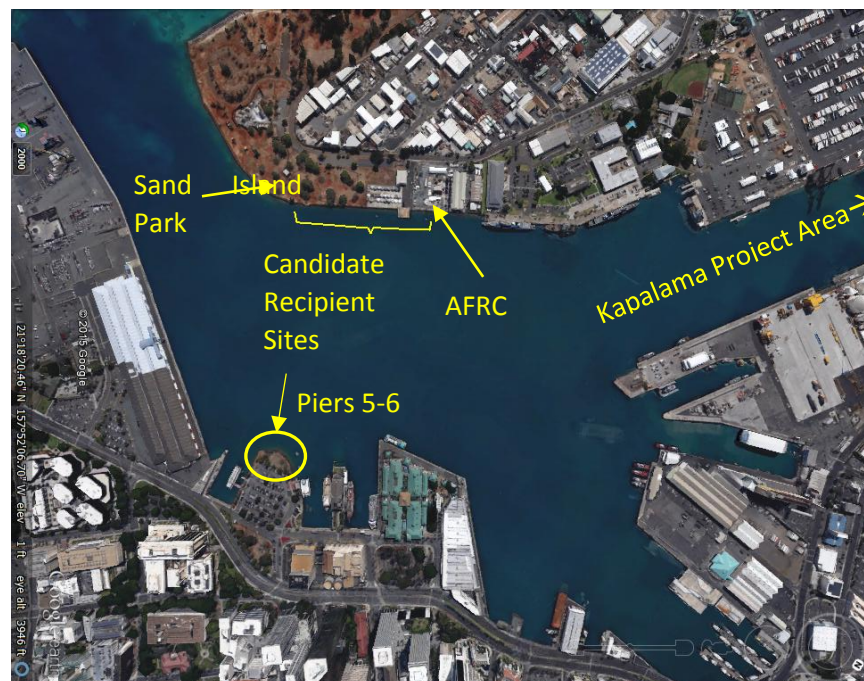


Figure 6. Candidate Coral Recipient Sites in Honolulu Harbor

4. PHASE II: TRANSPLANTATION PLAN

Phase II of the Plan includes:

- Identify the coral harvesting schedule relative to the construction schedule.
- Describe the method of field identification of corals, cleaning and temporary storage of specimens.
- Describe methods and conditions for transportation to the recipient site.
- Describe the method of preparing the recipient site, spacing between corals, and method of affixing the corals to the recipient site substrate.

4.1 Timeframe for Harvesting

Corals will not be transplanted during the coral breeding season of *P. lobata* (July through August) or the preceding month. Corals will not be transplanted if the temperature of the harbor surface water exceeds 28 degrees Celsius or if the salinity of the water at the surface is lower than 27 parts per thousand. Suitable time windows for coral harvesting would be available from March to June.

Coral will be harvested and removed from the Project area before beginning any work that may impact them. Preparations at the recipient site should be complete before harvesting begins. The coral transplantation activity will be included in the master construction schedule to ensure the above requirements are met.

4.2 Coral Selection and Harvesting

All corals with a diameter greater than 40 cm will be considered for transplantation. About 84% of these corals will be *P. lobata*, which has a tendency to form encrusting colonies in some locations and may make intact colony removal impracticable. In the event that removal of the coral results in a colony less than 10 cm in diameter or with less than 10% living coral tissue, the coral colony may be discarded. Criteria for selection of donor corals for transplantation include:

- Living tissue portion of coral colony is greater than 10 cm diameter.
- Living coral tissue covers at least 25% of transplanted substrate area.
- Coral appears to be in a generally healthy condition.
- Coral base that allows it to be fixed to a ceramic or aragonite plug transplant button or otherwise firmly attached at the recipient site.

Methods to harvest corals vary with the species and size of each individual coral specimen, as well as with the type of substrate. Corals must be carefully removed, handled, and cleaned to minimize damage and to maximize the number of larger diameter corals transplanted. All corals should be measured, photographed and tagged to document suitability and health of the harvested specimens.

- Corals targeted for transplantation will be identified by affixing a uniquely numbered tag, color coded to depth strata.
- Prior to the removal of the coral, the species, size, percent live coral, and depth (+/- 1 foot) of the tagged coral will be recorded.

- The color code on the tag will indicate the depth strata (shallow, <5 feet; mid, 5–15 feet; or deep, > 15 feet) from which the coral was removed.
- Chisels, putty knives, and flat-blade pry bars in combination with hammers are useful tools that may be used to loosen the coral from its substrate.

Corals with flattened or irregular morphologies adhered to artificial substrate (pier columns, sheet piles) are likely to fragment. All fragments from a single colony will be combined in a single container to maintain their identity as coming from the same colony. Such fragments would be appropriate for planting in a set of closely spaced plug holes or onto a single concrete pad. Where the damaged faces of broken coral meet live coral tissue, the exposed boundary will be sealed with marine epoxy.

Immediately after harvesting, each coral specimen will be transferred to a cage kept at a depth of 10 feet below the surface and shaded from direct sunlight. A diver in the holding cage will be responsible for cleaning, preparing and documenting the specimens for transplantation. The diver will use a pressurized seawater hose to remove invasive species and other unwanted invertebrates and macro-algae from the coral specimens.

As the coral is placed into the cage, a ceramic or aragonite plug (button) will be affixed to the underside of the coral with marine epoxy. Sometimes, when a colony is removed from the substrate, it brings with it a piece of the substrate where it was attached. Where colonies remain attached to substrate that is small enough, (less than about three times the mass of the living coral) the coral harvested with the substrate will be transplanted along with the coral and both will be subject to cleaning. Each numbered coral will be photographed on a scaled background to record its size and general health characteristics.

4.3 Preparation of Recipient Site

Approximately 167 coral specimens will be harvested for transplanting. The recipient site will be surveyed for sufficient space, appropriate substrate, and required depth. Preparation of the recipient site will be completed prior to coral removal and transportation. A bathymetric survey of the recipient site will be conducted with as much detail as necessary to map the location, substrate type, and depth. The location, depth, species, and size of each existing coral within the recipient area will be recorded. Survey resolution should be sufficient to identify shallow, mid, and deep strata (0–5 feet, 5–15 feet, and greater than 15 feet MLLW). An area sufficient in size to support approximately 167 coral specimens or 69 sq. m., whichever is greater, will be identified.

Surface preparation is dependent upon substrate type. Boulders or hard pavement at the recipient site should be marked and pre-drilled with a total of 167 holes ($\frac{1}{2}$ " diameter, $\frac{3}{4}$ " depth, to match the plug size) on the upper and side faces of surfaces. The holes will not be drilled on overhangs or back-slopes within 1 foot of an existing coral head or within 1 foot of another recipient hole. The recipient holes will be used to insert pre-numbered yellow plastic marker plugs and fired ceramic or aragonite mushroom plugs to which the transplanted corals will be adhered. The location and depth of each hole will be mapped and numbered according to the marker plug number.

Immediately prior to affixing the transplanted corals, the plastic marker plugs will be removed and an area around each hole equal to the area of the coral to be transplanted will be scrubbed down to bare rock with a stainless steel wire brush to clear away algae and invertebrates. Where drillable hard substrate is not available, the corals should be embedded in small concrete pads to maintain stability within shallow holes or cracks on the benthic substrate.

Fast-setting marine concrete will be mixed on the support vessel and transferred down to the recipient site in a plastic bag, from which the concrete can be squeezed into the pre-cleaned hole or crack. Only one coral species (preferably one colony or fragments derived from a single colony) should be planted within each pad to avoid allelopathic effects.

4.4 Coral Specimen Holding and Transportation

Harvested coral specimens will be transplanted to the recipient site on the same day they are harvested. The specimens can be transported to the recipient site in two ways. They may be 1) transferred while in the holding cage at the desired water depth or, 2) transferred in air on the deck of the support boat while keeping them completely shaded and in a wetted condition until they are returned to the water. Care should be taken to move the support boat slowly (less than one knot) to prevent damage to corals from excessive currents when transferred within the submerged cage. The support boat should be sufficiently stable to prevent excessive sloshing in the transport vessel if the corals are transferred out of water. Considering the short distance from the harvesting site to each of the potential recipient sites, underwater transfer is recommended in this case.

4.5 Coral Transplant Attachment

The support vessel will be anchored at the designated recipient site, with the tagged corals held in a shaded cage suspended beneath the boat. Divers will transfer corals to the depth zone corresponding to the color-coded tag (affixed according to depth at the harvest site) and locate one of the pre-drilled recipient holes. The area around the recipient hole will be scrubbed with a wire brush over an area equal to the size of the coral to be transplanted and the numbered yellow plug marking the hole will be removed. Pre-mixed marine epoxy will be used to permanently affix the stem of the ceramic or aragonite plug into the hole. It will not be necessary to hold the coral while waiting for the epoxy to cure. Some corals will either be too large or be affixed to existing substrate that is too unwieldy to allow them to be positioned on the new substrate with ceramic plugs. In these instances, colonies will be secured with epoxy, underwater concrete, or otherwise fastened to prevent their movement during periods of large waves or swells.

As each tagged coral is removed from the transfer cage, the coral's designation will be checked off on the underwater data sheet. Upon returning to the cage following transplantation, the diver will record the number of the corresponding yellow recipient-

hole tag. In this manner, the precise location of the donor site and recipient site will be logged for each transplanted coral.

4.6 Transplant Reporting and Success Criteria

A report detailing the coral harvesting and transplantation activities will be produced within one month following completion of the transplant effort. The report will include a map and support documentation indicating the location, species, size, general health and a photograph of each transplanted coral at the recipient site. This transplant report will serve to document baseline conditions immediately following transplantation, achievement of the success criteria and act as the baseline for future monitoring at 6-months, 1-year, 2-years, and 4-years.

The two key success criteria for the coral transplantation are to:

- Remove all corals larger than 40 cm from the Project site;
- Transplant 69 square meters of live coral to the recipient sites.

5. PHASE III: POST-TRANSPLANTATION MONITORING

Phase III of the coral transplantation plan includes:

- Describe the post-transplantation monitoring method
- Define long-term success criteria and reporting requirements.

5.1 Control Corals

Both mortality and growth are anticipated among the 167 corals to be transplanted. To distinguish between natural mortality versus mortality caused by transplantation, it is necessary to have control populations for comparison. Coral populations near the Project area and at the recipient site may be used as controls to identify natural variations in coral growth and mortality at these sites.

Control sites at the harvesting and transplanting site should be established to monitor mortality of existing and transplanted corals.

Corals growing along five randomly selected vertical transects on the existing sheet pile wall at Pier 40 which is adjacent to, but outside of the Project area, will serve as the control group adjacent to the Project area. A census and complete photographic record of corals and all fouling community organisms on these transect locations will be conducted. Both the minimum and maximum diameter of each living coral colony greater than 5 cm in diameter will be recorded as the percent of live coral tissue within each colony. This survey will be conducted immediately prior to the harvesting of corals for transplantation and will also serve as the location for subsequent post-transplantation control surveys.

Corals growing at or near the recipient site will be used as a second set of controls. Between 30 and 40 corals native to the recipient site will be selected to represent a cross-section of the two or three most common species present over the range of their

sizes at the recipient site. The locations, size, depth, and percent live coral tissue of these corals will be documented when the site is first surveyed prior to coral transplantation. These corals will be similarly tagged and monitored in association with each subsequent coral survey of the recipient site.

5.2 Transplanted Corals

Each transplanted coral will have a unique identification tag. The large majority of transplanted corals will be *Porites lobata*. Each coral will be photographed and the size and percent live coral tissue assessed and recorded.

5.3 Post Transplantation Monitoring Schedule

Monitoring of the recipient site and the Pier 40 control site, and recipient control site will be conducted after transplantation is completed and upon elapse of the following periods: 1 month; 6 months; 1 year; 2 years; and 4 years. This monitoring schedule is consistent with other coral transplant projects in Hawaii.

5.4 Post Transplantation Monitoring Methodology

Post-transplantation monitoring will consist of the following components:

- Photographs of each numbered coral with measurements, geometric calculated area, and percent live coral estimates.
- A scaled bathymetry map will show the location of each transplanted coral, with photographs of each of the transplanted corals, and each of the 30 control corals at the recipient site.
- Coral census and complete photographs of each of the control corals in 5 randomly selected transects at Pier 40.
- Any deviations from the transplant methods and recommendations for future efforts.

In the event that a transplanted coral selected for monitoring is physically lost or suffers 100% mortality, another coral of the same species and size will be selected from the same depth stratum as a substitute for continued monitoring.

5.5 Success Criteria

The results of each of the surveys will be applied to compare the number and area of transplanted corals to the control coral populations at Pier 40 and the recipient site. The following criteria will be used to determine the likelihood of long term coral growth:

- 70% transplanted coral colony viability (% coral colonies alive) for 1 year, OR
- Survival statistically equal to or greater than the control coral populations at either control site

5.6 Reporting Criteria

Following the initial transplantation and each monitoring event, survey information will be compiled and interpreted in a report within 30 calendar days of the last day of monitoring. Ten copies of the report (plus two electronic copies on CD and in Adobe PDF) will be submitted to the State of Hawaii Department of Transportation, Harbors

Division (DOT-HARBORS) who will then submit the report to the USACE Regulatory Branch for review and determination of compliance. Each report will summarize the coral transplantation effort and conditions at the control sites and will contain photographs of all the monitored corals and a map showing the location of each transplanted and monitored coral. At a minimum, each report will include:

- Photographs of each numbered coral with measurements, geometric calculated area, and percent live coral estimates.
- A scaled bathymetry map noting the location of each transplanted coral, with photographs of each of the transplanted corals and (30 to 40) of the control corals at the recipient site.
- Coral census and complete photographs of each of the 5 selected control locations at Pier 40.
- Any deviations from the transplant methods and recommendations for future efforts.

The report will highlight comparisons between the transplanted corals and the control coral populations at Pier 40 and at the recipient site to determine whether the success criterion has been met.

6. IMPLEMENTATION AND MANAGEMENT

The corals being transplanted to either of the two sites within the harbor are to remain in the area of control and under the auspices of DOT-Harbors and remain their responsibility. The transplanted area should be managed to satisfy requirements of USACE, EPA, USFWS, Division of Aquatic Resources, State of Hawaii and other relevant regulatory agencies.

7. REFERENCES

- AECOS. 2011, Lahaina Small Boat Harbor Ferry Terminal Improvements Compensatory Mitigation Plan for Impacts to Waters of the U.S., AECOS Report No. 1045F. Provided by State of Hawaii Division of Boating and Ocean Recreation.
- AECOS. 2012, (March) Kaunakakai Ferry System Improvements Coral Transplantation Plan, AECOS Report No. 1211B. Provided by State of Hawaii Division of Boating and Ocean Recreation.
- AECOS. 2013, (August) Kawaihae Small Boat Harbor Phase I Improvements Coral Transplantation Implementation Plan, AECOS Report No. 1182D. Provided by State of Hawaii Division of Boating and Recreation.
- AECOS. 2013, (February) Maalaea Small Boat Harbor Ferry Pier Coral Transplantation Plan, AECOS Report No. 1080D. Provided by State of Hawaii Division of Boating and Recreation.
- AECOS. 2013, (June) Manele Small Boat Harbor Coral Transplantation Plan, AECOS report No. 1353. Provided by State of Hawaii Division of Boating and Recreation.
- AECOS. 2014, Baseline Assessment for Kapalama Container Terminal Improvements. AECOS Report No. 1354B.
- Bentivoglio, A. 2003, Compensatory mitigation for Coral Reef Impacts in the Pacific Islands. U.S. Fish and Wildlife Service, Honolulu, Hawaii URL: <http://www.coralreef.gov/mitigation/pacmit.pdf>
- Birkeland, C., Randall, R.H., and Grimm, G., 1979 Three Methods of Coral Transplantation for the Purpose of Reestablishing a Coral Community in the Thermal Effluent Area at the Tanguisson Power Plant. University of Guam Marine Lab Technical Report No. 60, 1979.
- Calfo, A. 2007, Book of Coral Propagation. Reef Gardening for Aquarists. (6th edition) 400 pp Reading Trees Publication.
- Carlson, B. 1978 Director of Waikiki Aquarium. Personal Communication. First culture of corals in Public Aquaria occurred at Waikiki Aquarium in 1978.
- Coral Reef Magazine 1999 (in German), 2006 (First edition in English), The Reef Marine Aquarium Magazine. <http://www.coralmagazine.com/about-us.html>
- Edwards, A.J., and S. Clark, 1999, Coral Transplantation: A Useful Management Tool or Misguided Meddling? Mar. Pol. Bull. 1999, 474.
- Edwards, A.J. (ed.) 2010, Reef Rehabilitation Manual. Coral Reef Targeted Research & Capacity Building for Management Program: St. Lucia, Australia.

- Gorman, John. 2015, Personal communication. Curator at the Maui Ocean Aquarium. Responsible for implementation of coral transplantation for DOBOR Lahaina, Maalaea, Manele Bay, coral transplantation projects.
- Kai Tak, 2009, Site formation for Kai Tak Cruise Terminal Development Detailed Coral Translocation Plan. Available at:
<http://www.epd.gov.hk/eia/register/english/permit/ep3282009/documents/ctp/pdf/ctp.pdf>
- Maui Ocean Center, 2014, Kaunakakai Harbor Coral Transplantation Follow-Up report. Dec. 7.
- Maui Ocean Center, 2013, Lahaina Small Boat Harbor Coral Transplantation and Monitoring.
- Maui Ocean Center, 2014, Manele Small Boat Harbor Coral Transplantation Follow-Up Report July 21.
- Maui Ocean Center, 2015, Kailua-Kona Wharf Coral Transplantation Follow-Up Report February 24.
- Maui Ocean Center, 2015, Keauhou Small Boat Harbor Coral Transplantation Follow-Up Report February 24.
- Nedimyer, K., M.E. Johnson, C. Lusic, E. Bartels, I.B. Baums, D.S. Gilliam, L. Larson, D. Lirman, M.W. Miller, and S. Schopmeyer, 2012, Best Practices for Propagation and Population Enhancement Caribbean Acropora Restoration Guide. Available at: <http://rjd.miami.edu/wp-content/uploads/2013/09/Johnson-2011-Acropora-Restoration-Guide.pdf>
- NOAA, 2015, Personal communication with Matthew Parry, mitigation specialist. 808 724 4092
- Maragos, J.E., 1974, Coral transplantation, a method to create, preserve and manage coral reefs. University of Hawaii Sea Grant Publication UNIH SEAGRANT AR-74-03
- MRC, 2012, (Marine Research Consultants) Essential Fish Habitat Consultation: Waterfront Operations Facility Boat Ramp Replacement Marine Corps Base, Hawaii. In: USACE Public Notice January 17, 2013. File No. POH-2013-00138 Available at: <http://www.poh.usace.army.mil/Portals/10/docs/publicnotices/POH-2013-00138.pdf>
- NOAA; Vargas-Angel, personal communication. 2015, Dr. Vargas-Angel provided data summaries of the NOAA Main Hawaiian Islands hard bottom benthic survey results.
- Neilsen, A. J., and S. A. Fossa, 1991, Korallenriff Aquarium Book 1.

- Precht, W.F. (editor), 2006, Coral Reef Restoration Handbook. CRC Press, Boca Raton 363 pp.
- Sathe, M., S.E. Thanner, and S.M. Blair, 2012, Bal harbor Mitigation Artificial Reef Monitoring Program Year 12. Miami-Dade County Permitting, Environment and Regulatory Affairs.
- Western Pacific Regional Fishery Management Council, 2001. *Final Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region*. Available online at URL: <http://www.wpcouncil.org/wp-content/uploads/2013/03/COMPLETE-CRE-FMP-CD.pdf>
- _____. 2009a. *Fishery Ecosystem Plan for the Hawaii Archipelago*. Honolulu, HI: N.P., 2009. Available online at URL: [http://www.wpcouncil.org/fep/WPRFMC%20Hawaii%20FEP%20\(2009-09-21\).pdf](http://www.wpcouncil.org/fep/WPRFMC%20Hawaii%20FEP%20(2009-09-21).pdf).
- Ulrich, A.B. 2015, How to Frag Corals. A Simple Guide to Coral Propagation and Coral Fraggling. 211 pp. Also available as a Kindle Book file.