State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Honolulu, Hawaii 96813

October 26, 2018

Board of Land and Natural Resources
State of Hawaii
Honolulu, Hawaii

REQUEST FOR APPROVAL TO ENTER INTO A MEMORANDUM OF AGREEMENT BETWEEN THE STATE OF HAWAII, BOARD OF LAND AND NATURAL RESOURCES AND THE STATE OF HAWAII, DEPARTMENT OF TRANSPORTATION REGARDING THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING, HONOLULU HARBOR, OAHU, HAWAII (JOB H.C. 10498) AND THE PROPOSED MINIMIZATION AND OFFSET MEASURES DESIGNED TO MINIMIZE OR OFFSET THE TOTAL LOSSES TO AQUATIC RESOURCES

Submitted for your consideration and approval is a request to enter into a Memorandum of Agreement Between the State of Hawaii, Board of Land and Natural Resources (or "BLNR") and the State of Hawaii, Department of Transportation (or "DOT"), which oversees its Harbors Division (or "HAR"), regarding the New Kapalama Container Terminal Wharf and Dredging, Honolulu Harbor, Oahu, Hawaii (Job H.C. 10498) and the proposed minimization and offset measures designed to minimize or offset the total losses to natural hard substrate (live rock), fouling community (marine invertebrates) on natural hard substrate, and stony coral, that will occur as a result of the development.

Background

A large volume 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.

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.

DOT proposes to develop the Kapalama Container Terminal ("KCT"), through the demolishment and removal of existing shoreline facilities; the installation of 972 meters (3,190 feet) of sheet/king pile along the newly constructed shoreline; the removal of 319,740 cubic meters (417,900 cubic yards) of material to accommodate cargo vessels along the new docks; the enclosing and filling of Snug Harbor, the Rail Slip and Pier 40F to create 10,077 square meters (2.49 acres) of fast lands; the placement of 757 cubic meters (990 cubic yards) of rock at the west end of Pier 43 and adjacent to the Sand Island Bridge for shore protection; and the disposal of approximately 151,700 cubic meters (198,400 cubic yards) of dredged material to the South Oahu Offshore Dredged Material Disposal Site.

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. Location Map, Page 11 of Board Submittal, Item F-1; also in Exhibit 2, Appendix B, Page 4). 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. Project Waters, Page 12 of Board Submittal, Item F-1; also in Exhibit 2, Appendix B, Page 5). 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. (Figure 2. Project Waters, Page 12 of Board Submittal, Item F-1; also in Exhibit 2, Appendix B, Page 5). 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. Project Waters, Page 12 of Board Submittal, Item F-1; also in Exhibit 2, Appendix B, Page 5).

The KCT development will result in the following short and long-term loss of natural hard substrate (live rock), fouling community (marine invertebrates) on natural hard substrate, and stony coral associated with these habitats:

1. Long term loss of 305 meters (1,000 feet) of shoreline and 5,710 square meters (m^2) (1.4 acres) of natural hard substrate;

2. Short term loss of 11,844 square meters (m^2) (2.9 acres) of fouling community on hard substrate;

3. Long-term loss of stony corals less than 40 cm diameter (<40 cm diameter; ≈ 56,698)

(Figure 3. Amount, Size and Species of Corals to be impacted by KCT development project, Page 13 of Board Submittal, Item F-1; similar table in Exhibit 2, Appendix B, Page 10, and Figure 4. Distribution of all live Coral Species across the existing Project Site and adjacent Shoreline, Page 13 of Board Submittal, Item F-1; also in Exhibit 2, Appendix B, Page 11).

Proposed Management Measures

Natural hard substrate, coral and other marine invertebrates associated with these habitats are part of the unique aquatic ecosystems that the Department of Land and Natural Resources (or "DLNR") Division of Aquatic Resources ("DAR") of the State of Hawaii is tasked with managing, conserving and restoring. The following minimization and offset measure projects are designed to minimize or offset the total losses to natural hard substrate, fouling community on hard substrate and coral as listed above, and have been proposed and agreed upon between the DAR and DOT (Figure 5. Minimization and Offset Measures proposed to offset the total losses to natural hard substrate, fouling community on hard substrate and coral, Page 14 of Board Submittal, Item F-1; complete details in Exhibit 2, Appendices B, C, E):

1) **The long-term loss of 305 meters (m) (1,000 feet [ft.]) of shoreline** and 5,710 square meters (m^2) (1.4 acres) of natural hard substrate.

   Minimization or offset measure projects: DAR **Urchin Hatchery and Monitoring**: Urchin production and out-planting in Waikiki MLCD to generate natural hard substrate on invasive algae-covered reefs and monitoring to document the results of this out-planting.

2) **The short-term loss of the 11,844 square meters (m^2) (2.9-acre) of fouling community** on hard substrate at the project site.

   Minimization or offset measure projects: DAR **Urchin Hatchery and Monitoring**: Urchin production and out-planting to generate natural hard substrate with successional colonization of native invertebrates and algae (fouling community) on invasive algae-covered reefs and monitoring to document the results of this out-planting.

3) **The 7-year loss of the 56,690 corals that are less than 40 cm in diameter** from the project area seafloor (on natural substrate; i.e., corals that are not on piles-artificial substrate).

   Minimization or offset measure projects: DAR **Coral Nursery and Monitoring**: Coral colony production and out-planting at nexus sites to generate the replacement for the loss of corals and monitoring to document the results of this out-planting.

Note: The total amount of coral colonies on the project area sea floor (natural substrate) to be impacted by the KCT development is 56,805 colonies. All stony coral colonies greater than 40 cm diameter (>40cm) will be transplanted by DOT through a contractor as a minimization measure. This is approximately (≈)115 coral colonies. This is described under section A) Minimization Measure 1 - Coral Transplantation (below) and the Coral Transplantation Plan in Appendix B. The transplantation effort is not work being conducted by DAR but is a minimization action for which DAR has provided biological consultation, and requested certain criteria to be met, and is therefore included in the MOA to be comprehensive. The loss of the remainder of the stony coral colonies which are less than 40 cm in diameter (<40cm) will be minimized or offset by the production, out-planting and monitoring of a select number of coral colonies that have been determined to be equal to the ecological services and function values of the coral colonies lost from the KCT Project area, through the use of the DAR Coral Tool used to calculate the Hawaiian Coral Ecological Characterization Value (ECV). This is described under section Minimization Measure 2 – Support for Coral Nursery Program to Minimize the Long-Term loss of Corals Less than 40cm.

The reason there is not an effort to transplant the coral colonies outside Honolulu harbor or the total amount (56,805) of impacted coral colonies is because of various biological advantages or disadvantages including the following: a) concerns about the risk of introduction or transportation of Aquatic Invasive Species (AIS) inside and outside the Harbor, b) the anticipated success rate of the transplantation effort, c) the amount of suitable habitat (including the biological capacity of the site) and the associated risk for future development at the site (i.e. potential future impact to transplanted coral colonies), d) the ecological value of larger corals and e) the long-term ecological benefit of the minimization or offset efforts to be implanted by DAR.

See the Appendices B-F **(Partial EFH Assessment)** at end of the board submittal for comprehensive details for the Kapalama Container Terminal Wharf and Dredging Project Coral Transplantation Plan (from EFH Assessment), Urchin Hatchery/Monitoring Project and Coral Nursery/Monitoring Project scopes of work (from EFH Assessment) and rationale for reduced scope of coral transplantation efforts. **Appendix A: Complete EFH Assessment; available by PDF on CD** or paper (if requested); 227 pages.

Below is a synopsis of the minimization and offset measure projects which are designed to minimize or offset the total losses to natural hard substrate, fouling community on hard substrate and stony coral as listed above, and have been proposed and agreed upon between DAR and DOT:

A) Minimization Measure 1 - Coral Transplantation. As described in the Essential Fish Habitat Assessment ("EFHA") as well as in the "Kapalama Container Terminal Wharf and Dredging Project (H.C. 10498) Coral Transplantation Plan" revised July 2017 (or "CTP"), incorporated into this Agreement by reference and attached as Appendix B, and conditional upon the issuance of DA Permit to DOT from the USACOE, DOT shall harvest a total area of coral equivalent to 69 square meters (≈ 115 coral colonies), favoring corals greater than 40 centimeters in diameter from the KCT Project area, and transplant them to Piers 5 and 6, in Honolulu Harbor.

B) Offset 1 - Urchin Hatchery, Removal of Invasive Algae from Reefs and Monitoring. As described in the EFHA, to offset for the long-term loss of 305 meters (1,000 feet) of shoreline, and 5,710 square meters (1.4 acres) of natural hard substrate from the KCT Project, DOT will provide financial support to the DLNR-DAR Sea Urchin Hatchery Program and the Reef Restoration Field Team at the DLNR-DAR Anuenue Fisheries Research Center facility at Sand Island (or "AFRC"). Production, release, augmentation, and monitoring of urchins to the candidate reef site is intended to facilitate the removal of nuisance and invasive algae on a cumulative area of 1.4 acres of reef, thereby restoring area of natural hard marine substrate equal to that lost due to the KCT Project.

Offset 1 funding will support the sea urchin hatchery program at AFRC and the release of sea urchins to a candidate reef site, such as the Waikiki Marine Life Conservation District (or "MLCD"), the Waikiki-Diamond Head Shoreline Fisheries Management Area ("FMA") or other location agreed to by the Parties, and the subsequent monitoring of the site, all as described in the final "Waikīkī Reef Restoration using Sea Urchin Biocontrol to Control Invasive Algae, Scope of Work", revised November/December 2017 (or the "DAR Urchin Biocontrol Plan"), and the accompanying "Kapalama Offset Measures Scope of Work Modifications" dated December 2017 (or the "DAR Scope of Work Modifications"), both prepared by DAR and incorporated into this Agreement by reference and attached as Appendices.

DAR will collect, spawn and rear sea urchins at AFRC, and release them at the MLCD, the FMA or other location agreed to by the Parties, as described in the DAR

Urchin Biocontrol Plan, as well as in the DAR Scope of Work Modifications. DAR will release a minimum of 33, 993 sea urchins over a period of thirty (30) months, for Offset 1, to reduce invasive algae coverage to 5% or less, by area, over the cumulative 1.4 acres of reef applicable to Offset 1. DAR will conduct a baseline survey of the release site prior to the first urchin out-planting or before the release of the first cohort of sea urchins. Monitoring of the sea urchins, at the release site, will be conducted by DAR for a minimum of eight years bi-annually (i.e. two times annually), or a minimum of five years after the last out-planting of sea urchins is completed, whichever is longer, to map invasive algae trends. The first monitoring survey will be conducted concurrently with the release of the first cohort of sea urchins.

C) Offset 2 – Urchin Hatchery, Removal of Invasive Algae from Reefs and Monitoring. As described in the EFHA, to offset for the short-term loss of 11,844 square meters (or 2.9 acre) of fouling community resulting from the dredging to be performed under the KCT Project, DOT will provide financial support for the DLNR-DAR Sea Urchin Hatchery Program and Reef Restoration Field Team at the DLNR-DAR AFRC. Production, release, augmentation and monitoring of urchins at the candidate reef site is intended to remove invasive algae and expose hard substrate, which will facilitate the recolonization of native algae, coral and non-invertebrates on a cumulative area of 2.9 acres of reef, thereby facilitating the restoration of an area of native fouling community equal to that lost due to the KCT Project.

Offset 2 funding will support the sea urchin hatchery program at AFRC, the release of sea urchins to a candidate reef site, such as the MLCD, the FMA or other location agreed to by the Parties and the subsequent monitoring of the site, all as described in the DAR Urchin Biocontrol Plan and the DAR Scope of Work Modifications.

DAR will collect, spawn and rear sea urchins at AFRC, and release them at the MLCD the FMA, or other location agreed to by the Parties, as described in the DAR Urchin Biocontrol Plan, as well as in the DAR Scope of Work Modifications. DAR will release a minimum of 70, 413 sea urchins over a period of thirty (30) months, for Offset 2, as well as for Offset 1 described above, to reduce invasive algae coverage to 5% or less, by area, over the cumulative 2.9 acres of reef applicable to Offset 2. DAR will conduct a baseline survey of the release site prior to the first urchin out-planting or before the release of the first cohort of sea urchins. Monitoring of the sea urchins, at the release site, will be conducted by DAR for a minimum of eight years bi-annually (i.e. two times annually), or a minimum of five years after the last out-planting of sea urchins is completed, whichever is longer, to map invasive algae trends. The first monitoring survey will be conducted concurrently with the release of the first cohort of sea urchins.

D) Minimization Measure 2 – Support for Coral Nursery Program to Minimize the Long-Term loss of Corals Less than 40cm: As described in the EFHA, to minimize the long-term loss of 56,690 corals smaller than 40 centimeters in size from the KCT Project area seafloor, and not affixed to man-made substrates, due to the dredging to be performed under the KCT Project, DOT shall provide financial support for the DLNR-

DAR "Coral Restoration Nursery" at AFRC. Expansion of the existing Coral Restoration Nursery facilities at AFRC, collection of corals, coral husbandry to grow the collected corals to a suitable out-plant size, subsequent out-planting of the grown-out corals to the original donor site as well as to appropriate new out-plant sites selected by DLNR-DAR, and monitoring of the out-planted corals, will work to replace a select amount of coral colonies that have been determined to be equal to the ecological services and function values of the coral colonies lost from the KCT Project area, through the use of the DLNR-DAR Coral Tool used to calculate the Hawaiian Coral Ecological Characterization Value (ECV).

DAR will collect corals from the KCT Project site, as well as from donor sites, quarantine, grow, hold, and acclimate the collected corals at AFRC, and out-plant them at MLCD, or other location selected by DAR, as described in the DAR Coral Nursery Plan, and the DAR Scope of Work Modifications. DAR will outplant up to 475 coral colonies, as apportioned by sizes and species indicated in the DAR Coral Nursery Plan, and the DAR Scope of Work Modifications, at the out-plant site(s) selected by DAR, over a period of three and a half (3.5) years for Minimization Measure 2, inclusive of the 17-month period after DAR's receipt of funding from DOT to support Minimization Measure 2 until it outplants the first coral colonies. DAR will conduct a baseline survey of the out-plant site prior to out-planting of coral at the site. DAR will monitor the out-planted corals, at the out-plant site(s) for a minimum of five (5) years after the last out-planting of corals is completed at the site, to monitor the progress of the out-planted corals and document changes in benthic cover due to the out-planting of the new coral as detailed in the DAR Coral Nursery Plan, the DAR Scope of Work Modifications, as well as the DAR Urchin Biocontrol Plan.

The number of coral colonies to be out-planted by DAR from its Coral Restoration Nursery under Minimization Measure 2 will replace the lost ecological services and function values of the coral colonies from the KCT Project area. The total ecological services and function value is higher for the lower number of out-planted corals than the originally larger number of harbor coral colonies, due to replacement of a non-endemic species found in the harbor with the out-planted colonies of endemic species, the larger average size of out-planted colonies and the placement of out-planted coral colonies onto natural reef as opposed to artificial structure. DAR therefore has incorporated contingency planning into the calculations for the coral collection, husbandry, and out-planting efforts for Minimization Measure 2.

DAR will be responsible for all efforts associated with coral husbandry, and out-planting to appropriate sites selected by DAR, including, but not limited to, harvesting corals from appropriate locations including but not limited to the KCT Project site, growing the harvested corals to a suitable size at AFRC, transporting and out-planting them to appropriate sites to be determined by DAR, monitoring and documentation of coral harvesting, growing and out-planting results, and obtaining any permits or approvals that DAR may need in order to conduct this work, all as described in the EFHA, the DAR Scope of Work Modifications, the DAR Urchin Biocontrol Plan, and the DAR Coral Nursery Plan.

Funding for Offsets 1 and 2. DOT will provide funding in the amount of Two Million, One Hundred Twenty-Three Thousand, Nine Hundred Ninety-One and 00/100 DOLLARS ($2,123,991), which is the sum of the funding needed to support Offset 1 and Offset 2 together, in a one-time lump-sum payment to DAR to support the Sea Urchin Hatchery Program at AFRC as described in the DAR Urchin Biocontrol Plan and clarified in the accompanying DAR Scope of Work Modifications.

Funding for Minimization Measure 2. DOT will provide funding; in the amount of Two Million Two Hundred Fifty-Seven Thousand Eight Hundred and 00/100 DOLLARS ($2,257,800) for Minimization Measure 2, in a one-time lump-sum payment to DAR to support the Coral Restoration Nursery at AFRC as described in the DAR Coral Nursery Plan and clarified in the accompanying DAR Scope of Work Modifications.

DAR and DOT have prepared this Agreement regarding the minimization and offset measures that DOT will undertake, to provide information on the types minimizations or measures that will be funded, the funds to be allocated to each measure, the type of impact to aquatic resources the measures will be offsetting or minimizing, which department or division will be conducting the work, and the outcomes or deliverables expected from these measures.

As a state agency, DOT is considered exempt from the coral and live rock rules (§§ 13-95-70 and 13-95-71, Hawaii Administrative Rules (HAR)), as the term "person" is not explicitly defined, and therefore no authorization from DLNR-DAR is required for DOT for the take of coral and live rock. However, DOT will need to implement these minimization measures (or "minimization") and offset measures (or "offsets"), as a condition for issuance of the Department of the Army (DA) Permit, pursuant to consultations with applicable federal and state agencies and as anticipated conditions of the DA Permit. As an applicable state agency, DAR has conducted pre-consultations with DOT since November 2016, to provide best management policies to recommend appropriate minimization and offsets that work to lessen further impact to aquatic resources and/or restore habitat.

RECOMMENDATIONS:

That the Board:

1) Authorize and approve the request to enter into a Memorandum of Agreement Between the State of Hawaii, Board of Land and Natural Resources (or "BLNR") and the State of Hawaii, Department of Transportation (or "DOT"), which oversees its Harbors Division (or "HAR"), regarding the New Kapalama Container Terminal Wharf and Dredging, Honolulu Harbor, Oahu, Hawaii (Job H.C. 10498) and the proposed minimization and offset measures designed to minimize or offset the total losses to aquatic resources.

Respectfully submitted,

Brian J. Neilson, Acting Administrator
Division of Aquatic Resources

APPROVED FOR SUBMITTAL

Suzanne Case., Chairperson
Board of Land and Natural Resources

Attachments:

Exhibit 1 – **Memorandum of Agreement** Between the State of Hawaii, Board of Land and Natural Resources (or "BLNR") and the State of Hawaii, Department of Transportation (or "DOT"), which oversees its Harbors Division (or "HAR"), regarding the New Kapalama Container Terminal Wharf and Dredging, Honolulu Harbor, Oahu, Hawaii

Exhibit 2 - **Appendices B-F (Partial EFH Assessment)** with details for the Kapalama Container Terminal Wharf and Dredging Project Coral Transplantation Plan (from EFH Assessment), Urchin Hatchery/Monitoring Project and Coral Nursery/Monitoring Project scopes of work (from EFH Assessment) and rationale for reduced scope of coral transplantation efforts.

Exhibit 3 – **Appendix A: Complete EFH Assessment;** available by PDF on CD or paper (if requested); 227 pages

Figure 1. Location Map (also in Exhibit 2, Appendix B, Page 4)

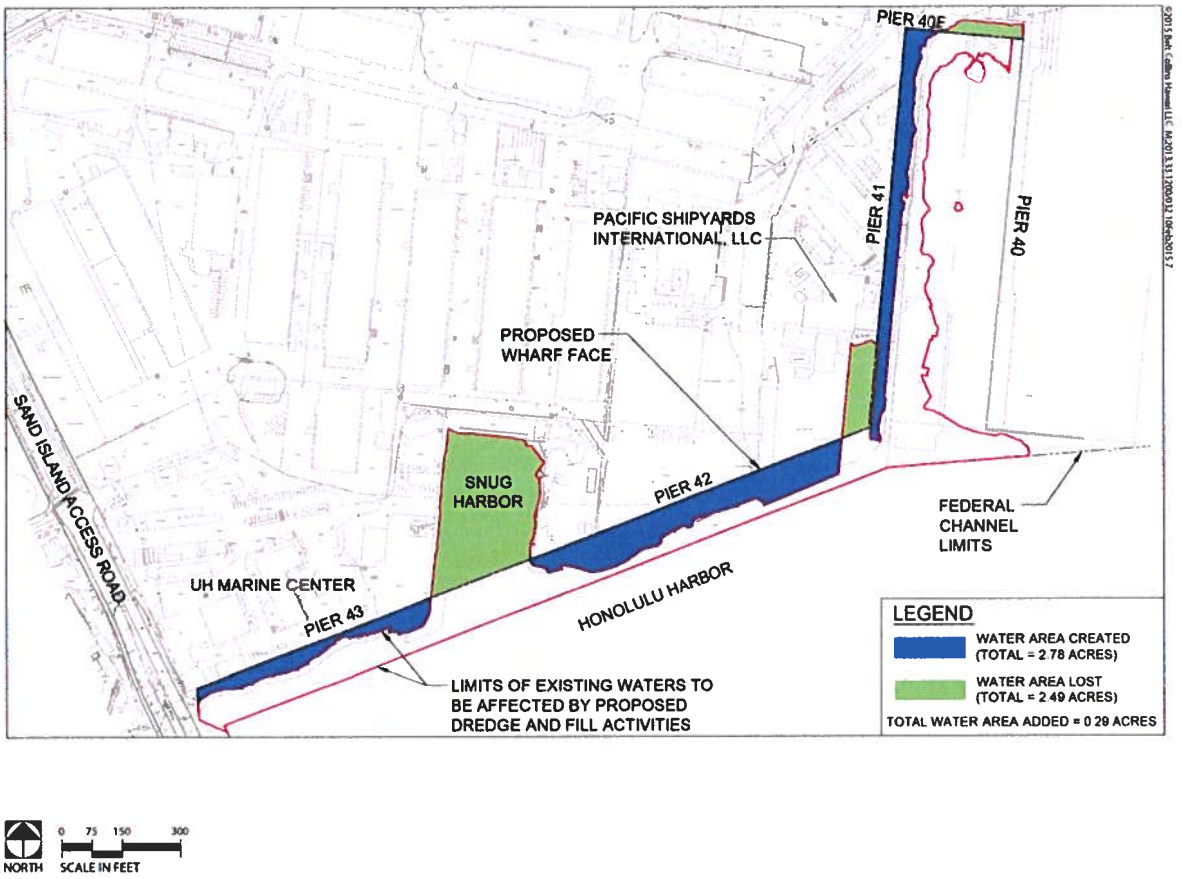

Figure 2. Project Waters (also in Exhibit 2, Appendix B, Page 5)

Sea-Floor Colonies to be Impacted by KCT Development										
Coral Species	1-5 cm	6-10 cm	11-20 cm	21-40 cm	Totals per species for DAR CRN to Replace (Equal Ecological Services and Function Values to be Replaced)	41-80 cm	81-160 cm	>160 cm	Transplant Totals per Species	
Cyphastrea ocellina	14	0	7	0	21	0	0	0	0	
Leptastrea sp.	13943	1059	13	0	15015	0	0	0	0	
Pavona varians	0	0	0	0	0	0	0	0	0	
Porites compressa	14	0	0	7	21	0	7	0	7	Porites compressa
Porites lobata	28035	9609	3368	621	41633	101	7	0	108	Porites lobata
	42,006	10668	3388	628	56690	101	14	0	115	
	56,690					115				
	Totals to not be transplanted; Colonies with Equal Ecological Services and Function Values to be Grown and Outplanted by the DAR CRN					Totals to be Transplanted by DOT				

Figure 3. Amount, Size and Species of Corals to be impacted by KCT Development (similar table in Exhibit 2, Appendix B, Page 10)

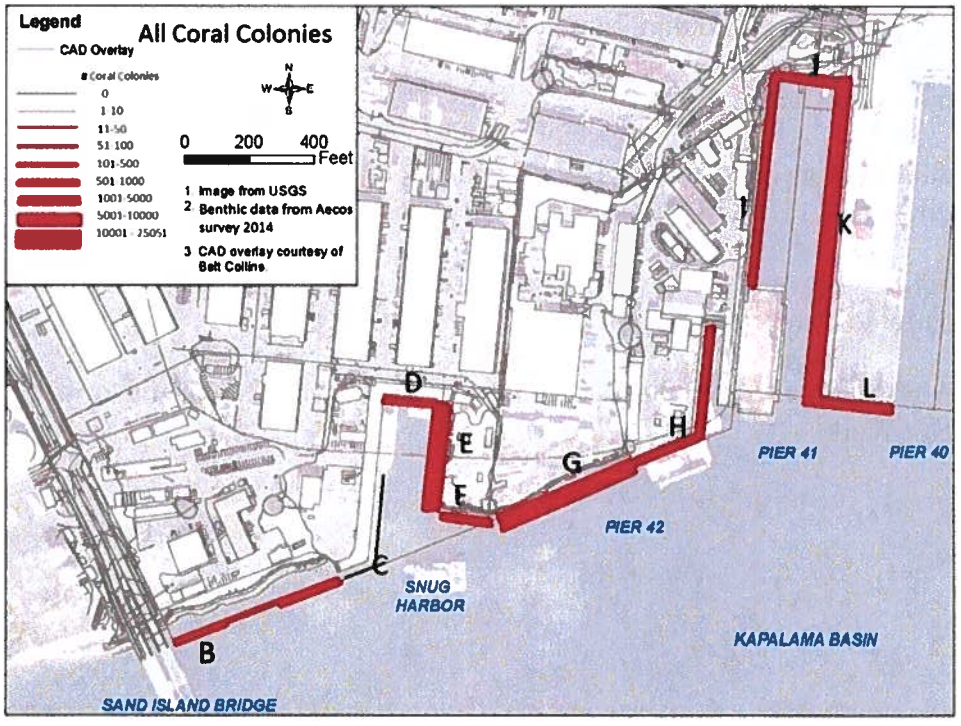

Figure 4. Distribution of all live coral Species across the existing Project site and adjacent Shoreline (also in Exhibit 2, Appendix B, Page 11)

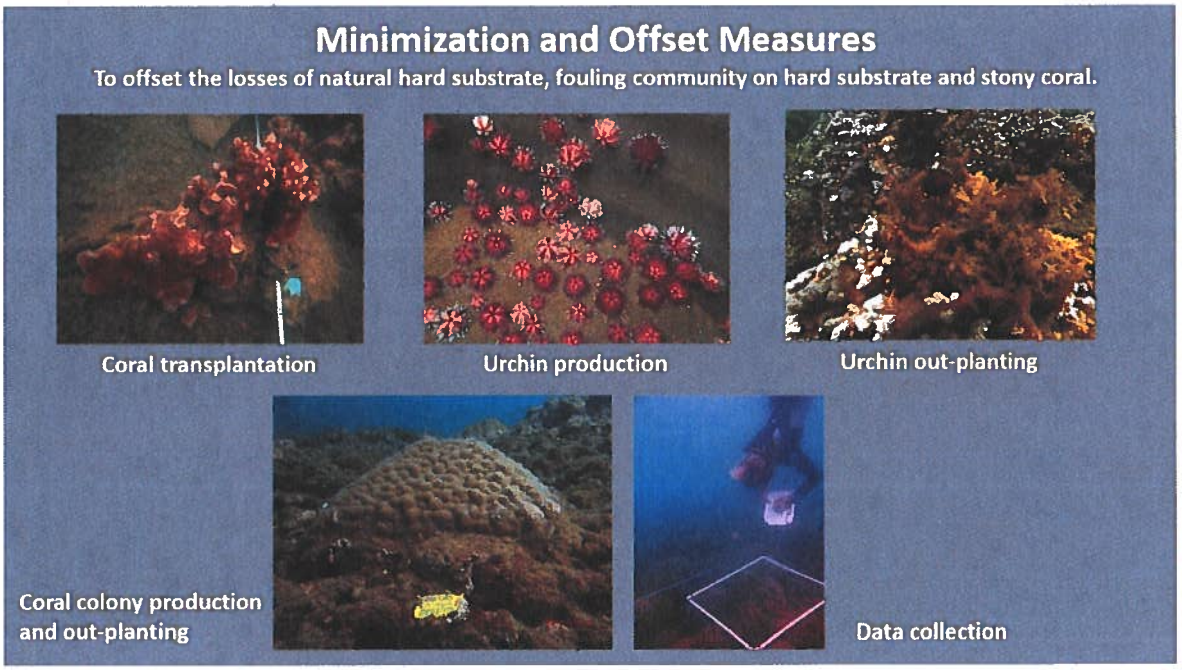

Figure 5. Minimization and Offset Measures proposed to offset the total losses to natural hard substrate, fouling community on hard substrate and coral

Comprehensive details in:

1) Exhibit 2, Appendix B: The New Kapalama Container Terminal Wharf and Dredging Project (H.C. 10498) Coral Transplantation Plan;

2) Exhibit 2, Appendix C: DAR Waikīkī Reef Restoration using Sea Urchin Biocontrol to Control Invasive Algae, Scope of Work and;

3) Exhibit 2, Appendix E: DAR Coral Restoration Nursery Kapalama Projects, Scope of Work.

Exhibit 1 (Item F-1)

MEMORANDUM OF AGREEMENT BETWEEN
THE STATE OF HAWAII, BOARD OF LAND AND NATURAL RESOURCES,
AND THE STATE OF HAWAII, DEPARTMENT OF TRANSPORTATION
REGARDING A DEPARTMENT OF THE ARMY PERMIT FOR
THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING,
HONOLULU HARBOR, OAHU, HAWAII, JOB H.C. 10498

This Memorandum of Agreement ("Agreement") is effective this day of _____ ("Effective Date"), by and between the State of Hawaii, Board of Land and Natural Resources (or "BLNR"), whose mailing address is 1151 Punchbowl Street, Room 130, Honolulu, Hawaii, 96813, and the State of Hawaii, Department of Transportation (or "DOT"), which oversees its Harbors Division (or "HAR"), whose mailing address is 79 South Nimitz Highway, Honolulu, Hawaii 96813, (BLNR and DOT sometimes hereafter collectively referred to as the "Parties"), regarding offset measures that DOT must undertake as conditions of a Department of the Army Permit (or "DA Permit") required for its "The New Kapalama Container Terminal Wharf and Dredging, Honolulu Harbor, Oahu, Hawaii, Job H.C. 10498" project and which is to be located at Tax Map Key Nos: (1) 1-2-025:009, 011, 012, 016, 017, 040, 042, 044, 046, 071, and 076 and (1)1-5-032: 002 and 43.

RECITALS

WHEREAS, DOT has management jurisdiction over Honolulu Harbor, as well as portions of the former Kapalama Military Reservation (or "KMR"), as provided under Chapter 266, Hawaii Revised Statutes and by Executive Order No. 1458, dated July 23, 1951, Executive Order No. 3013, dated June 25, 1980, Executive Order No. 4006, dated September 11, 2003, and Executive Order No. 4206, dated November 6, 2007;

WHEREAS, Honolulu Harbor is the primary entry point for approximately 80% of cargo for the State of Hawaii (or the "State"), which already is at, or will imminently exceed, its capacity to safely handle cargo;

WHEREAS, DOT desires to develop the former KMR areas within its management jurisdiction into a new container terminal yard under its "The New Kapalama Container Terminal Wharf and Dredging, Honolulu Harbor, Oahu, Hawaii, Job H.C. 10498" project (or "KCT Project") to provide additional cargo handling capacity, located as shown on attached Exhibit 2;

WHEREAS, the KCT Project was identified in the Honolulu Waterfront Master Plan (1989) as DOT's highest priority project to meet the projected increase of cargo handling volume due to, and to support, forecasted population growth;

WHEREAS, the KCT Project proposes to demolish and remove existing shoreline facilities; install 972 meters (3,190 feet) of sheet/king pile along the newly constructed shoreline; remove 319,740 cubic meters (417,900 cubic yards) of material to accommodate cargo vessels along the new docks; enclose and fill Snug Harbor, the Rail Slip and Pier 40F to create 10,077 square meters (2.49 acres) of fast lands; place 757 cubic meters (990 cubic yards) of rock at the west end of Pier 43 and adjacent to the Sand Island Bridge for shore protection; and dispose of approximately 151,700 cubic meters (198,400 cubic yards) of dredged material to the South Oahu Offshore Dredged Material Disposal Site.

WHEREAS, the KCT Project would result in the following short and long-term loss of both man-made and natural hard substrate habitat, coral and other organisms associated with these habitats:

1. Long term loss of 305 meters (1,000 feet) of shoreline and 5,710 sq. meters (1.4 acres) of natural hard substrate;

2. Short term loss of 11,844 sq. meters (2.9 acres) of fouling community on hard substrate; and

3. Long-term loss of corals <40 cm.

WHEREAS, DOT must obtain a Department of the Army Permit from the U.S. Army Corps of Engineers (or "USACOE") for the KCT Project, which has been assigned DA File No. POH-2012-00081 (or "DA Permit") to construct the KCT Project to comply with Section 404 of the federal Clean Water Act and Section 10 of the federal Rivers and Harbors Appropriation Act, the process of which will involve consultations with applicable federal and state agencies under the Essential Fish Habitat (or "EFH") provisions of the Magnuson-Stevens Fishery Conservation and Management Act;

WHEREAS, DOT intends to issue an Invitation for Bids (IFB) to solicit construction bids for its KCT Project and upon receipt of bids execute a contract with the awarded construction contractor and subsequently issue a written Notice to Proceed (or "NTP") to proceed with construction of the KCT Project;

WHEREAS, DOT will need to implement minimization measures (or "Minimization Measures") as well as offset measures (or "Offsets"), as described in "The New Kapalama Container Terminal Wharf and Dredging Project (H.C. 10498) Essential Fish Habitat Assessment" (or "EFHA"), revised March 2018, incorporated into this Agreement by reference and attached as Appendix A, or a subsequent version accepted and incorporated by USACOE, as a condition for issuance of the DA Permit, pursuant to consultations with the aforesaid applicable federal and state agencies and as anticipated conditions of the DA Permit;

WHEREAS, the Department of Land and Natural Resources (or "DLNR") is the agency of the State of Hawaii tasked with managing, conserving, and restoring the unique aquatic ecosystems of the State of Hawaii for present and future generations; and

WHEREAS, the corals to be lost under the KCT Project, and their associated aquatic habitat, are part of the unique aquatic ecosystems that DLNR is tasked with managing, conserving, and restoring; and,

WHEREAS, the Parties agree that the Minimization Measures and Offsets as described herein to be implemented as conditions of the DA Permit to be issued for the KCT Project, satisfy the missions and objectives of each Party.

NOW THEREFORE, in consideration of the mutual promises and representations contained herein, and good and valuable consideration, the receipt of which is hereby acknowledged, the Parties agree as follows:

A) Minimization Measure 1 - Coral Transplantation. As described in the EFHA as well as in the "Kapalama Container Terminal Wharf and Dredging Project (H.C. 10498) Coral Transplantation Plan" revised July 2017 (or "CTP"), incorporated into this Agreement by reference and attached as Appendix B, and conditional upon the issuance of the DA Permit to DOT from the USACOE, DOT shall harvest a total area of coral equivalent to 69 square meters, favoring corals greater than 40 centimeters in diameter from the KCT Project area, and transplant them to Piers 5 and 6, in Honolulu Harbor.

1) DOT will harvest coral colonies from the KCT Project area, transplant them to Piers 5 and 6, and perform post-transplantation monitoring, as described in the EFHA as well as in the CTP.

2) DOT will complete the transplantation of corals before any KCT Project construction activities begin within, or directly over, waters of the United States, including but not limited to demolishing existing shoreline facilities, installing sheet/king piles, dredging, and placing fill material in waters of the United States, for the KCT Project.

3) DOT will perform the coral transplantation, which will consist of one full attempt, and subsequent post-transplantation monitoring, at its sole cost and expense.

B) Offset 1 - Urchin Hatchery, Removal of Invasive Algae from Reefs and Monitoring.

1) As described in the EFHA, to offset for the long- term loss of 305 meters (1,000 feet) of shoreline, and 5,710 square meters (1.4 acres) of natural hard substrate due to the KCT Project, DOT will provide financial support, in the form of funding, to the DLNR Division of Aquatic Resources ("DAR") Sea Urchin Hatchery Program and the Reef Restoration Field Team at the DLNR DAR Anuenue Fisheries Research Center facility at Sand Island (or "AFRC"). Production, release, augmentation, and monitoring of sea urchins to a candidate reef site is intended to facilitate the removal of nuisance and invasive algae on a cumulative area of 1.4 acres of reef, thereby restoring area of natural hard marine substrate equal to that lost due to the KCT Project.

2) Offset 1 funding will support the sea urchin hatchery program at AFRC and the release of sea urchins to a candidate reef site, such as the Waikiki Marine Life Conservation District (or "MLCD"), the Waikiki-Diamond Head Shoreline Fisheries Management Area ("FMA") or other location agreed to by the Parties, and the subsequent monitoring of the site, all as described in the final "Waikīkī Reef Restoration using Sea Urchin Biocontrol to Control Invasive Algae, Scope of Work", revised November/December 2017 (or the "DAR Urchin Biocontrol Plan"), and the accompanying "Kapalama Offset Measures Scope of Work Modifications" dated December 2017 (or the "DAR Scope of Work Modifications"), both prepared by DAR and incorporated into this Agreement by reference and attached as Appendices C and D respectively.

(a) DAR shall proceed with the work described in its DAR Urchin Biocontrol Plan and its accompanying DAR Scope of Modifications, including the spawning and growing of sea urchins at AFRC for their eventual release at the MLCD, the FMA or other location agreed to by the Parties, within sixty (60) calendar days of DAR's receipt of funding from DOT to support Offset 1.

(b) DAR will collect, spawn and rear sea urchins at AFRC, and release them at the MLCD, the FMA or other location agreed to by the Parties, as described in the DAR Urchin Biocontrol Plan, as well as in the DAR Scope of Work Modifications, and summarized as follows:

- On the basis that it takes approximately six (6) months to produce the first cohort of sea urchins at AFRC, DAR will release the first cohort of sea urchins, at the release site as described in Paragraph B) 2) above, no later

than eight (8) months after DAR's receipt of the funds from DOT to support Offset 1 and Offset 2 described below.

- DAR will release a minimum of 33, 993 sea urchins over a period of thirty (30) months, for Offset 1 described below, to reduce invasive algae coverage to 5% or less, by area, over the cumulative 1.4 acres of reef applicable to Offset 1.

- The terms "release" and "outplant" are used interchangeably throughout this Agreement and shall be taken to mean the same thing.

(c) DAR will monitor the sea urchins, at the release site described above, and prepare and submit reports summarizing the monitoring findings, as detailed in the DAR Urchin Biocontrol Plan, as well as in the DAR Scope of Work Modifications, and as follows:

- DAR will conduct a baseline survey of the release site prior to the first urchin out-planting or before the release of the first cohort of sea urchins.

- Monitoring of the sea urchins, at the release site, will be conducted by DAR for a minimum of eight years bi-annually (i.e. two times annually), or a minimum of five years after the last out-planting of sea urchins is completed, whichever is longer, to map invasive algae trends. The first monitoring survey will be conducted concurrently with the release of the first cohort of sea urchins.

- DAR will prepare monitoring reports, detailing the progress of the sea urchin biocontrol project, with the first report submitted no more than seven (7) months following the release of the first cohort of sea urchins and containing the findings of the baseline survey and first monitoring survey.

- DAR will transmit both a hard copy, as well as an electronic copy, of each monitoring report to DOT, as well as to the USACOE, annually (one time per calendar year), no later than thirty (30) calendar days after the conclusion of the last monitoring survey conducted in any calendar year. The hard copies shall be printed in color and bound. The electronic copies shall be in PDF format.

3) DAR's experience, supported by two years of records, is that restoration of natural substrate on a coral reef covered with invasive algae requires 2 to 3 sea urchins per square meter of reef. The area being considered as the candidate reef site for sea urchin release under Offset 1 is the MLCD and the FMA, which encompasses a total of 76 acres of which 18.5 acres is cumulatively impacted by invasive algae. If the entire 18.5 acres of the impacted portion of the MLCD and the FMA were fully covered by invasive algae, 270,000 sea urchins would be required to restore natural substrate, based on the ratio of 2 to 3 urchins per square meter. However, the invasive algae coverage at the MLCD and the FMA is patchy rather than complete and the cumulative area of the invasive algae patches to be addressed under Offset 1 is 1.4 acres. To effectively apply biocontrol to the 1.4 acres with algal coverage only, DAR has modified its application strategy to increase the density of urchins to six (6) urchins per square meter (to account for urchin mortality as well as emigration of biocontrol

from the patches) resulting in the urchin count described in Paragraph B) 2) (b) above. DAR therefore has incorporated contingency planning into the calculations for the urchin hatchery and algae removal efforts for Offset 1 by this modification.

4) DAR will be responsible for all efforts associated with sea urchin husbandry and release to the agreed upon release site thereafter, including, but not limited to, collecting, spawning, and growing urchins at AFRC, transporting and releasing urchins to the agreed upon release site, observing and physically redistributing the urchins within the candidate release site, monitoring and documenting sea urchin augmentation results, and obtaining any permits or approvals that DAR will need to conduct its work, all as described in the DAR Scope of Work Modifications and the DAR Urchin Biocontrol Plan.

5) DAR will perform the restoration of hard substrate using sea urchin biocontrol to control invasive algae (collecting, spawning, growing, releasing and augmentation of sea urchins) and subsequent monitoring, which will consist of one full attempt of the proposed work as described in the "Waikīkī Reef Restoration using Sea Urchin Biocontrol to Control Invasive Algae, Scope of Work", revised November/December 2017 (or the "DAR Urchin Biocontrol Plan"), and the accompanying "Kapalama Offset Measures Scope of Work Modifications" dated December 2017 (or the "DAR Scope of Work Modifications"). DAR will take efforts to avoid, but is not responsible for, any unforeseen variables that may interfere with the anticipated results or completion of the restoration effort, including (but not limited to) coral bleaching conditions or high sea-surface temperatures, disease, natural disasters, over-harvesting of biocontrol, predation, biological conditions that affect reproductivity during spawning or husbandry, low acclimatization rates, etc.

C) Offset 2 – Urchin Hatchery, Removal of Invasive Algae from Reefs and Monitoring.

1) As described in the EFHA, to offset for the short-term loss of 11,844 square meter (or 2.9 acre) of fouling community resulting from the dredging to be performed under the KCT Project, DOT will provide financial support, in the form of funding, for the DLNR DAR sea urchin hatchery program and reef restoration field team at the DLNR DAR AFRC. Production, release, augmentation and monitoring of urchins at the candidate reef site is intended to remove invasive algae and expose hard substrate, which will facilitate the recolonization of native algae, coral and non-invertebrates on a cumulative area of 2.9 acres of reef, thereby facilitating the restoration of an area of native fouling community equal to that lost due to the KCT Project.

2) Offset 2 funding will support the sea urchin hatchery program at AFRC, the release of sea urchins to a candidate reef site, such as the MLCD, the FMA or other location agreed to by the Parties and the subsequent monitoring of the site, all as described in the DAR Urchin Biocontrol Plan and the DAR Scope of Work Modifications.

   (a) DAR shall proceed with the work described in its DAR Urchin Biocontrol Plan and its DAR Scope of Modifications, including spawning and growing of sea urchins, at AFRC for their eventual release at the MLCD, the FMA or other location agreed to by the Parties, within sixty (60) calendar days of DAR's receipt of funding from DOT, to support Offset 2.

(b) DAR will collect, spawn and rear sea urchins at AFRC, and release them at the MLCD the FMA, or other location agreed to by the Parties, as described in the DAR Urchin Biocontrol Plan, as well as in the DAR Scope of Work Modifications, and summarized as follows:

- On the basis that it takes approximately six (6) months to produce the first cohort of sea urchins at AFRC, DAR will release the first cohort of sea urchins, at the release site as described in Paragraph C) 2) above, no later than eight (8) months after DAR's receipt of the funds from DOT to support Offset 2 and Offset 1 described above.

- DAR will release a minimum of 70, 413 sea urchins over a period of thirty (30) months, for Offset 2, described above, to reduce invasive algae coverage to 5% or less, by area, over the cumulative 2.9 acres of reef applicable to Offset 2.

(c) DAR will monitor the sea urchins, at the release site described above, and prepare and submit reports summarizing the monitoring findings, as detailed in the DAR Urchin Biocontrol Plan, as well as in the DAR Scope of Work Modifications, and as follows:

- DAR will conduct a baseline survey of the release site prior to the first urchin out-planting or before the release of the first cohort of sea urchins.

- Monitoring of the sea urchins, at the release site, will be conducted by DAR for a minimum of eight years bi-annually (i.e. two times per year), or a minimum of five years after the last out-planting of sea urchins is completed, whichever is longer, to map invasive algae trends. The first monitoring survey will be conducted concurrently with the release of the first cohort of sea urchins.

- DAR will prepare monitoring reports, detailing the progress of the sea urchin biocontrol project, with the first report submitted no more than seven (7) months following the release of the first cohort of sea urchins and containing the findings of the baseline survey and first monitoring survey.

- DAR will transmit both a hard copy, as well as an electronic copy, of each monitoring report to DOT, as well as to the USACOE, annually (one time per year), no later than thirty (30) calendar days after the conclusion of the last monitoring survey conducted in any calendar year. The hard copies shall be printed in color and bound. The electronic copies shall be in PDF format.

3) DAR's experience, supported by two years of records, is that restoration of natural substrate on a coral reef covered with invasive algae requires 2 to 3 sea urchins per square meter of reef. The area being considered as the candidate reef site for sea urchin release under Offset 2 is the MLCD and the FMA, which encompasses a total of 76 acres of which 18.5 acres is cumulatively impacted by invasive algae. If the entire 18.5 acres of the impacted portion of the MLCD and the FMA were fully covered by invasive algae, 270,000 sea urchins would be required to restore natural substrate, based on the ratio of 2 to 3 urchins per square meter. However, the invasive

algae coverage at the MLCD and the FMA is patchy rather than complete and the cumulative area of the invasive algae patches to be addressed under Offset 2 is 2.9 acres. To effectively apply biocontrol to the 2.9 acres with algal coverage only, DAR has modified its application strategy to increase the density of urchins to six (6) urchins per square meter (to account for urchin mortality as well as emigration of biocontrol from the patches) resulting in the urchin count described in Paragraph C) 2) (b) above. DAR therefore has incorporated contingency planning into the calculations for the urchin hatchery and algae removal efforts for Offset 2 by this modification.

4) DAR will be responsible for all efforts associated with sea urchin husbandry and release to the agreed upon release site thereafter, including, but not limited to, collecting, spawning, and growing urchins at AFRC, transporting and releasing urchins to and release at the agreed upon release site, observing and physically redistributing the urchins within the candidate release site, monitoring and documenting of sea urchin augmentation results, and obtaining any permits or approvals that DAR may need in order to conduct its work, all as described in the DAR Scope of Work Modifications and the DAR Urchin Biocontrol Plan.

5) DAR will perform the restoration of native fouling community sea urchin biocontrol to control invasive algae (collecting, spawning, growing, releasing and augmentation of sea urchins) and subsequent monitoring, which will consist of one full attempt of the proposed work as described in the "Waikīkī Reef Restoration using Sea Urchin Biocontrol to Control Invasive Algae, Scope of Work", revised November/December 2017 (or the "DAR Urchin Biocontrol Plan"), and the accompanying "Kapalama Offset Measures Scope of Work Modifications" dated December 2017 (or the "DAR Scope of Work Modifications"). DAR will take efforts to avoid, but is not responsible for, any unforeseen variables that may interfere with the anticipated results or completion of the restoration effort, including (but not limited to) coral bleaching conditions or high sea-surface temperatures, natural disasters, disease, predation or over-harvesting of biocontrol, low fecundity or reproductivity during spawning or husbandry and low acclimatization rates to new environments.

D) <u>Minimization Measure 2 – Support for Coral Nursery Program to Minimize the Long-Term Loss of Corals Less than 40cm</u>:

1) As described in the EFHA, to minimize the long-term loss of 56,690 corals smaller than 40 centimeters in size from the KCT Project area seafloor, and not affixed to man-made substrates, due to the dredging to be performed under the KCT Project, DOT shall provide financial support for the DLNR DAR "Coral Restoration Nursery" at AFRC.

2) Minimization Measure 2 funding will support the Coral Restoration Nursery, including expansion of the existing Coral Restoration Nursery facilities at AFRC, collection of corals, coral husbandry to grow the collected corals to a suitable out-plant size, subsequent out-planting of the grown-out corals to the original donor site as well as to appropriate new out-plant sites selected by DAR, such as open substrate areas within MLCD, the Honolulu International Airport Reef Runway reef (eastern end), and possibly the outer reef area between the two channels fronting Honolulu Harbor and Sand Island, and monitoring of the out-planted corals, all as described in the DAR Scope of Work Modifications, the DAR Urchin Biocontrol Plan, as well as in the "DAR Coral Restoration Nursery Kapalama Projects" dated December 2017 (or the

"DAR Coral Nursery Plan") prepared by DAR and incorporated into this Agreement by reference and attached as Appendix E.

(a) DAR will proceed with the work described in its DAR Coral Nursery Plan, its DAR Scope of Modifications, and its DAR Urchin Biocontrol Plan, including expansion of the Coral Restoration Nursery, and harvesting of corals necessary for coral colony production at AFRC for out-planting, within sixty (60) calendar days of DAR receipt of funding from DOT to support Minimization Measure 2.

(b) DAR will collect corals from the KCT Project site, as well as from donor sites, quarantine, grow, hold, and acclimate the collected corals at AFRC, and out-plant them at MLCD, or other location selected by DAR, as described in the DAR Coral Nursery Plan, and the DAR Scope of Work Modifications, and summarized as follows:

- On the basis that DAR will take six (6) months for start-up, inclusive of expansion of the Coral Restoration Nursery at AFRC along with the collection of donor corals to grow, and that on average, DAR can grow a forty-two (42) centimeter coral colony (a suitable size for out-planting) from ten (10) centimeters of donor coral tissue in about eight (8) months followed by a one (1) month acclimation period, DAR will outplant the first coral colonies, grown specifically for Minimization Measure 2, at the out-planting site(s) determined by DAR, no later than seventeen (17) months after DAR's receipt of funding from DOT to support Minimization Measure 2, unless out-planting is delayed due to coral spawning periods.

- DAR will outplant up to 475 coral colonies, as apportioned by sizes and species indicated in the DAR Coral Nursery Plan, and the DAR Scope of Work Modifications, at the out-plant site(s) selected by DAR, over a period of three and a half (3.5) years for Minimization Measure 2, inclusive of the 17-month period after DAR's receipt of funding from DOT to support Minimization Measure 2 until it outplants the first coral colonies.

(c) DAR will monitor the out-planted corals, at the out-plant site(s) described above, and prepare and submit reports summarizing the monitoring findings, as detailed in the DAR Coral Nursery Plan, the DAR Scope of Work Modifications, as well as the DAR Urchin Biocontrol Plan, and as follows:

- DAR will conduct a baseline survey of the out-plant site prior to out-planting of coral at the site.

- Monitoring of the out-planted corals, at the outplant site(s), will be conducted by DAR for a minimum of five (5) years after the last out-planting of corals is completed at the site, to monitor the progress of the out-planted corals and document changes in benthic cover due to the out-planting of the new coral colonies.

- DAR will prepare annual monitoring reports, detailing the progress of the out-planted corals, as described in the DAR Coral Nursery Plan and the DAR Urchin Biocontrol Plan with the first report containing the findings of the baseline survey and first monitoring survey.

- DAR will transmit both a hard copy, as well as an electronic copy, of each monitoring report to DOT, as well as to the USACOE, annually (one time per year), no later than thirty (30) calendar days after the conclusion of the last monitoring survey conducted in any calendar year. The hard copies shall be printed in color and bound. The electronic copies shall be in PDF format.

3) The number of coral colonies to be out-planted by DAR from its Coral Restoration Nursery under Minimization Measure 2 will replace the lost ecological services and function values of the coral colonies from the KCT Project area. The total ecological services and function value is higher for the lower number of out-planted corals than the originally larger number of harbor coral colonies, due to replacement of a non-endemic species found in the harbor with the out-planted colonies of endemic species, the larger average size of out-planted colonies and the placement of out-planted coral colonies onto natural reef as opposed to artificial structure. DAR therefore has incorporated contingency planning into the calculations for the coral collection, husbandry, and out-planting efforts for Minimization Measure 2.

4) DAR will be responsible for all efforts associated with coral husbandry, and out-planting to appropriate sites selected by DAR, including, but not limited to, harvesting corals from appropriate locations including but not limited to the KCT Project site, growing the harvested corals to a suitable size at AFRC, transporting and out-planting them to appropriate sites to be determined by DAR, monitoring and documentation of coral harvesting, growing and out-planting results, and obtaining any permits or approvals that DAR may need in order to conduct this work, all as described in the EFHA, the DAR Scope of Work Modifications, the DAR Urchin Biocontrol Plan, and the DAR Coral Nursery Plan (Appendix E).

5) DAR will perform the restoration of coral colonies using coral colony out-planting (collecting, husbandry, growing and out-planting coral colonies), which will consist of one full attempt of the proposed work as described in the "DAR Coral Restoration Nursery Kapalama Projects" dated December 2017 (or the "DAR Coral Nursery Plan") and the accompanying "Kapalama Offset Measures Scope of Work Modifications" dated December 2017 (or the "DAR Scope of Work Modifications"). DAR will take efforts to avoid, but is not responsible for, any unforeseen variables that may interfere with the anticipated results or completion of the restoration effort, including (but not limited to) coral bleaching conditions or high sea-surface temperatures, natural disasters, disease, predation or over-harvesting of biocontrol, low fecundity or reproductivity during spawning or husbandry and low acclimatization rates to new environments.

E) Funding for Offsets 1 and 2. DOT will provide funding in the amount of Two Million, One Hundred Twenty-Three Thousand, Nine Hundred Ninety-One and 00/100 DOLLARS ($2,123,991), which is the sum of the funding needed to support Offset 1 and Offset 2 together,

in a one-time lump-sum payment to DAR to support the Sea Urchin Hatchery Program at AFRC as described in the budget included in the DAR Urchin Biocontrol Plan and clarified in the accompanying DAR Scope of Work Modifications.

1) DAR will ensure that they are able to receive the financial support for Offsets 1 and 2.

2) DOT will transfer the funding to DAR to support the Sea Urchin Hatchery Program at AFRC for the production of urchins and to support the Reef Restoration Field Team at AFRC, for collection of urchin brood stock, and out-planting of cultured urchins, maintenance and monitoring in appropriate amounts (as described in the DAR Urchin Biocontrol Plan and accompanying DAR Scope of Work Modifications), by Journal Voucher or alternative mechanism agreeable to both Parties, within sixty (60) calendar days after DOT has received confirmation that DAR has an appropriation that is available to receive the funds, or within sixty (60) calendar days after the Effective Date of this Agreement, whichever is later.

3) The funding will support implementation of the work described in the DAR Urchin Biocontrol Plan and accompanying DAR Scope of Work Modifications on 4.3 acres of reef at the MLCD, the FMA or other location agreed to by the Parties, which is the cumulative amount of the urchin outplant (and monitoring) areas for Offset 1 and 2, or 1.4 acres and 2.9 acres respectively.

4) DAR will reserve the funds, and use them solely for costs specific to raising sea urchins at AFRC; releasing, monitoring and maintaining (i.e. redistributing and replacing, etc.) and monitoring the urchins at the agreed upon release site; and permitting and documenting the urchin program for the KCT Project.

5) Full Payment: The funding amount(s) to be provided for Offsets 1 and 2 will constitute full compensation and satisfaction in full of DOT's obligation towards DAR labor and manpower, supervision, overhead, expenses, materials, equipment, insurance, taxes and all other direct and indirect costs associated with sea urchin husbandry, permitting, release, monitoring, reporting, and maintenance at the agreed upon release site, as described under Paragraphs B and C above.

F) Funding for Minimization Measure 2. DOT will provide funding in the amount of Two Million Two Hundred Fifty-Seven Thousand Eight Hundred and 00/100 DOLLARS ($2,257,800) for Minimization Measure 2, in a one-time lump-sum payment to DAR to support the Coral Restoration Nursery at AFRC as described in the budget included in the DAR Coral Nursery Plan and clarified in the accompanying DAR Scope of Work Modifications.

1) DAR will ensure that they are able to receive the Minimization Measure 2 financial support.

2) DOT will transfer funding to DAR, to support the Coral Restoration Nursery at AFRC, for expansion of the Coral Restoration Nursery, collection of corals and subsequent quarantine, holding, and coral husbandry to grow the collected corals to suitable out-plant sizes, subsequent out-planting of the grown-out corals to the original donor as well as to appropriate new out-plant sites selected by DAR, and monitoring of the out-planted corals (as described in the DAR Coral Nursery Plan, the accompanying DAR

Scope of Work Modifications, and the DAR Urchin Biocontrol Plan) by Journal Voucher or alternative mechanism agreeable to both Parties within sixty (60) calendar days after DOT has received confirmation that DAR has an appropriation that is available to receive the funds, or within sixty (60) calendar days after the Effective Date of this Agreement, whichever is later.

3) DAR will reserve the funds, and use them solely for costs specific to its Coral Restoration Nursery at AFRC as well as for project coral acquisition, out-planting and monitoring of corals from AFRC for the KCT Project.

4) The funding will support implementation of the work described in the DAR Coral Nursery Plan, the accompanying DAR Scope of Work Modifications, and the DAR Urchin Biocontrol Plan which will result in the out-planting and monitoring of up to 475 coral colonies at outplant site(s) selected by DAR.

5) Full Payment: The funding detailed above for Minimization Measure 2 will constitute full compensation and satisfaction in full of DOT's obligation towards DAR labor and manpower, supervision, overhead, expenses, materials, equipment, insurance, taxes and all other direct and indirect costs associated with coral husbandry, out-planting, monitoring, reporting and maintenance including all necessary permits and approvals as described under Paragraph D above.

G) Should DOT elect to cancel, or indefinitely defer the KCT Project, for whatever reason, and/or if approval of the DA Permit is denied, DOT may terminate this Agreement, by written notice to DLNR, without penalty, charge, or other liability.

H) DAR may utilize the funding provided for Offsets 1, 2 and 3 as outlined in this Agreement interchangeably between the proposed restoration projects and interchangeably between budgeted or unbudgeted items, as necessary to fulfill the deliverables of the proposed restoration projects.

I) Should either party materially breach this Agreement and fail to cure such breach within sixty (60) days of written notice thereof, the non-breaching party may terminate this Agreement by written notice to the breaching party.

J) This Agreement shall be governed and construed in accordance with the laws of the State of Hawaii.

K) No third-party beneficiaries are intended by this Agreement, and the terms and provisions of this Agreement shall not give rise to any right in third parties to enforce the provisions of this Agreement.

L) Notwithstanding any provision to the contrary, DAR shall not be responsible for non-compliance of any provision in this agreement due to factors outside of its control, including (but not limited to) coral bleaching conditions or high sea-surface temperatures, natural disasters, disease, predation or over-harvesting of biocontrol, low fecundity or reproductivity during spawning or husbandry, low acclimatization rates to new environments, or any changes to the KCT Project.

This Agreement constitutes the entire agreement of the parties with respect to the matters set forth in this Agreement, and, except as specifically provided otherwise herein, there are no agreements, understandings, warranties, or representations between the parties except as set forth herein. This Agreement cannot be amended or modified except by an instrument, in writing, signed by each of the parties.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement as of the Effective Date.

APPROVED AS TO FORM

_____
DEPUTY ATTORNEY GENERAL

STATE OF HAWAII,
Department of Transportation

_____
JADE T. BUTAY
Director
Department of Transportation

APPROVED AS TO FORM:

_____
DEPUTY ATTORNEY GENERAL

STATE OF HAWAII,
Board of Land and Natural Resources

_____
SUZANNE D. CASE
Chairperson
Board of Land and Natural Resources

Exhibit 2 (Item F-1)

New Kapalama Container Terminal
Wharf and Dredging Project

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.

EXHIBIT 2

APPENDIX A:

THE NEW KAPALAMA CONTAINER TERMINAL WHARF AND DREDGING PROJECT

(H.C. 10498)

Essential Fish Habitat Assessment

APPENDIX B:

The New Kapalama Container Terminal Wharf and Dredging Project (H.C. 10498)

Coral Transplantation Plan

APPENDIX B

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

Prepared by:

State of Hawaii, Department of Transportation
Harbors Division

February 2016
(Revised July 2017)

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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

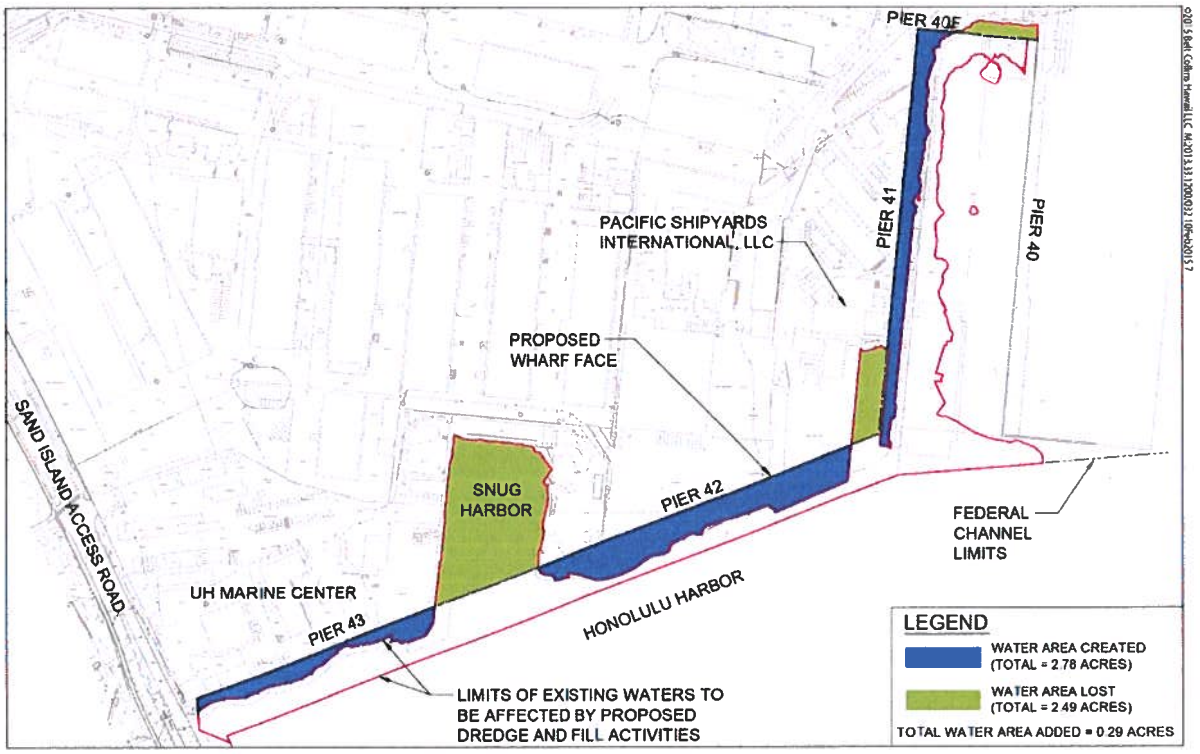

Figure 2. Project Waters

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

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.

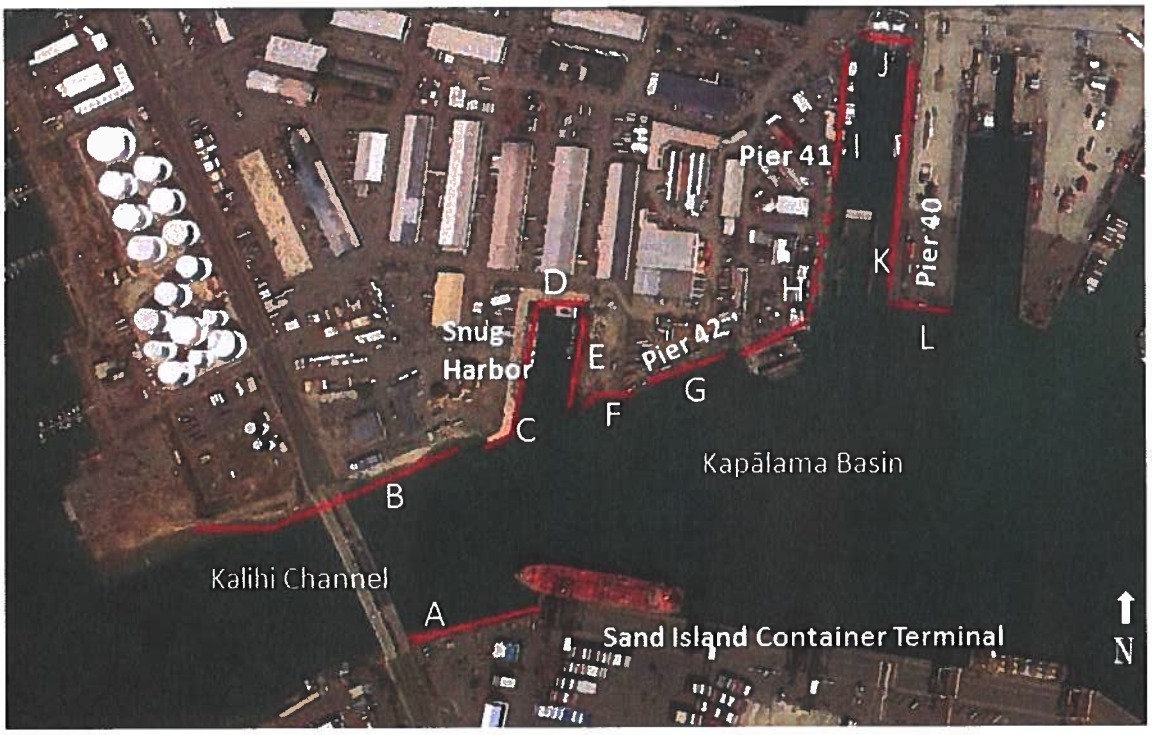

Figure 3. Marine Survey Sectors

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
Cyphastrea ocellina	21	0	7	0	0	0	0	29	0
Leptastrea	32444	1560	13	0	0	0	0	34017	23
Pavona varians	23	15	8	0	8	0	0	53	2
Porites compressa	14	0	0	7	0	7	0	27	8
Porites lobata	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)

Project Area Only

Size class ->	1-5cm	6-10cm	11-20cm	21-40cm	41-80cm	81-160 cm	>160cm	Total #	Coral m^2
Cyphastrea ocellina	14	0	7	0	0	0	0	21	0
Leptastrea	13943	1059	13	0	0	0	0	15015	12
Pavona varians	0	0	0	0	0	0	0	0	0
Porites compressa	14	0	0	7	0	7	0	27	8
Porites lobata	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)

Project Area Only

Size class ->	1-5cm	6-10cm	11-20cm	21-40cm	41-80cm	81-160 cm	>160cm	Total #	Coral m^2
Cyphastrea ocellina	8	0	0	0	0	0	0	8	0
Leptastrea	18501	501	0	0	0	0	0	19002	11
Pavona varians	23	15	8	0	8	0	0	53	2
Porites compressa	0	0	0	0	0	0	0	0	0
Porites lobata	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% (241m^2/275m^2) 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.

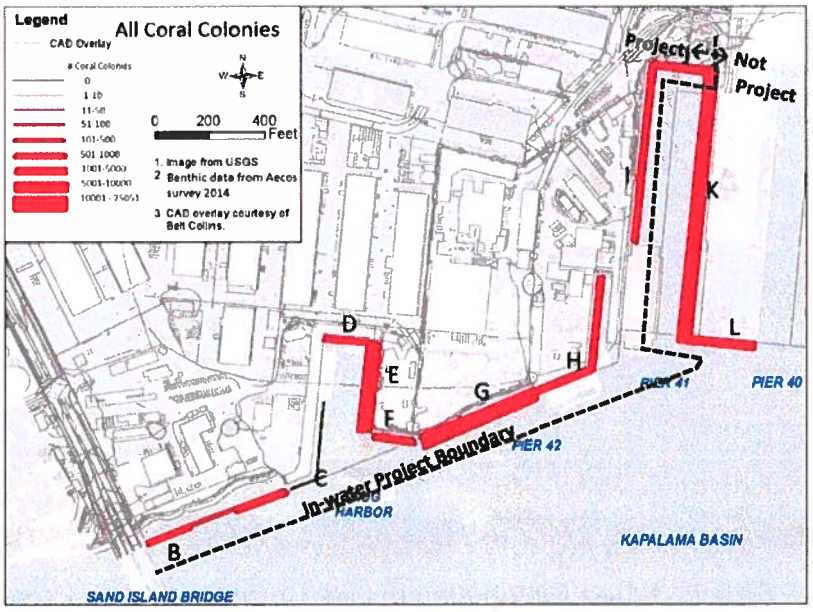

Figure 4. Distribution of all live coral Species across the existing Project site and adjacent Shoreline

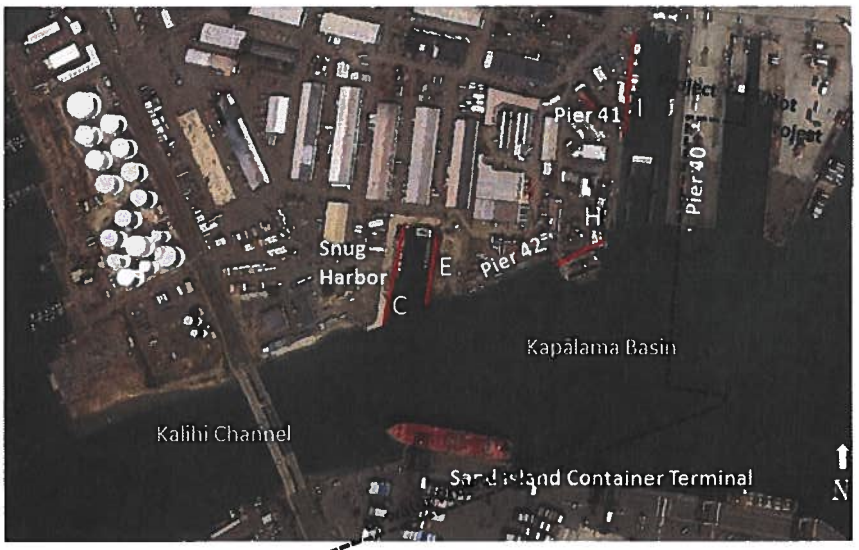

Figure 5. Distribution of live corals >40 cm displayed as red lines within Project area.

Coral Species	Area (m2) per Size Class			
		41-80 cm	81-160 cm	Total area
Porites lobata		37.7	21.4	59.1
Porites compressa		0	7.6	7.6
Pavona varians		2.1	0	2.1
Total Coral Colony Area		39.8	29.0	68.8
% Total (275 m²) 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 experts[1], 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.

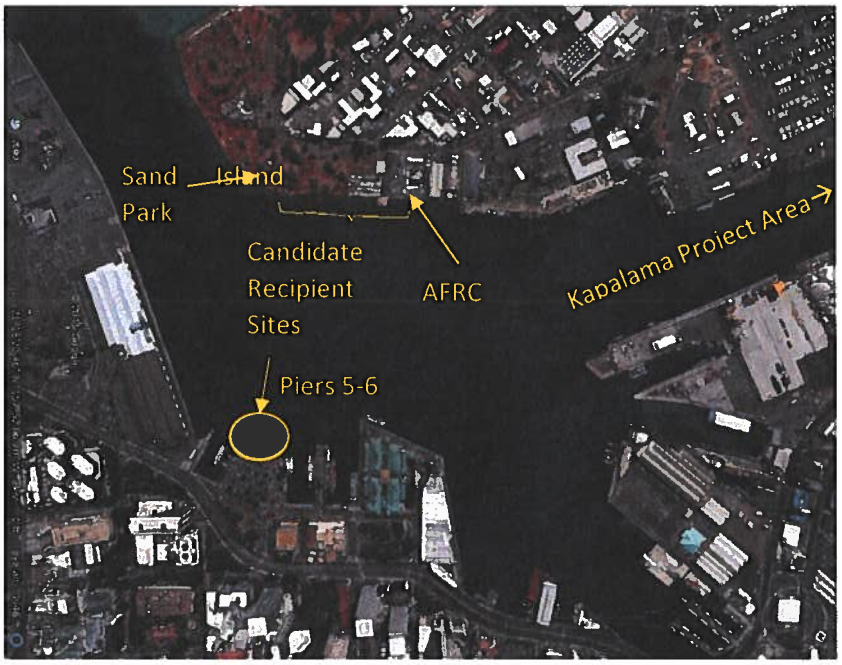

Figure 6. Candidate Coral Recipient Sites in Honolulu Harbor

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 ($^1/_2$" diameter, ¾" 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.

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APPENDIX C:

Waikīkī Reef Restoration using Sea Urchin Biocontrol to Control Invasive Algae, Scope of Work

APPENDIX C - DAR URCHIN BIOCONTROL PLAN

Waikīkī Reef Restoration using Sea Urchin Biocontrol to Control Invasive Algae

Scope of Work

Department of Land and Natural Resources,
Division of Aquatic Resources

Executive Summary

Invasive algae severely alter coral reef ecosystems by overgrowing reefs and eventually killing coral colonies. Removing invasive algae allows corals to regrow where partial mortality has occurred and recolonize previously occupied habitats. Removing invasive algae also creates higher rugosity on the reef providing more niches for various fish, invertebrates, and native algae species. DLNR proposes to restore coral reef habitat within the Waikīkī Marine Life Conservation District using a biocontrol method of outplanting hatchery-raised native sea urchins (*Tripneustes gratilla*) to reduce the levels of invasive algae in the Waikīkī MLCD. Wild urchins are collected from local reefs, spawned, and raised for outplanting in the Ānuenue Fisheries Research Center sea urchin hatchery. Once outplanted to the reef, the urchins graze on invasive algae in turn reducing the competition for space and nutrients which allow corals to grow and colonize these previously occupied areas. DLNR proposes a 30 month project to raise and outplant approximately 100,000 sea urchins to treat approximately 4.3 acres of invasive algae. This scope of work also includes monitoring of the sea urchin biocontrol project and the coral nursery project. Monitoring will be conducted throughout the course of the project and five years following urchin outplanting and coral outplanting.

Introduction

DLNR proposes to restore coral reef habitat within the Waikīkī Marine Life Conservation District ("Waikīkī MLCD") using a native biocontrol method of outplanting hatchery-raised native sea urchins (*Tripneustes gratilla*) to reduce the levels of invasive algae in the Waikīkī MLCD. Urchins are collected from the wild, spawned, and then raised in the Ānuenue Fisheries Research Center (AFRC) sea urchin hatchery. The urchins graze on invasive algae and prevent it from growing back over time. The native collector sea urchin *Tripneustes gratilla*, is capable of grazing at least five different species of invasive algae found on Hawai'i's reefs (Conklin and Smith 2005, Westbrook et al. 2015) and has been successful in controlling invasive algae on coral reefs (Conklin and Smith 2005, Neilson et. al. 2017 in-review).

The impacts of invasive algae to coral reefs are well documented. Invasive algae are capable of overgrowing reef building corals, outcompeting native species, physically altering the benthic habitat, and changing the aquatic environment (i.e., chemistry, irradiance, and sediment loading) (Russell 1983, Conklin & Smith 2005, Chandrasekaran

et al. 2008, Martinez et al. 2012, Rasher and Hay 2010, Davidson et al. 2015, Murphy & Richmond 2016). The dominant invasive algae species in Waikīkī, *Gracilaria salicornia,* impacts reef corals by decreasing exposure to sunlight via smothering, altering water chemistry (hypoxia and acidification), increasing sedimentation surrounding corals (Martinez et al. 2012), monopolizing reef habitats and reducing reef complexity (e.g. shelter, resting areas, and surfaces for reef organisms to attach) (Conklin 2007) (Fig 1).

Removal of invasive algae via biocontrol allows re-colonization and re-exposure of native species (Conklin and Smith 2005, Neilson et al. 2017 in-review). In addition, Conklin (2007) documented an increase in reef complexity after *G. salicornia* was removed from reef habitats. Although coral colonization may take several years to occur, monitoring results have shown statistically significant increases in corals, crustose coralline algae (important for coral recruitment), and bare space (e.g. sand, pavement, rubble) that could provide fish habitat and areas for colonization by native algae and invertebrate species once invasive algae has been removed (Conklin and Smith 2005, Neilson et al. 2017 in-review).

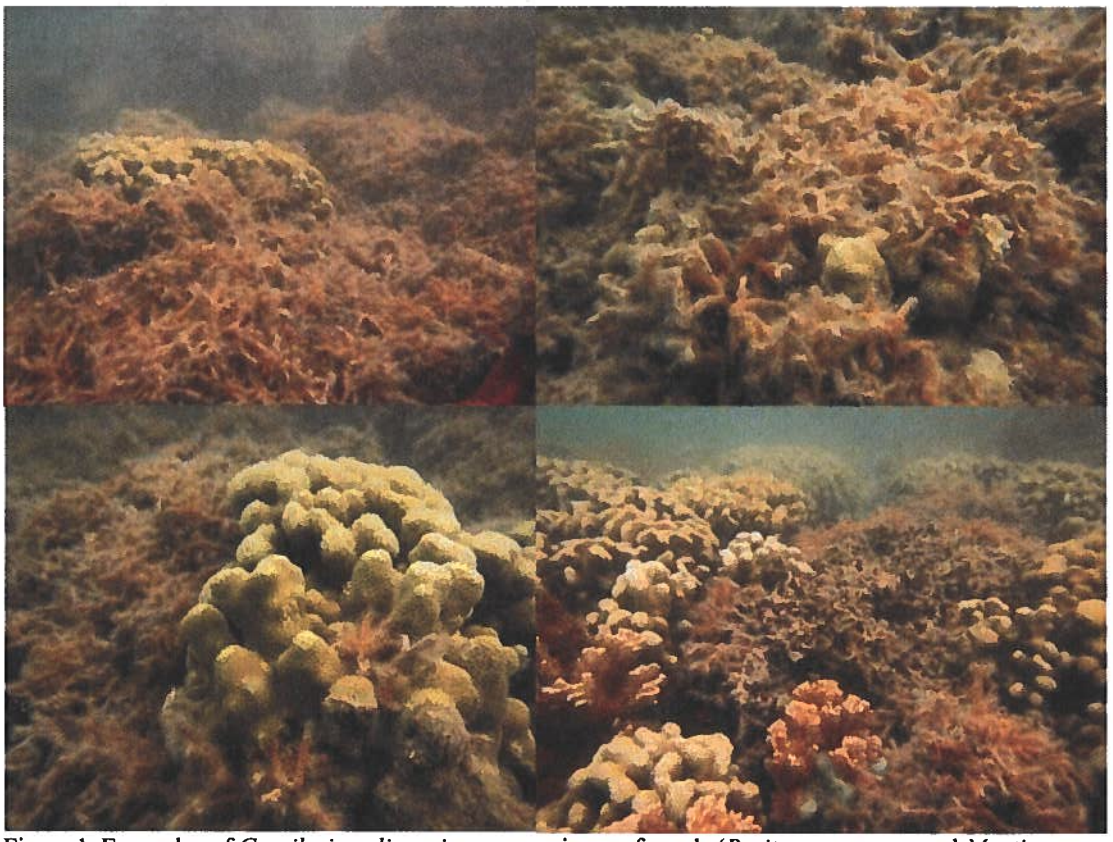

Figure 1. Examples of *Gracilaria salicornia* overgrowing reef corals (*Porites compressa* and *Montipora capitata* pictured).

Restoration Site

The Waikīkī MLCD is located at the east end of Waikīkī Beach on the south shore of O'ahu (Fig. 2). The Waikīkī MLCD encompasses 76 acres (30.76 hectares) of near-shore habitat. HAR Chapter 13-36 establishes Waikīkī MLCD as a "no take" protected area in which all forms of natural resource extraction are prohibited and recreational activities are limited. The State also regulates fishing and boating activities in the marine areas immediately adjacent to the MLCD.

A preliminary snapshot (SNAP) assessment was performed on the restoration reefs to determine hotspots of invasive algae. These invasive algae hotspots will be prioritized within the Waikīkī MLCD for treatment with sea urchin biocontrol (Fig 2).

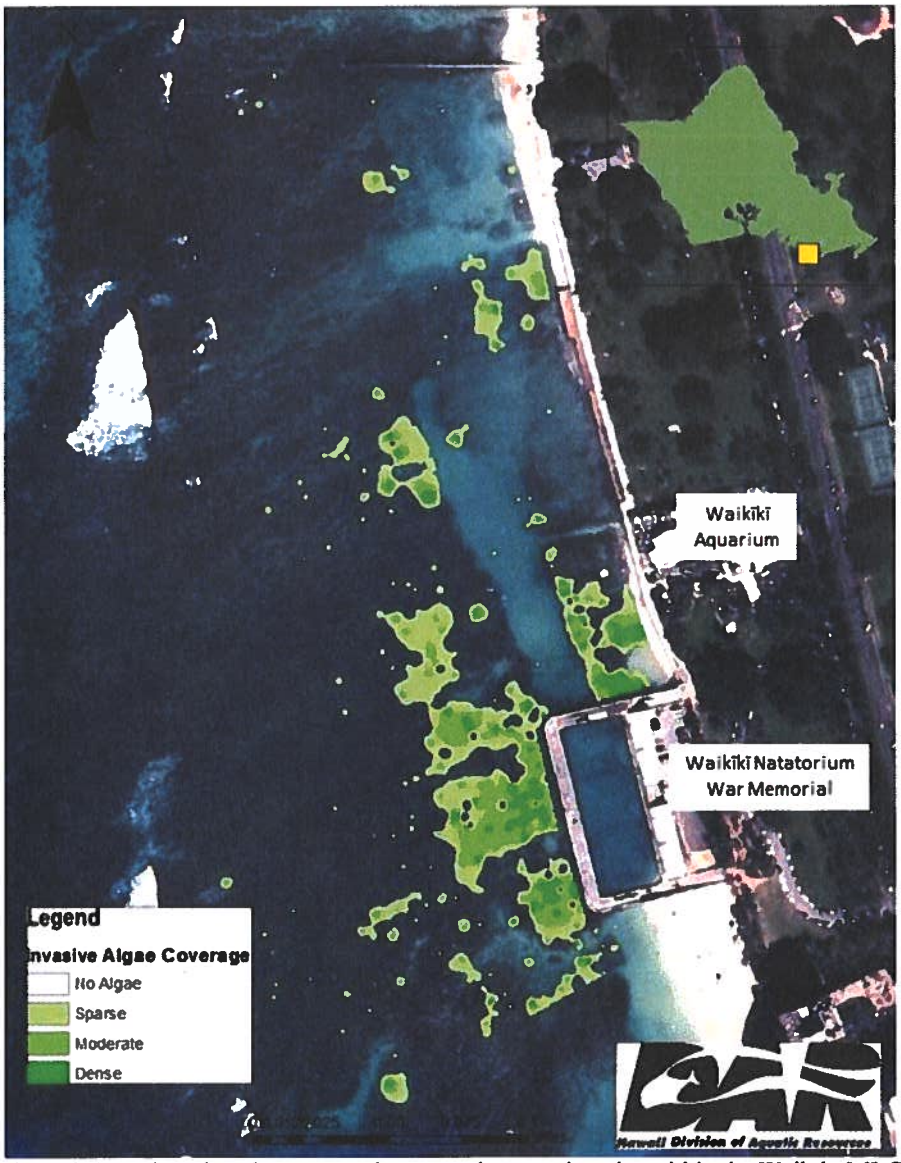

Figure 2. Invasive algae hotspots and proposed restoration site within the Waikīkī MLCD.

Restoration Methodology

Sea urchin outplanting will be used to treat invasive algae hotspots within the Waikīkī MLCD in order to control invasive algae, allow regrowth and colonization by reef corals, and increase habitat used by native fish, algae, and invertebrates.

Tripneustes gratilla will be produced in a hatchery using wild brood stock. Wild brood stock *T. gratilla* will be collected from local reefs and transported to the hatchery at the AFRC where they are spawned, fertilized, and reared to approximately 15 mm test diameter. The urchin hatchery produces approximately 100,000 urchins per year and it takes approximately six months to produce the first cohort. The hatchery's production will be split with another project during this period, therefore it is estimated that 50,000 urchins per year will be produced for this project over the course of approximately 30 months.

When urchins have reached a suitable size for outplanting they will be transported from the AFRC hatchery to the Waikīkī restoration site where divers will place urchins on invasive algae hotspots. Urchins are systematic in their grazing behavior. They have relatively low vagility and will stay in the general vicinity where they are out planted. In addition, urchins can easily be manipulated by divers and moved to different infestation areas if the invasive algae becomes sufficiently reduced in a particular reef area.

Previous restoration efforts have stocked sea urchins at a density of 4 urchins/m^2 when applied at a solid coverage across an area (Neilson et al. 2017 in-review). However, field surveys following urchin releases estimated only 0.5 urchins/m^2, a reduction of 3.5 sea urchins per m^2 (Neilson et al. 2017 in-review). The discrepancy between stocking density and field surveys densities may be explained by a number of factors including predation, emigration, and detectability. Despite the reduction in sea urchin density, invasive algae cover was significantly reduced and sustained over a two-year period with minimal sea urchin restocking (Neilson et al. 2017 in-review).

The sea urchin treatment proposed for the Waikīkī MLCD differs from previous approaches in that the invasive algae occurs in patches (hotspots) rather than a continuous coverage (Fig. 2). This will require a modification of previous methods by spot-treating invasive algae hotspots rather than outplanting urchins throughout a continuous area. Spot treating the patchy algae in the Waikīkī MLCD will require a higher concentration of sea urchins per square meter of algae, but less urchins per square meter of reef area. We estimate that approximately 6 urchins per square meter of algae will be needed to treat the area including maintenance stocking. The increased urchin density will account for emigration of urchins outside of the hotspots. Maintenance stocking will entail stocking additional urchins in areas where algae still persists after the initial treatment. It's estimated that 104,406 urchins will be necessary to treat the 4.3 acres of affected reef within the 18 acre area. Based on past hatchery production levels, it's possible to produce 104,406 urchins over a three year period.

DAR will conduct eight years of bi-annual monitoring in the Waikīkī MLCD to map invasive algae trends beginning when the first urchins are outplanted. This will allow for five years of monitoring after the final urchin outplanting. Invasive algae declines can be observed within months of sea urchin out planting at sufficient densities (Neilson et al. 2017 in-review). DAR's monitoring results show that urchins can graze invasive algae to levels < 5% cover within one year. Generally, the limiting factor in biocontrol efforts is the urchin hatchery's ability to produce urchins at sufficient quantities. Consequently, for the Waikīkī restoration site, DAR estimates it will take 2-3 years for the urchins to graze invasive algae to levels < 5% cover at projected hatchery production levels.

Project Outcomes

The outcome of this project will be the control of 4.3 acres of invasive algae from an approximate 18 acre area of coral reef habitat in the Waikīkī MLCD. This will result in the re-exposure of corals and suitable substrate for coral growth and colonization.

Project Timeline

<u>Urchin Hatchery and Outplanting</u>

Year 1: (March 1, 2018 – February 28, 2019)
- Q1: Collect, spawn and rear urchins
- Q2: Collect, spawn and rear urchins
- Q3: Collect, spawn and rear urchins
  Outplant first cohort of hatchery raised urchins
- Q4: Collect, spawn and rear urchins
  Outplant second cohort of hatchery raised urchins

Year 2: (March 1, 2019 – February 29, 2020)
- Q1: Collect, spawn and rear urchins
  Outplant third cohort of hatchery raised urchins
- Q2: Collect, spawn and rear urchins
  Outplant fourth cohort of hatchery raised urchins
- Q3: Collect, spawn and rear urchins
  Outplant fifth cohort of hatchery raised urchins
- Q4: Collect, spawn and rear urchins
  Outplant sixth cohort of hatchery raised urchins

Year 3: (March 1, 2020 – February 28, 2021)
- Q1: Collect, spawn and rear urchins
  Outplant seventh cohort of hatchery raised urchins
- Q2: Collect, spawn and rear urchins
  Outplant eighth cohort of hatchery raised urchins
- Q3: Outplant ninth cohort of hatchery raised urchins
- Q4: Outplant tenth cohort of hatchery raised urchins

Monitoring

Sea Urchin Biocontrol Monitoring
Monitoring in the Waikīkī MLCD will be conducted for eight years bi-annually to map invasive algae trends beginning with a baseline survey prior to the first urchin outplanting. This will allow for a five-year monitoring period after the urchin outplanting is complete. A monitoring report detailing the progress of the urchin biocontrol project will be prepared annually.

Coral Nursery Outplanting Monitoring
Transplanted and outplanted coral monitoring will be conducted according to the schedule outlined below. A monitoring report detailing the progress of coral outplanting will be prepared annually.

- Week 1: Monitor 3x (3 monitoring dives including Coral Restoration Nursery staff)
- Month 1: Monitor 1x/week (3 monitoring dives including Coral Restoration Nursery staff)
- Months 2 – 6: Monitor 1x/month (5 monitoring dives)
- Months 7 – 12: Monitor 1x/2 months (3 monitoring dives)
- Years 2 – 5: Monitor 2x/year (8 monitoring dives)

Budget Narrative (Detailed budget is shown in Appendix A)

The projected annual budget includes urchin hatchery costs, outplanting, and monitoring in the Waikīkī MLCD for three years as well as an additional five year monitoring costs for urchin outplanting and monitoring for the coral nursery outplanting project. For the three years of combined urchin outplanting and monitoring, the field restoration and monitoring budget is planned for two civil service biologists at 10% of their time and two civil service technician at 50% of their time. A RCUH Marine Resource Specialist and Field Technician will be working on the projects at 50%. From year four through the project completion, operational costs for field restoration and monitoring will be reduced by 50% as urchin outplanting will be complete. The urchin hatchery is staffed by RCUH employees and Kupu interns at 50% time. 50% of the urchin hatchery's output will be dedicated to this project for three years.

Year 1 – 3 annual average total (includes 5% annual increase)	$499, 657
Year 4 – 8 annual average total (includes 5% annual increase)	$125,004
Total Project Cost:	$2,123,991

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APPENDIX D:

Kapalama Offset Measures Scope of Work Modifications

APPENDIX D - DAR SCOPE OF WORK MODIFICATIONS

DOT-H has requested that DAR provide the following specifics for the offsets:

DOT-H Question:

1. **Confirmation that the proposed methodology to prorate the cost of the urchin project at the Waikiki MLCD is acceptable.**

DAR Answer: The following changes have been made to original proposal for the urchin project at the Waikiki MLCD in order to align as best as possible with the proposed prorated methodology (please see DAR Urchin Outplanting Project-Scope of Work-Final-KCT Development Offset Project for details):

1) **Change in Numbers of Urchins and Area:** The DAR Urchin Hatchery has made efforts to **reduce the number of urchins needed overall and has downsized the respective area to be outplanted with urchins**, as requested by DOT-H. However, DAR is not able to reduce the number of urchins and the area all the way down to numbers and areas **proposed in the prorated plan** because, based on previous trials, this will not be effective in achieving the desired results of restoration. DAR is required to fulfill deliverables in order to qualify as a successful offset measure project and therefore needs to employ the same types of methodologies that have been successful in the past. The prorated cost of the urchin project cannot be accepted as proposed; an alternative has been outlined below.

   The sea urchin treatment proposed for the Waikīkī MLCD differs from previous approaches in that the invasive algae occurs in patches (hotspots) rather than a continuous coverage. These patches amount to roughly 4.3 acres (equal to KCT impact area) but sit within a larger area. The larger area to be treated equals 18.5 acres, but as stated above, the area of algae to be grazed is approximately equal to the KCT impact area; the long-term loss of 305 meters (m) (1,000 feet [ft.]) of shoreline, 5,710 square meters (m2 (1.4 acres) of natural hard substrate, and the short-term loss of the 11,844-m2 (2.9-acre) fouling community on hard substrate (total = 4.3 acres).

   In the past, a systematic approach was used to outplant urchins to achieve a relatively consistent urchin density throughout the entire reef or area proposed (i.e. larger numbers such as those proposed initially were utilized. In order to reduce the number of urchins as requested, this unique patchy distribution of algae within the Waikīkī MLCD will require a modification of previous methods by spot-treating invasive algae hotspots rather than outplanting urchins throughout a continuous area. Spot treating the patchy algae in the Waikīkī MLCD will require a higher concentration of sea urchins per square meter of algae, but less urchins per square meter of reef area. DAR has reduced the number of urchins overall and focused on populating the essential areas (areas with dense patches of algae) with higher densities of urchins per focused area than previously employed (i.e. enough urchins to effectively graze the algae-dense areas without having to conduct continuous maintenance to keep the urchins in these focused areas). DAR estimates that approximately six (6) urchins per square meter of algae will be needed to treat the area, including maintenance stocking (replacing urchins after natural mortality or predation). The increased urchin density will account for emigration of urchins outside of the hotspots. Maintenance

stocking will entail stocking additional urchins in areas where algae still persists after the initial treatment.

270,000 urchins were originally proposed; number has been reduced to 104,406 urchins. 104,406 urchins will be necessary to treat the 4.3 acres of algae covered reef within the 18-acre area.

The suggested lower prorated amount of 62,647 urchins would be equal to the number of urchins needed for 4.3 acres at three (3) urchins per $1m^2$ with 20% mortality.

The proposed increase from 62,647 urchins to 104,410 urchins is equal to the number of urchins needed 4.3 acres at approximately six (6) urchins per $1m^2$ with 20% mortality.

This increased density per square meter will provide sustained grazing pressure, while accounting for some emigration of the urchins from each algae-dense area and avoiding frequent manual "herding" of the biocontrol.

If urchins are outplanted in minimally "clumped" densities as proposed with the prorated plan (62,647 urchins), then divers will have to conduct more frequent maintenance on a weekly to monthly basis for 2-3 years (locating the urchins and returning them back in the algae-dense areas by hand), instead of the less frequent maintenance proposed in this new scope of work. More frequent maintenance would require extensive manpower and increase costs.

In order to preserve the effectiveness and success of the biocontrol measure, DAR needs to outplant the urchins using a methodology that is based on the types of biocontrol behavior and movements that have been observed in earlier restoration efforts.

2) Change in Timeline: The second change is a **reduced timeline** for the production of urchins from the previous proposal and an increased timeline with the addition of monitoring. **Production of Urchins**: The first cohort will take 6 months. In order to account for a more accurate production rate of urchins per year, the rate per year has been modified to 60,000 urchins per year instead of 100,000. It is more realistic to incorporate a conservative projection of average production rate, as this is a potential outcome. Therefore, based on this average production levels, it's possible to produce 104,406 urchins over a 30-month period, including the first 6 months. The previous timeline included the production of 270,000 urchins and would have required about 38 months. **Monitoring**: Monitoring has been included in this scope of work; monitoring would be conducted for a five (5) year period after the last outplanting of urchins to document changes in benthic cover as a result of the application of biocontrol.

3) Change in Monitoring. The third change in the scope of work for the urchin outplanting project is the **incorporation of monitoring costs** for both offset measure projects (the urchin and coral production projects) for a full five (5) year-period after the end of the outplanting phases for both projects. The same field team that outplants the urchins will conduct benthic surveys to document the change in benthic cover after biocontrol has been applied and the health status and growth rate of the coral colonies once outplanted.

The attached scope of work for the coral project also includes a lesser degree of monitoring (specific to the health of the coral colonies in terms of parasites or disease) and will take place between coral outplantings (during the first three years), but the coral project budget does not include monitoring for the five years post completion of final outplantings.

Urchin project cost totals:

Total Project Cost: (new proposal 3 yrs. outplanting + 5 yrs. monitoring)	**$2,123,991**
Total Project Cost: (old proposal 3 yrs. outplanting + 0 yrs. monitoring)	$1,700,000

Urchin project cost per year:

Year 1 – 3 (new proposal) annual avg. total (includes 5% annual increase) -OUTPLANTING
= $499,657 x 3

Year 4 – 8 (new proposal) annual avg. total (includes 5% annual increase) - MONITORING
= $125,004 x 5

Year 1 – 3 (old proposal) annual average total (includes 5% annual increase) - OUTPLANTING
= $566, 666 x 3

Year 4 – 8 (old proposal) annual average total (includes 5% annual increase) – = not included

DOT-H Question:

2. Confirmation that the proposed years (2.33 years) of funding for the DLNR-DAR coral nursery is acceptable.

1) **Change in Timeline:** The DAR Coral Nursery has recalculated it's expected timeline to 3 years (36 months) of funding (with 6 months preparatory time for building out the facility in order to accommodate these corals): **total = approximately 36 months**. **Monitoring**: Monitoring has been included in the DAR Urchin Outplanting Project-Scope of Work-Final-KCT Development Offset Project; monitoring would be conducted for a five (5) year period after the last outplanting of coral colonies to document changes in benthic cover as a result of the outplanting

of new coral colonies. Select amounts of monitoring (specific to the health of the colonies) will be conducted by the Coral Restoration Nursery during outplanting (within the first 3 years) in order to verify that colonies are acclimating to their new environment; the smaller monitoring efforts are included in the DAR Coral Restoration Nursery-Scope of Work-Final-KCT Development Offset Project.

Other changes to the coral nursery are as follows (please see scope of work DAR Coral Restoration Nursery-Scope of Work-Final-KCT Development Offset Project for details):

2) **Change in Numbers of Corals to be outplanted:**
The DAR Coral Restoration Nursery has recalculated the estimated number of colonies need to replace the ecological functions and services of the ≈ 56,698 colonies (<40cm) on the project seafloor to be impacted by the KCT development.

The number of colonies required to offset impact has **changed from 248 colonies (as initially proposed) to 475 colonies. The following table from the KCT Coral Transplantation Plan 2016** (pg. 13) was modified to display the proposed actions for different size-classes of coral colonies to be impacted by the KCT Development Project and used to populate the DAR Coral Ecological Services and Functions Characterization Tool to determine the amount and sizes of colonies per species that need to be grown and outplanted by the DAR Coral Restoration Nursery.

Sea-Floor Colonies to be Impacted by KCT Development										
Coral Species	1-5 cm	6-10 cm	11-20 cm	21-40 cm	Totals per species for DAR CRN to Grow	41-80 cm	81-160 cm	>160	Transplant Totals per Species	
Cyphastrea ocellina	14	0	7	0	21	0	0	0	0	
Leptastrea sp.	13943	1059	13	0	15015	0	0	0	0	
Pavona varians	0	0	8	0	8	0	0	0	0	
Porites compressa	14	0	0	7	21	0	7	0	7	Porites compressa
Porites lobata	28035	9609	3368	621	41633	101	7	0	108	Porites lobata
	42,006	10668	3396	628	56698	101	14	0	115	
	56,698					115				
	Totals to not be transplanted; To be regrown and outplanted by the DAR					To Be Transplanted				

This change from the initially proposed amount of colonies is due to the theory that the colonies (<40cm) that were identified as *Porites lobata* from the surveys (41,633 out of the total of 56,698 (≈73%)), have a high probability of actually being the non-native coral recently discovered in Honolulu Harbor, tentatively called "Harbor *Porites*". In order to replace the ecological function and services of these colonies with native species (e.g. *Porites lobata, Porites evermanni* or *Porites compressa*), the DAR Coral Restoration Nursery will need to collect and sample native colonies from areas outside the harbor, fragment these colonies and use this source material to generate double the volume of colonies using the fast grow method in the nursery. This means that the nursery will replace the native colonies from which it sampled outside the harbor for source material, so that these ecological functions and services are

replaced, in addition to outplanting new colonies that will function as replacements for those "*Porites lobata*" colonies (41,633) that are impacted from the KCT Development.

From the DAR Coral Restoration Nursery-Scope of Work-Final-KCT Development Offset Project:

Determination of Loss Using the DAR Coral Ecological Services and Functions Characterization Tool for Kapalama Seafloor Corals. Results are presented in terms of the number of coral colonies and the DAR Hawaiian Coral Ecological Characterization Value (ECV):

Kapalama Seafloor Coral **Loss** Projections (based on AECOS and/or Dollar data)
Corals < 40 cm [Total of 56,698 coral colonies with an ECV of 183,656]

i. *Porites compressa* 21 colonies, ECV = 168
ii. *P. lobata* (?) 41,633 colonies, ECV = 167,338
iii. *Pavona varians* 8 colonies, ECV = 16
iv. *Leptastraea spp.* 15,015 colonies, ECV = 16,113
v. *Cyphastraea ocellina* 21 colonies, ECV = 21

Corals < 40 cm [Total of 245 coral colonies with an ECV of 188,276 need to be produced to offset 56,698 coral colonies impacted with an ECV of 183,656]:

i. Porites compressa 7 total colonies, ECV = 4,480
7 colonies 42cm each

ii. P. lobata 110 total colonies, ECV = 39,500
25 colonies 20+cm each
80 colonies 42cm each
5 colonies 80+cm each

iii. P. evermanni 100 total colonies, ECV = 142,000
25 colonies 20+cm each
70 colonies 42cm each
5 colonies 80+cm each

iv. Pavona varians 8 total colonies, ECV = 160
8 colonies 20cm+ each

v. Leptastraea spp. 13 total colonies, ECV = 2,080
13 colonies 42cm each

i. Cyphastraea ocellina 7 total colonies, ECV = 56
7 colonies 20cm+ each

While producing 245 colonies to outplant, 10 of these colonies would be 80+cm long and involve the connection of two 42cm genetically-identical colonies together each, resulting in a total of

255 total colonies needing to be produced at the Coral Restoration Nursery in order to outplant 245 colonies onto natural reef flats. Additionally, sourcing the *P. lobata* and *P. evermanni* would require growing an additional 220 colony frags to return to the original source site (i.e. collect 30cm fragments of *P. lobata* and *P. evermanni* from natural reefs to outgrow three 42cm colonies (one from each 10cm fragment of the original 30 cm piece), one each of these three 42cm colonies would be returned to the original source site.

Natural seafloor frag outplants to replace Harbor corals <40cm require a total of 475 colonies (i.e. 245 colonies to outplant, plus 10 additional colonies to produce 80+ cm outplants, plus 220 colonies to replace source coral material at collection sites outside Honolulu Harbor (to offset the Harbor Porites)) to replace the 56,698 colonies (<40 cm) projected to be lost. Total number of colonies to be grown at the Coral Restoration Nursery would therefore be **245 + 10 + 220 = 475 colonies**. This will require 3 years of funding (**Total $ 2,257,800**).

3) **Change in Estimated Costs:**

Coral project cost totals:

Total Project Cost: (new proposal: 6 months nursery expansion and 3 yrs. of coral module outplanting (475 colonies) and monitoring of modules between outplanting dates = total ≈ 3.5 years):
= $2,257,800

Total Project Cost: (old proposal 2.33 yrs. coral module outplanting (248 colonies) + 0 yrs. monitoring + 0 years expansion = total 2.33 yrs.): = $1,398,000

Coral project cost per year:

Year 0.5 – 3 (new proposal) annual avg. total -OUTPLANTING (475 colonies) + concurrent monitoring
=$680,000 x 3

Year 0 – 0.5 (new proposal) annual avg. total - one-time cost for Coral Fragment Room expansion

=$223,800 x 1

Year 1 – 2.33 (old proposal) annual avg. total – OUTPLANTING (248 colonies) + concurrent monitoring (not included) =$600,000 x 3

Year 0 – 1 (old proposal) annual avg. total - one-time cost for Coral Fragment Room expansion (not included) = not included

3. Determination if offsets would be required for coral growing on artificial (manmade) structures. Please note that the USACE does not require offsets for corals growing on artificial

structures. However, if they are required by DLNR-DAR, what would be needed to provide the offset and what is the cost of the offset.

DAR does not distinguish between coral growing on natural and artificial substrate. However, DAR recognizes that the recent unforeseen increase in costs necessary to fully execute the primary offset projects will likely render it financially infeasible to add further offsets for the corals on artificial substrates. DAR is comfortable moving forward without secondary offsets for the corals on artificial substrate, so long as the primary offset measures proposed here are funded in their entirety.

4. **Confirmation that the cost for the urchin and coral projects include obtaining all necessary permits and approval for the urchin and coral outplanting.**

DAR is currently inquiring with state agencies to determine if permits are needed to implement these offset measure projects and can account for any state permits that may be required. Coral Project DAR biologist will confirm with state agencies of requirements and notify DOT-H of response. At this time the need for federal permits has not been determined.

5. **The scope of services provided by DLNR-DAR needs to be revised to include more detail on the services to be provided including but not limited to identifying existing and/or new staff and facilities needed to support the urchin and coral projects; proposed outplanting sites for corals grown and/or quarantined in the coral nursery; required permits and/or approvals needed urchin and coral outplanting; outplanting methodology and monitoring details for urchins and coral outplanting.**

Please see the attached scopes of work and the additionally attached document titled Kapalama Offset Measures Scopes of Work Modifications; these documents include all updated details, including: identifying existing and/or new staff and facilities needed to support the urchin and coral projects; proposed outplanting sites for corals grown and/or quarantined in the coral nursery; outplanting methodology and monitoring details for urchins and coral outplanting.

APPENDIX E:

DAR Coral Restoration Nursery Kapalama Projects

APPENDIX E - DAR CORAL NURSERY PLAN

DAR Coral Restoration Nursery Kapalama Projects

The State of Hawaii Department of Land and Natural Resources is providing the following draft projections to offset the loss of living Hawaiian coral colonies within the Kapalama project area as provided for under applicable State law and rules.

A. Primary Proposed Action Presented to DLNR

Transplant all corals larger than 40 cm; offset for all corals smaller than 40 cm occurring on natural seafloor substrate within the Kapalama project area.

This scenario involves moving all corals larger than 40 cm to the identified transplant site (work to be conducted by commercial divers), collection of non-Harbor *Porites* Kapalama corals >10 cm and <40 cm that can be fast-grown at the Coral Restoration Nursery, and outplanting of resulting fast-grown Coral Restoration Nursery corals to pre-approved outplant sites on natural reefs. DAR would offset potentially harmful Harbor *Porites* corals for native *P. lobata* and *P. evermanni*, that would be grown and outplanted from the Coral Restoration Nursery (with replacement also to the donor site)[1].

B. Determination of Loss Using the DAR Coral Ecological Services and Functions Characterization Tool for Kapalama Seafloor Corals. Results are presented in terms of the number of coral colonies and the DAR Hawaiian Coral Ecological Characterization Value (ECV):

Kapalama Seafloor Coral **Loss** Projections (based on AECOS and/or Dollar data)

Corals < 40 cm [Total of 56,698 coral colonies with a ECV of 183,656]

i. *Porites compressa* 21 colonies, ECV = 168
ii. *P. lobata* (?) 41,633 colonies, ECV = 167,338
iii. *Pavona varians* 8 colonies, ECV = 16
iv. *Leptastraea spp.* 15,015 colonies, ECV = 16,113
v. *Cyphastraea ocellina* 21 colonies, ECV = 21

C. Kapalama Seafloor Coral **Offset** Projections Using Source Harbor and Non-Harbor (*Porites*)[1] Corals to Fast-Grow Colonies at the Coral Restoration Nursery for Outplanting Outside Honolulu Harbor.

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[1] Offsetting of native *Porites lobata* and *Porites evermanni* for Harbor *Porites* involves collection of 20cm of donor coral to produce two 10cm tissue fragged modules which will grow over eight months at the Coral Restoration Nursery into two 42cm colony modules; one of the modules will be outplanted as offset for the Kapalama project and the other will be returned to the donor site. Under this scenario the impact is minimized as we have balanced lost services and functions from the donor site by returning a far larger colony to offset the nine months of use off-site (Note: If 80+cm colonies are to be outplanted, would collect 30cm of donor coral and frag into three 10 cm fragged modules grown into 42cm modules, two of which will be joined together to form a 80+cm module, and the third returned to the donor site).

Corals < 40 cm [Total of 245 coral colonies[2] with a ECV of 188,276 need to be produced to offset 56,698 coral colonies impacted with a ECV of 183,656]:

i. *Porites compressa* 7 total colonies, ECV = 4,480
   7 colonies 42cm each

ii. *P. lobata* 110 total colonies, ECV = 39,500
   25 colonies 20+cm each
   80 colonies 42cm each
   5 colonies 80+cm each

iii. *P. evermanni* 100 total colonies, ECV = 142,000
   25 colonies 20+cm each
   70 colonies 42cm each
   5 colonies 80+cm each

iv. *Pavona varians* 8 total colonies, ECV = 160
   8 colonies 20cm+ each

v. *Leptastraea spp.* 13 total colonies, ECV = 2,080
   13 colonies 42cm each

i. *Cyphastraea ocellina* 7 total colonies, ECV = 56
   7 colonies 20cm+ each

Target outplanting sites would include appropriate open substrate areas within the Waikiki MLCD reef, the HNL Reef Runway reef (eastern end) and possibly the outer reef area between the two channels fronting Honolulu Harbor and Sand Island.

C. Budgeting for Coral-Related Efforts to be Conducted:

For all of the Offset Projects involving live coral, budgeting needs to be broken down as follows:

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[2] While producing 245 colonies to outplant, 10 of these colonies would be 80+cm long and involve the connection of two 42cm genetically-identical colonies together each, resulting in a total of 255 total colonies needing to be produced at the Coral Restoration Nursery in order to outplant 245 colonies onto natural reef flats. Additionally, sourcing the *P. lobata* and *P. evermanni* would require growing an additional 220 colony frags to return to the original source site (i.e. collect 30cm fragments of *P. lobata* and *P. evermanni* from natural reefs to outgrow three 42cm colonies (one from each 10cm fragment of the original 30 cm piece), one each of these three 42cm colonies would be returned to the original source site. Total number of colonies to be grown at the Coral Restoration Nursery would therefore be 245 + 10 + 220 = 475 colonies.

1. Collection Costs – these costs would include the costs to DAR of assessing corals pre-collection for viability and AIS, actual collection and transport of coral colonies to AFRC. It would also include costs of collecting outside *Porites* colonies with the understanding that for each 20 cm of coral collected, two 40 cm colonies would be produced (one for offsetting Kapalama coral and the other to be returned to the site of collection to offset the original collection impact)[3].
2. Quarantine Costs – these costs include costs to DAR to maintain collected corals for fast-growth under quarantine until they are fragged and fast-grown.
3. Holding Costs – these costs cover the cost of just holding Kapalama corals at AFRC until they are transplanted (does not include fast-grown corals). They include necessary re-fitting and re-plumbing costs, utilities, and staffing to care for the corals for a period of up to one year.
4. Expansion Costs – Depending upon the number of corals to be outplanted (fast-grown), expansion of the coral nursery may be necessary to increase fast-growth capacity. Such costs include re-fitting of the existing indoor office area to create a second fast-growth room and modification of outside areas to provide for additional fast-growth facilities. Increased electrical line, pumps, plumbing would be required. It would also include two office containers and covered deck to replace the indoor office areas to be converted for fast-growth.
5. Fast-Growth Costs – These are the costs to produce a 42cm colony (or other size as listed) from 10cm of source material over an 8 – 10 month period. Includes supplies, equipment, labor, and utilities.
6. Acclimation Costs – Costs for the time and materials required to acclimate the colonies to be out-planted to their out-planting environment (approximately 1 month for each batch of fast-grown colonies to be outplanted).
7. Outplant Costs – Costs to assess out-plant sites, establish baseline, and transport out-plant colonies to the field, prepping the out-plant site, and attaching the colonies to the substrate.
8. Monitoring Costs – monitoring costs only include costs for monitoring outplanted corals during the firstmonth of outplant to determine viability and replacement needs. All other required monitoring (costs not included in this budget) will be done independently by the DAR AIS Team as part of the larger project monitoring:

    - Week 1: Monitor 3x (3 monitoring dives including Coral Restoration Nursery staff)

    - Month 1: Monitor 1x/week (3 monitoring dives including Coral Restoration Nursery staff)

[3] Except for where 80+ cm colonies are to be produced; in that case, 30cm pieces would be collected to be fragmented into three 10cm frags, each of which will be grown into a 42cm module; two of the 42cm modules will be connected together to form a single 80cm+ colony for outplanting, and the remaining 42cm module will be outplanted back into the original collection site.

- Months 2 – 6: Monitor 1x/month (5 monitoring dives done just by DAR AIS Team)

- Months 7 – 12: Monitor 1x/2 months (3 monitoring dives done just by DAR AIS Team)

- Years 2 – 5: Monitor 2x/year (8 monitoring dives done just by DAR AIS Team)

Most of the monitoring for these projects would be conducted by DAR AIS Team personnel over the time periods listed and would be batched in with their other Kapalama projects.

D. Projected Annual Preferred Budget (Detailed budget is shown in Appendix I):
With Frag Room and Outside Expansion of the Coral Restoration Nursery up to 200 40cm+ fast-grown colonies per year could be produced:

Staffing	$411,300	
Travel	$16,500	
Supplies	$65,300	
Equipment	$51,400	
Contractual	$7,800	
Other (incl Utilities)	$80,747	
	Sub	$633,047
Averaged Annual Increases (~5%) Over the Life of Project		$46,953
	Total Annual Cost[4]:	$680,000

With expanded infrastructure at the Coral Restoration Nursery, can produce up to 200 fast-grown colonies per year[5]:

Natural seafloor frag outplants to replace Harbor corals <40cm require a total of 475 colonies (i.e. 245 colonies to outplants, plus 10 additional colonies to produce 80+ cm outplants[5], plus 220 colonies to replace source coral material at collection sites outside

[4] Annual cost for Frag Room expansion does not include the one-time cost (in Year 1) of $223,800 for creation of replacement office area to allow for a second frag room, and outside growth raceways and a required electrical upgrade; replacement office area would consist of converted shipping containers to replace existing office building area to be converted into the second frag room for fast-growth (added in to the final total cost shown).

[5] Assumes 8 months prior for first coral outplant (i.e. start-up time).

Honolulu Harbor (to offset the Harbor *Porites*)) to replace the 56,698 colonies (<40 cm) projected to be lost. This will require 3 years of funding[5,6,7,8] (**Total $ 2,257,800**)[4,9].

E. Project Timeline (Assumes Coral Restoration Nursery Expansion and Shorter Time Frame)

Year 0 (Estimated to be Jan – Jun 2018):

Quarters 3 - 4:

Funds Deposited with DLNR
Assess HNL Harbor for Collection
Collect HNL Harbor Corals
Assess Ex-Situ Coral Locations for Collection
Collect Ex-Situ Corals
Prep - New Frag Room
Prep – Quarantine
Order Trailers, Prep site
Remove outside round tanks
Order tanks, raceways, pumps, sand filter, plumbing, fiber grating
Hire new positions

Year 1: (July 1st, 2018 – June 30, 2019)

Q1: Finish new frag room and stabilize tank systems, relocate office
First 80 modules in existing frag room

Q2 Second 80 modules in new frag room

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[6] While producing mostly 42cm colonies, would also produce 8 80+cm colonies which would each involve the connection of two 42cm genetically-identical colonies together, resulting in a total of 16 total colonies needing to be produced at the Coral Restoration Nursery in order to outplant the 8 80+cm colonies onto natural reef flats. Additionally, sourcing the *P. lobata* and *P. evermanni* would require growing an additional 8 colonies to return to the collection site (i.e. collect 30cm fragments of *P. lobata* and *P. evermanni* on reef to outgrow three 42cm colonies (one from each 10cm fragment of the original 30cm piece). Total number of colonies to be grown at the Coral Restoration Nursery would therefore be 8 + 8 + 8 = 24 coral colonies.

[7] Offsetting of native *Porites lobata* and *Porites evermanni* for Harbor *Porites* involves collection of either 20cm or 30 cm of donor coral to produce two to three 10cm tissue fragged modules which will grow over eight months at the Coral Restoration Nursery into two to three 42cm colony modules; for 42cm outplants, one of the modules will be outplanted as offset for the Kapalama project; for 80+cm outplants, two of the 42cm genetically-identical modules will be joined together, the remaining 42cm module will be returned to the donor site. Under this scenario the impact is minimized as we have balanced lost services and functions from the donor site by returning a larger colony to offset the nine months of use off-site at the Coral Restoration Nursery.

[8] Includes 6 months of pre-production time as shown in schedule between January and June 2018.

[9] Includes all stages (other than long term monitoring, which will be covered by the DAR AIS Team).

Q3

Q4 First 80 modules to outplant (80 total outplanted), 3rd 80 modules in existing frag room

Year 2: (July 1st, 2019 – June 30, 2020)

Q1 Second 80 modules to outplant (160 total outplanted), 4th 80 modules to new frag room

Q2

Q3 Third 80 modules to outplant (240 total outplanted), 5th 80 modules to existing frag room

Q4 Fourth 80 modules to outplant (320 total outplanted), 6th 80 modules to new frag room

Year 3: (July 1st, 2020 – June 30, 2021)

Q1

Q2 Fifth 80 modules to outplant (400 total outplanted), 7th 70 modules to existing frag room

Q3 Sixth 80 modules to outplant (475 total outplanted)

F. Possible Secondary Action: Transplant only non-*Porites lobata* corals larger than 40 cm within Honolulu Harbor, offset for the *Porites lobata* corals that are questionable (Harbor *Porites*?).

This scenario involves moving only non-Harbor *Porites* (i.e. corals that can be positively identified as not being Harbor *Porites*) corals larger than 40 cm to the identified transplant site (work to be conducted by commercial divers), collection of non-Harbor *Porites* Kapalama corals >10 cm and <40 cm that can be fast-grown at the Coral Restoration Nursery, and outplanting of fast grown corals to pre-approved outplant sites on natural reefs to offset both small (<40 cm) Kapalama corals (all species) and those Kapalama corals > 40 cm that might have been Harbor *Porites*. We would offset Harbor *Porites* corals for native *P. lobata* and *P. evermanni*, that would be grown and outplanted from the Coral Restoration Nursery (with replacement also to the donor site)[1].

a. Determination of Loss Using the DAR Coral Tool for Kapalama Seafloor Corals. Results are presented in terms of the number of coral colonies and the DAR Hawaiian Coral Ecological Characterization Value (ECV):

   Corals > 40 cm [Total of 168 coral colonies with a ECV of 21,030] to be transplanted?

   i. *P. compressa* 7 colonies, ECV = 2,800
   ii. *P. lobata* (?) 153 colonies, ECV = 18,150
   iii. *P. varians* 8 colonies, ECV = 80

b. Kapalama Seafloor Coral **Offset** Projections Using Source Non-Harbor *Porites* Corals to Fast-Grow Colonies at the Coral Restoration Nursery for Outplanting.

   Corals > 40 cm - If the corals to be transplanted turn out to not be *P. lobata* (i.e. Harbor *Porites*)[Total of 8 80+cm coral colonies with a ECV of 20,000 needed to offset 153 coral >40cm colonies impacted with a ECV of 18,150].

   i. *P. lobata* 4 colonies, ECV = 4,000
   ii. *P. evermanni* 4 colonies, ECV = 16,000

c. Additional Cost (to above listed total budget for all corals <40cm) for Growing *Porites* Corals to Replace Harbor *Porites* >40cm.

   If replacement of all of the >40cm *P. lobata* (Harbor *Porites*(?)) corals are added in, this would require only an additional 24 colonies to be produced for a total of 499 colonies. This will require 3.3 years of funding[6,7] (Total $2,467,800)[4,8]. Note that this is total cost for the entire Kapalama coral project at the Coral Restoration Nursery (i.e. all corals <40cm and *Porites lobata* (?) corals >40cm).

G. Overview of Issues That Need To Be Addressed for all Kapalama Coral Projects:

- The State considers the risk of invasive species (cryptic or endofaunal, associated either directly with the target coral colonies or their base structures) or other contaminant introduction to outweigh any value from transplantation of live coral directly from within Honolulu Harbor to areas outside the harbor.

- The vast majority of the live corals documented within the Kapalama Project area were classified as *Porites lobata*. The State believes that a majority of these corals may be another species that currently is only found within Honolulu Harbor and near the Keehi SBH (closest to the Kalihi Channel Bridge). This unidentified *Porites* species (tentatively titled "Harbor Porites") cannot currently be classified as native or non-native, yet shows characteristics that would make it competitively superior to native corals (asexual planulator, extremely temperature and salinity tolerant, able to withstand broad changes in water quality and exposure). As such, we have strong concerns regarding any transplantation (inside or outside of the harbor) of this unidentified *Porites* species. The State proposes substituting non-harbor *Porites* (native *P. lobata* and *P. evermanni*) for the Harbor *Porites;* these replacement corals would be sourced from outside Honolulu Harbor and would be returned to their collection sites after frag and fast growth at the Coral Restoration Nursery in amounts that account for loss of services and functions.

- The Coral Restoration Nursery currently has the capacity to produce up to eighty (80) 40-cm (longest diameter) coral colonies (each from 10 cm source material) per year. With conversion of both outdoor and indoor available areas at the Coral Restoration Nursery to fast growth facilities, capacity can increase to one hundred sixty (160) to two hundred (200) 40-cm coral colonies (each from 10 cm source material) per year. This will require replacement of current office and holding tank areas, an additional electrical line, equipment, and staff increases.

- The Coral Restoration Nursery currently has the capacity to hold up to two thousand (2,000) small coral colonies (<40 cm) or one hundred (100) larger corals (> 40 cm) in two of its large acclimation tanks for a period of up to one year with upkeep. Under this scenario, both source material for outplanting of fast-grown corals and holding of large (>40 cm) colonies could occur along with re-tasking and modification of large external tanks located elsewhere at AFRC, otherwise corals for outplanting would be delayed slightly due to large acclimation tanks being used to hold corals during the first year for in-harbor transplant. If other large aquaculture tanks at AFRC were re-fitted and re-plumbed, along with the addition of another 3Hp 3-phase pump, we could hold up to 8,000 small corals and all the large corals (200+) without any delay of fast-grown coral production. Under this scenario one additional coral technician position would need to be added to care for these corals, and possibly an additional electrical line for the harbor pump.

H. Issues Regarding In-Harbor Transplantation versus Coral Restoration Nursery Out-Planting
Strong distinctions need to be made between in-harbor transplantation of coral colonies directly and outplanting of coral colonies produced at the Coral Restoration Nursery; they are distinctively different and directly non-equitable.

1. Transplantation of corals within the harbor involves movement of un-modified colonies (along with all of their associated natural and potentially-invasive endo- and ecto-symbionts, along with epi-fauna to the transplant site on the other side of Honolulu Harbor, a site which is distinctly different in terms of critical coral parameters from the donor site (in regards to light, water motion, invasive species, turbidity, substrate angle, etc.). As there has been no pilot study conducted, there is not confidence that such a transplantation conducted en masse will be successful and could in fact damage or severely impact the existent extensive coral congregation existing at the proposed transplant site. Previous attempts at transplantation within Honolulu Harbor for other projects have not been successful; however DAR feels that with some modification of scale, and if done in discrete phases and with careful oversight, moderate success may be expected.

2. Outplanting of corals onto natural coral reef produced from Harbor donor corals, fragged down and then fast-grown into large coral colonies at the State's Coral Restoration Nursery has been repetitively shown to be successful at our initial outplant site outside Honolulu Harbor; we have monitored numerous outplantings of large (40 cm) colonies starting late last year and have not experienced any significant colony mortality and continue to see healthy coral colonies (based on color and tissue coverage) compared with natural colony assemblages at the outplanting sites (See attached outplant photos).

I. Alternative (Non-Preferred) Budget Scenario Using Existing Coral Restoration Nursery Facility

1. Existing Infrastructure Budget (up to 80 40cm+ fast-grown colonies/year)

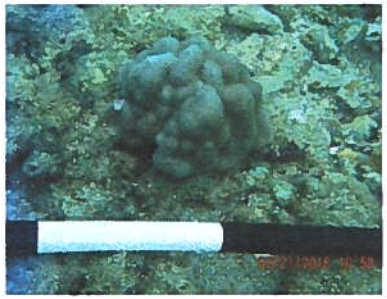
Staffing	$302,700	
Travel	$15,000	
Supplies	$41,300	
Equipment	$32,100	
Contractual	$7,800	
Other (incl Utilities & Overhead)	$59,811	
Sub		$458,311
Averaged Annual Increases (~5%) Over the Life of Project		$48,354
Total Annual Cost:		$510,000

With existing infrastructure, can produce up to 80 fast-grown colonies per year: Natural seafloor frag outplants require a total of 475 colonies (i.e. 245 colonies to outplants, plus 10 additional colonies to produce 80+ cm outplants, plus 220 colonies to replace source coral material at collection sites outside Honolulu Harbor (to offset the Harbor *Porites*) to replace the 56,698 colonies (<40 cm) projected to be lost. This will require 6.4 years of funding[8] (**Total $ 3,264,000**).

If replacement of the >40cm *P. lobata* (Harbor *Porites*(?)) corals are added in, this would require an additional 24 colonies to be produced for a total of 499 colonies. This will require 6.8 years of funding[6,7] (Total $3,468,000)[9].

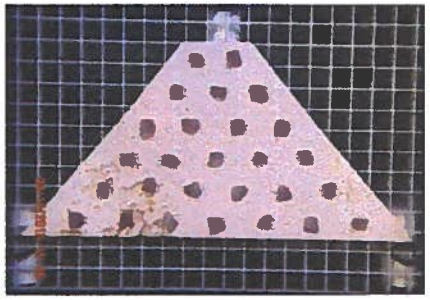
Hawai'i Coral Restoration Nursery

Native massive coral, *Porites evermanni* (endemic)

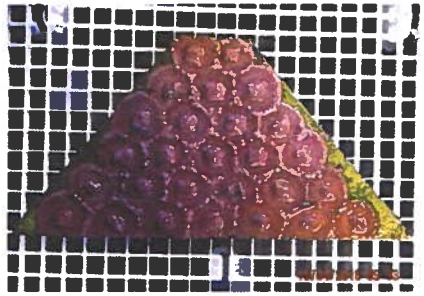


1. Collection of source colony within harbor. Size is less than 10 cm (longest diameter). [Date collected: 3/21/16]

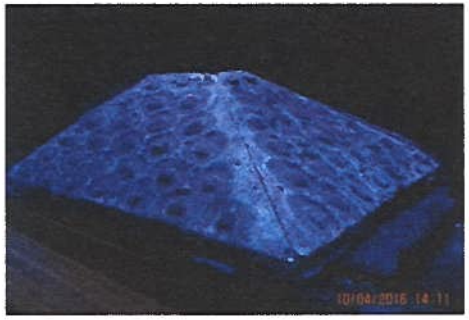
2. After quarantine, colony prior to fragmentation.



3. Fragments (1 cm) attached to stone tiles within fast-growth tanks at the Coral Restoration Nursery.. [Date fragged: 4/14/16]



4. The same tile a number of months later, completely fused, within the fast-growth tanks at the Coral Restoration Nursery..



5.. Fused tiles put together on module, within the fast-growth tanks at the Coral Restoration Nursery. Coral colony is now 42 cm longest diameter.

6.. Out-planted coral colony on test reef nine months after collection. [Date out-planted: 1/19/17]

In Hawai'i native corals grow at an average of 1 cm per year. It would take 20 or more years for a 10 cm coral colony to reach 40 cm (longest diameter). The Coral Restoration Nursery is able to do that in under 10 months!

For more information please contact:

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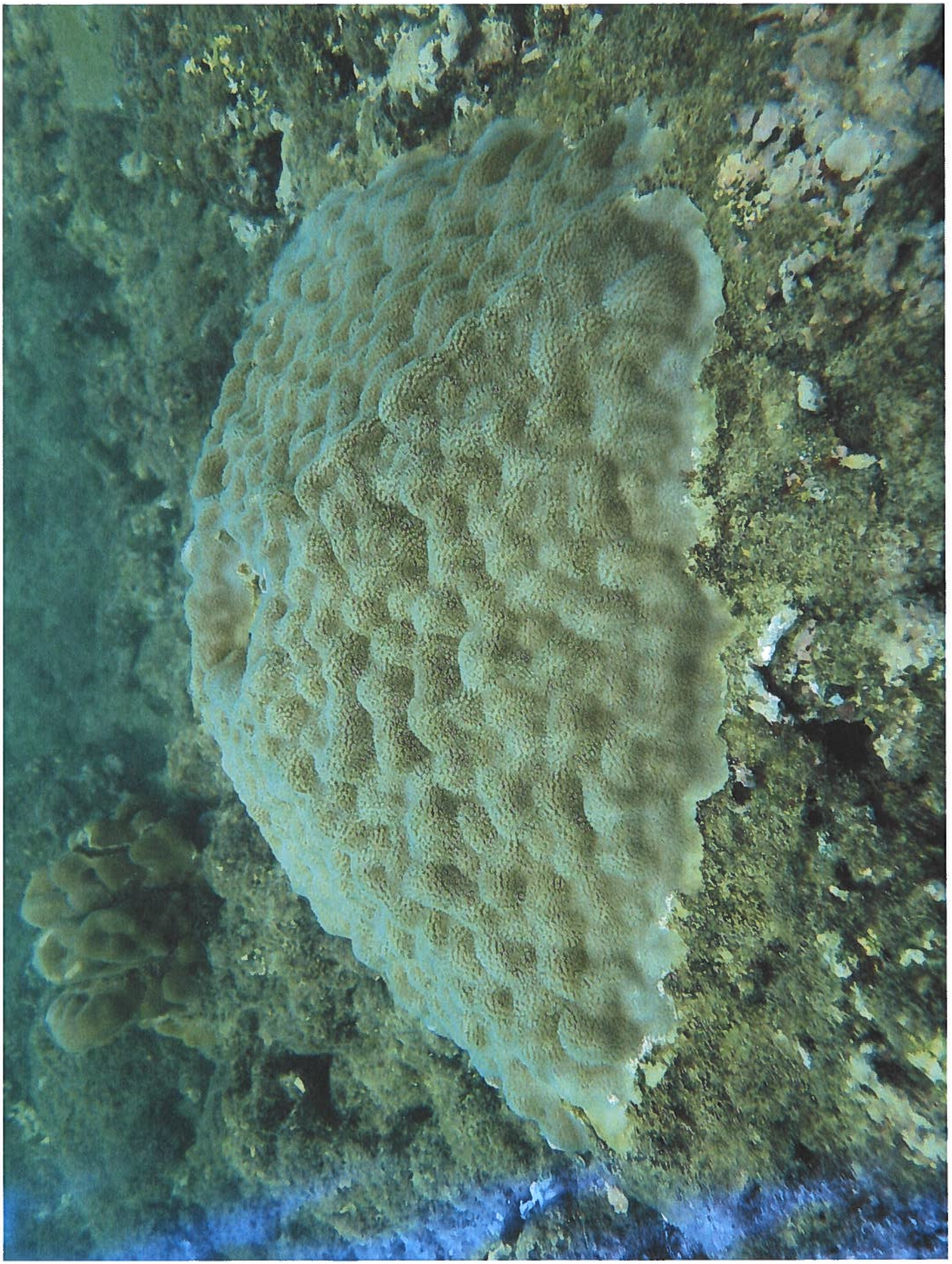

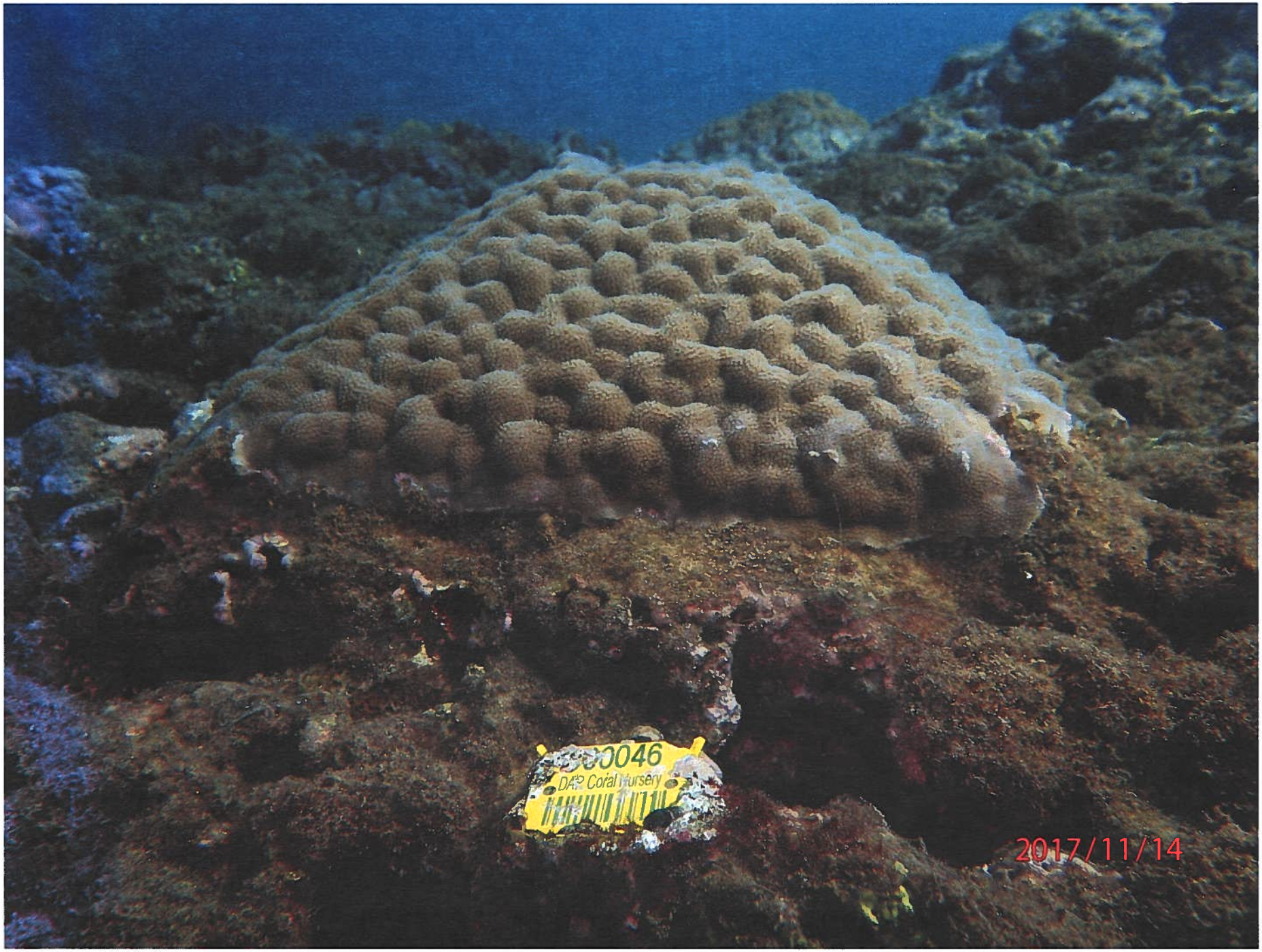
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DAR Coral Nursery
2017/11/14

APPENDIX F

Potential Concerns

1) Why is there not an effort to transplant the total amount (56, 805) of impacted coral colonies?

Initially DOT-H considered the possibility of transplanting all of the coral colonies to be impacted by the development outside of Honolulu harbor, as transplantation efforts (moving the corals to a new habitat) are considered the most promising method in which to minimize impact and potentially preserve the integrity of the coral colonies. After evaluation of the data provided, the Division of Aquatic Resources (DAR) did not recommend the transplantation of proposed corals from the Kapālama Container Terminal donor site in Honolulu harbor to any location outside of Honolulu harbor. DAR supported attempts to transplant coral colonies to areas inside Honolulu Harbor under the specific conditions, which limited the number of coral colonies recommended to be transplanted. DAR recommended in pre-consultation that only coral colonies greater than 40 cm diameter (>40cm) be transplanted (≈ 115 coral colonies), as opposed to DOT-H conducting a transplantation effort the total amount (56, 805) of impacted coral colonies. The remainder colonies will be produced at the DAR Coral Restoration Nursery. The variables taken into consideration when evaluating transplantation included concerns about the risk of introduction or transportation of Aquatic Invasive Species (AIS), the anticipated success rate of the transplantation effort and the amount of suitable habitat and space available in the harbor which is not at risk for future development (i.e. future impact to transplanted coral colonies). Below is the reasoning that was the basis of DAR deciding to recommend a lesser number of coral colonies for transplantation within Honolulu Harbor

Risk of Introducing Invasive/Non-native Species to the Reef outside Honolulu Harbor

Honolulu harbor ranks in the top 40 of North America's ports and is a major entry point for introduced species via hull fouling and ballast water (Davidson et al 2014, Godwin 2003). There is a risk of moving non-native species associated with the coral colonies to the outside reef environment where these species may not currently be present.

DAR currently spends approximately $500,000 per year on AIS research, management and implementation activities. Most of this funding can only support the management of one or two species of invasive algae despite other species that pose a continual invasive threat but have no support for funding. Examples of successful AIS eradication are rare and expensive, therefore preventing species introduction is optimal. Even if the same species of introduced organisms have been documented in Keehi Lagoon, these species are most likely associated with man-made structures such as docks and pilings and should not be necessarily assumed as prolifically distributed on the natural reef flats in these areas (Scott Godwin, marine invertebrate specialist, pers. com). Transplanting corals with non-native

species, from manmade structures to a natural reef flat, risks introducing non-native species to coral reefs that may not have yet been colonized by these organisms (Scott Godwin, marine invertebrate expert, pers. com). Often introduced species are confined and limited to certain locations due to the inability to cross channels, unsuitable substrate or differing water chemistry. For instance, AIS that are successful in coral reef structure are not necessarily as successful in non-coral reef structures, such as deep channels, sand or mud. Physical transplantation of coral colonies may unintentionally enable associated organism to cross the harbor channels to shallower reef, where they may become established.

The combined biological surveys conducted at the Kapālama Site and Piers 24–28 by Marine Research Consultants (Marine Biological Community Structure Report, EIS, 2012) and AECOS, Inc., (2014; post molasses spill), described a high density of fouling invertebrates in the Kapālama Basin area and identified up to 25 non-native invertebrate species in the survey. Four of the species identified are classified as Management Class 4 in the State AIS management plan meaning they may have potential for impacts, but current knowledge is unclear (DLNR 2003).

For a complete list of non-native and potentially invasive species documented at the Kapālama Site and Piers 24–28 by Marine Research Consultants (2012) and AECOS, Inc., (2014; post molasses spill) please refer to the DAR Comments sent in response to DOT-H request for comments in November 2016: DAR #5425 Kapalama Container Terminal Wharf and Dredging Project Honolulu Harbor Oahu Hawaii- Job H C 1049.

Given the broad range of organisms included in the 2012 and 2014 Kapālama site benthic surveys, DAR considers the non-native species detected in these surveys as an under-estimate of actual non-native species based on the specialized taxonomic skills needed to identify marine invertebrates and the cryptic nature of many of these species. Relying on the detection and exclusion of invasive/non-native species during the transplant process is also not believed to be feasible and considered a high risk by DAR; non-native species may be cryptic and difficult to detect all life stages of the organisms by visual inspection in the field.

<u>Transplantation within Honolulu Harbor</u>

Additionally, the recent survey conducted by Marine Research Consultants of Pier 5 & 6 did not include a comprehensive invertebrate survey. The report that provides the results of the marine survey performed on November 18, 2016 to evaluate the suitability of the habitat at Piers 5 and 6 in Honolulu Harbor for relocation of corals removed from the site of the proposed Kapalama Container Terminal, states on page two (pg. 2), "In addition, typical fouling communities of sponges, bryozoans, hydroids, and mollusks were not noted anywhere in the boulder zone. As these communities typically contain alien invasive species, it is not likely that invasive species are common to the boulder zone." The survey

states that there may be potential that this recipient area is relatively void of AIS despite being located in the harbor, therefore the division is requesting the transplantation of a lesser amount of select colonies in order to contain some of the risk by reducing the magnitude of the effort.

Suspected Non-Native Coral Species: The species that was identified as *Porites lobata* in previous surveys may in fact be a non-native/introduced species, potentially only existing within Honolulu Harbor and introduced through ballast water or vessel hulls. This concept was brought up to introduce the possibility that *all* the corals described as *Porites lobata* may actually be an introduced *Porites* species, tentatively termed "Harbor *Porites*". 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* before being transplanted to the recipient site (Piers 5 and 6). This introduced coral may not exist at the Piers 5 & 6 site (it may only exist close to the origin of introduction which may be the area proposed for development- the area between Pier 43 at the base of the Sand Island Bridge and Kalihi Channel and Piers 41 and 40F). Therefore, DAR would not want to advocate the transplantation of this species to the recipient site if it is not already populated with this species (to minimize the spread of a non-native coral throughout the harbor).

Although lower, the risk of spreading AIS from Pier 43 to 40F to Piers 5 & 6 is also present. Without an AIS survey of the recipient site by divers specialized in marine AIS taxonomy, it is difficult to fully assess the risks associated with transplantation and therefore the transplantation of lesser amount of select colonies (to reduce the potential incidences of AIS associated with each colony and also misidentification of "Harbor *Porites*") was requested by DAR (all colonies >40cm).

Probability of Success

After further evaluation of the information provided by the environmental consultants (AECOS and Moffit and Nichol), DOT-H and the Army Corps, DAR is not convinced that a larger scale transplantation effort is the best option in this case. DAR is recommending and requesting instead the transplantation of the total number of coral colonies ≥ 40cm on the seafloor in the donor site area to the recipient site area of Piers 5 and 6 in Honolulu Harbor. This total number of colonies ≥ 40cm equals approximately 115 colonies.

If certain colonies that constitute this upper size class (>40cm) do not meet the agreed upon environmental criteria for transplantation, or display visible signs that transplantation efforts may result in fragmentation of colony, then appropriate colonies from the next size class (20-40cm) should be utilized to replace the colony from the larger size class that does not meet the criteria.

Low Success of Previous Transplant Efforts: DOT-H and AECOS have provided documented and anecdotal information that indicates that past transplantation efforts conducted by DOT-H and AECOS for Piers 12 and 15 in Honolulu Harbor, did not display a high rate of success. The previous transplant effort showed very low survival of the approximately 80 coral colonies transplanted from Piers 12 and 15. Photo-documentation provided in the AECOS Report (Coral assessment and transplantation for Piers 12 and 15 in Honolulu Harbor, O'ahu, Hawai'i) showed:

a. Dense layers of sediment on the benthic substrate and indications of sediment laden water in the recipient site;

b. Low densities of coral colonies at the recipient sites and only smaller size classes present, indicating that environment may not be conducive to coral growth and/or long-term growth to maturity;

c. Signs of larger corals being fragmented into many pieces due to difficulty of detaching the colony from the benthic substrate during the transplantation effort;

Anecdotal information was also provided which indicated visual surveys of the site showed signs of mortality from sedimentation.

Although the newly proposed recipient sites of Piers 5 and 6 have conditions that are more favorable for coral growth (in terms of absence of sediment and presence of coral colonies in similar size classes), the same stresses on the corals that result from transplantation methodologies and differences in environmental variables will occur with the transplantation of colonies from Pier 43 to 40F to Piers 5 & 6.

The transplantation effort for Piers 12 and 15 consisted of the transplantation of 80 corals. DAR recommends that another similar scale transplantation effort be conducted with the 125 larger size class corals referenced above (>40cm), provided they meet the agreed upon environmental criteria for transplantation (comparisons between sites of water motion, light exposure, turbidity/sedimentation, depth, water chemistry, non-native species, available substrate to successfully adhere colonies, coral species, size and morphology or any other comparable environmental variables) and do not display visible signs that transplantation efforts may result in fragmentation of colony. If so, alternate colonies that have comparable environments or colonies that can be collected without fragmentation will be substituted from the next size-class down.

Additionally, DAR is in favor of focusing offset measures on areas that are *outside the harbor* and have no potential of being developed in the future. DOT-H has stated that there are no immediate plans to develop Piers 5 & 6, but the nature of submerged land in the harbor is that these areas *do have the*

potential of being proposed for development or expansion in the future. Therefore DAR is in favor of a smaller effort to test if this type of transplantation within the harbor may be successful with a second attempt (first attempt being the transplant effort from Piers 12 and 15), but DAR thinks the best choice is to use the majority of effort and resources to try to restore or populate an area that is unlikely to be developed and enhances the reef systems that have a closer nexus to natural reef systems subject to less environmental degradation that results from the activities in commercial shipping areas.

"Minimization" Requirements. "Minimization" (as a mitigation mechanism of the EFH Consultation) through the transplantation of coral colonies, does not include deliverables that need to be fulfilled in relation to coral survivability. The act of transplantation (with potential additional monitoring) constitutes minimization, but the results of the minimization are inconsequential; i.e.: the corals do not need to survive after transplantation and mortality of colonies still constitutes minimization. Transplantation efforts therefore can be implemented without comprehensive consideration into the potential outcomes; there are no repercussions for differences between environmental variables between donor and recipient habitats or compromised transportation or handling methodologies, etc.

Therefore, based on previous transplantation effort success rates DAR recommended minimizing the risk of failure by reducing the number of colonies transplanted. DAR is in support of this smaller transplantation effort and would be interested in evaluating the results, but advocates instead for the support of projects and efforts that have shown success. DAR is in favor of supporting an action that has more investment and accountability of long-term ecological gain. At this time, DAR has determined that out-planting corals produced by DAR's coral nursery and the control of invasive algae at Waikiki MLCD via urchin biocontrol would provide a much higher ecological benefit to Hawai'i's resources than transplanting corals from one site in the harbor to another.

Suitable Habitat and Space Availability

Success case studies of coral transplantation attempts tend to share similar habitat parameters between the donor and recipient site (Jokiel et al. 2005 and Naughton and Jokiel 2001). If corals of same species and size of transplants are not there currently, there is probably a reason (i.e. unsuitable habitat).

DAR recommended an assessment of the habitat compatibility of the donor site vs. the recipient site including comparisons of: water motion, light exposure, turbidity/sedimentation, depth, water chemistry, non-native species, available substrate to successfully adhere colonies, coral species, size and morphology and any other comparable environmental variables. If all habitat parameters were found to be similar between the donor and recipient site then DAR recommended transplant efforts with post-monitoring and recommended that DOT receive mitigation/offset crediting for transplant efforts and post-monitoring efforts to determine rate of survival and document any changes in environmental parameters. DAR recommended that post-monitoring be conducted for five years at minimum in order

to accurately gauge and document survival rates and additionally requested to review and contribute input on the transplantation and monitoring methods and plan.

Literature suggests that the best chance of success in coral transplantations is attained by transplanting donor corals to similar habitats that do not fall within the marginal range of depths, irradiance levels, water motion, water chemistry and associated algal and trophic assemblages, etc., (Naughton and Jokiel, 2001). Several case studies of transplantation of colonies from harbors to outside reef habitat in Hawaii have resulted in the eventual loss of colonies over time through exposure to higher water motion or wave action, or differing water chemistry and associated algal or trophic assemblages, resulting in overgrowth of algae (Naughton and Jokiel, 2001). Additionally, DAR biologists reported that coral transplantation projects in Lahaina, Maalaea, and Manele have had low survival rates (Skippy Hau, DAR Aquatic Biologist, pers. com.).

The donor site is comprised of a cluster of sheltered dock areas in Honolulu Harbor, in addition to some channel ledge shelves populated with colonies that run parallel to the harbor channel in water depth ranged from about 7-10 meters along the pier faces, where biota was generally not abundant in the upper meter of the water column or within 2-3 meters of the Harbor floor. In contrast, the proposed recipient sites are located in open reef flat habitats of 1-3 m of water with differing turbidity and moderate to high water motion situated in full sunlight.

Based on previous studies that have shown declining survival rates of colonies when the environmental parameters of the donor site and recipient site are at variance, it is assumed that the differences between these habitats are likely to result in slow acclimation of colonies and potential mortality over time due to the inability to adapt quickly enough without stressing or compromising the health of the colonies. Another possibility is the physical displacement of colonies due to the difference in water motion or anomalous storm events compounded with underdeveloped methods of successful adhesion of colonies to the benthic substrate (Kolinski, 2006).

The initial baseline biological assessments conducted by Marine Research Consultants (2012) and AECOS, Inc., (2014; post molasses spill), did not include surveys of the proposed recipient transplantation sites in Keehi Lagoon. The above quoted description of the physical habitat of the proposed recipient sites in Keehi Lagoon describes the physical and environmental parameters that were interpreted from bathymetry maps and biological surveys conducted by DAR. The description of the physical and environmental parameters of the proposed recipient sites has been included to aid the discussion of the differences of the donor sites and the proposed recipient sites. Corals are extremely sensitive and have specific habitat requirements. If the coral species proposed to be transplanted don't currently exist in the recipient site, then the habitat is probably not suitable to support these species. A biological community survey was not conducted of the recipient sites to evaluate whether the same species of corals were present. An overview of several case studies utilizing coral reef mitigation and restoration techniques in the Pacific Islands maintains that other projects have been successful when

transplant habitats are close in proximity and habitat parameters do not differ significantly (Naughton and Jokiel, 2001).

Biological Capacity of Recipient Site: The initial assessment provided by Marine Research Consultants, Inc. determined that the amount of open substrate available in the recipient site (Piers 5 and 6) could provide habitat to accommodate all of the colonies proposed to be displaced by the Kapalama development (based on a comparison of total square area of the coral colonies at the donor site to the square area of available substrate at the recipient site). DAR questions the suitability of the recipient site and why corals haven't naturally recruited to these areas. DAR theorizes that the current distribution of corals at the recipient site and their spacing is most likely a good indicator of what is naturally successful and viable in terms of growth and recruitment at this site. Open space (available substrate) may not be colonized by benthic organisms for biological or physical reasons. In order to avoid potential over-crowding in a currently healthy distribution of coral colonies, and not incur additional impacts through competition between corals transplanted in close proximity to each other, DAR recommends the transplantation of the lesser amount of 115 colonies. This conservative approach is more likely to maintain appropriate spacing between the organisms, while utilizing the colonies that provide more value in terms of ecological services (habitat, rugosity, shelter and food source). The consultant's recommendation that the available substrate at the recipient site can potentially accommodate the total amounts of colonies to be displaced by the development is not informed or supported by any past transplant effort and the potential result is unknown. At this time, DAR is not confident that space availability equates to viable habitat for the continued growth of larger numbers of transplants and recommends that the more conservative approach of transplanting the lesser number of colonies would lead to a greater chance of success.

Although DAR ultimately supports efforts to develop successful coral transplantation methods, the proposal to transplant corals from inside the harbor to reef areas outside of the harbor pose a high risk of introducing non-native species to reef habitats. In addition, the difference in habitat between sites, indicates a low probability of coral survival and ultimate success of the project and therefore, after evaluation of the data provided, the Division of Aquatic Resources (DAR) did not recommend the transplantation of proposed corals from the Kapālama Container Terminal donor site in Honolulu harbor to any location outside of Honolulu harbor and instead recommended a lesser number of coral colonies for transplantation within Honolulu Harbor.