AECOS No. 1176D

Macroinvertebrate Relocation Plan for Honoapiʻilani Highway Shoreline Improvements at Olowalu, Maui

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[1] Report prepared for Sato & Associates, Inc. as a result of EFH consultation with NOAA/NMFS. This document will become part of the public record for the project.

Introduction

The State of Hawaiʻi, Department of Transportation (HDOT) proposes to undertake shoreline protection for a stretch of Honoapiʻilani Highway between Launiupoko Point and Kekili Point near Olowalu on the west coast of Maui ("Project"; see Figure 1). The Project involves placement of large boulders underlain by smaller rocks and geotextile fabric along the shore and widening of the existing road shoulder. In April 2008, *AECOS* conducted a marine reconnaissance survey in the Project area (*AECOS*, 2008). In 2010, the Final Environmental Assessment (FEA) was prepared (HDOT, 2010). Since that time, recommendations were made by National Oceanic and Atmospheric Administration -Pacific Islands Regional Office (NOAA-PIRO), Habitat Conservation Division in an email message (D. Jayewardene, pers. comm., 2015) to address impacts to marine habitats (Essential Fish Habitat; EFH) off the Project shore. In May 2015, we updated the findings of our 2008 report and identified impacts to fishes and corals in the Project vicinity (*AECOS*, 2015). Based on our EFH assessment, NOAA provided conservation recommendations to avoid and minimize impacts to marine resources (NOAA-NMFS, 2015). Specifically, National Oceanic and Atmospheric Administration-National Marine Fisheries Service (NOAA-NMFS) recommended removing and relocating, to the extent practicable, any coral colonies and macroinvertebrates (e.g., sea urchins, sea cucumbers, mollusks) from out of the direct footprint of the Project.

The relocation plan presented here details protocols for macroinvertebrate relocation. The objectives of this plan are to minimize loss of marine resources, enhance reef components in nearby reef areas, and provide data for future projects that may consider relocation and transplanting as part of an avoidance and minimization strategy. The plan presented is based on coordination with NOAA-NMFS and results of marine resources surveys conducted in 2008 and 2015 to characterize the marine assemblages in the Project area.

Site Description

The waters off Olowalu are used by surfers, swimmers, snorkelers, kayakers, and campers. Parking areas and trails access the shore from the highway. This leeward shore is exposed to southerly swells, generally in the summer months, but otherwise a small shore break allows easy entry into the ocean. When swells sweep up along the coast from the south, waves suitable for surfing occur off the north end of the Project area. The narrow coastal plain inland of the beach was, until recently, planted in sugar cane. Further inland, the topography slopes up to the steep West Maui Mountains. This coast is generally quite dry. South of the Project area, near the middle of Hekili Point, perennial Olowalu

Stream discharges into nearshore waters and, particularly during high rainfall events, contributes terrigenous sediment to the nearshore environment.

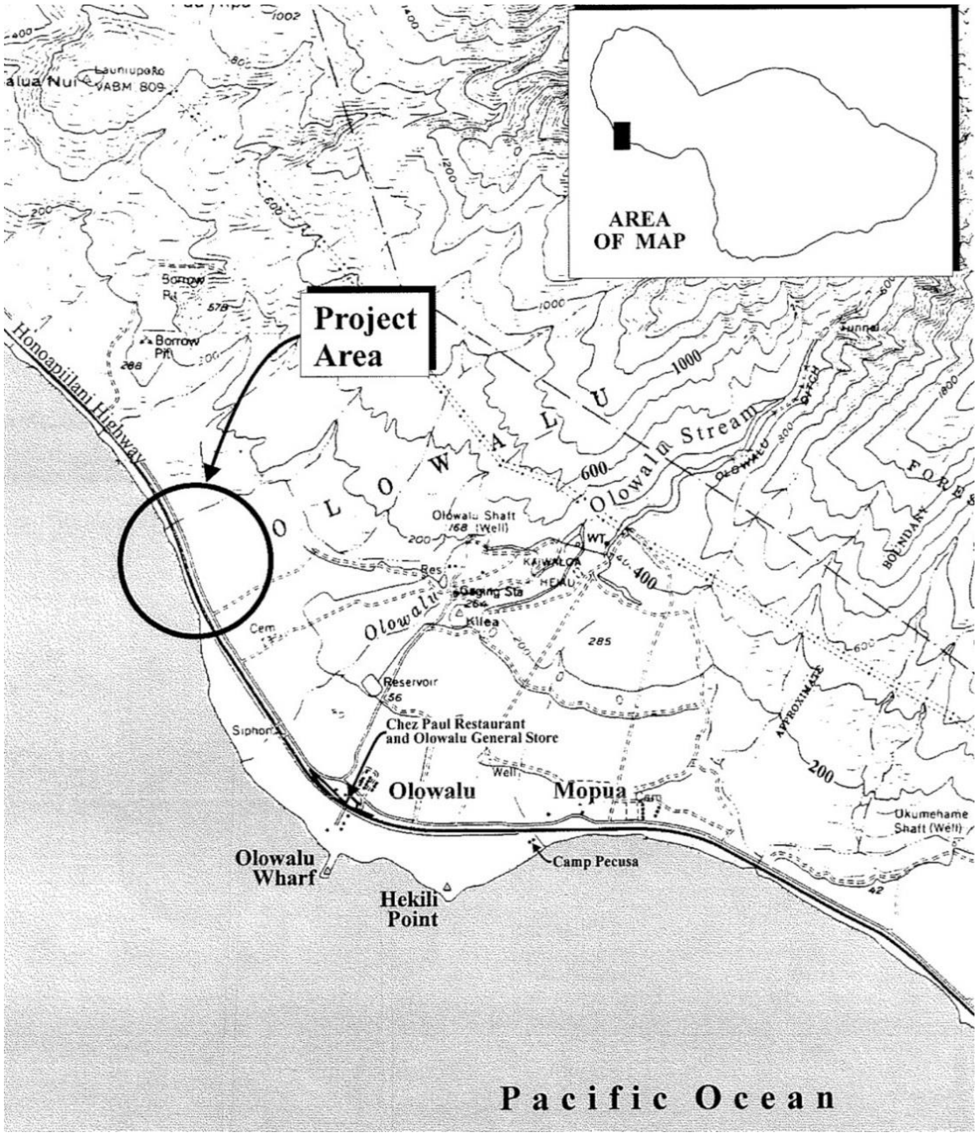

Figure 1. General location of Project on the Island of Maui (HDOT, 2010).

The southwest facing shore in the Project area ranges from large boulders and rock rubble in the south, to water worn cobbles and deposits of black sand in the north. Seaward, a fringing reef and rock shoals extend out to deeper water (UHCGG, 2008). The nearshore waters in the project area are generally less than 3 ft (1 m) deep and the low slope off the shore creates a broad intertidal zone (*AECOS*, 2008).

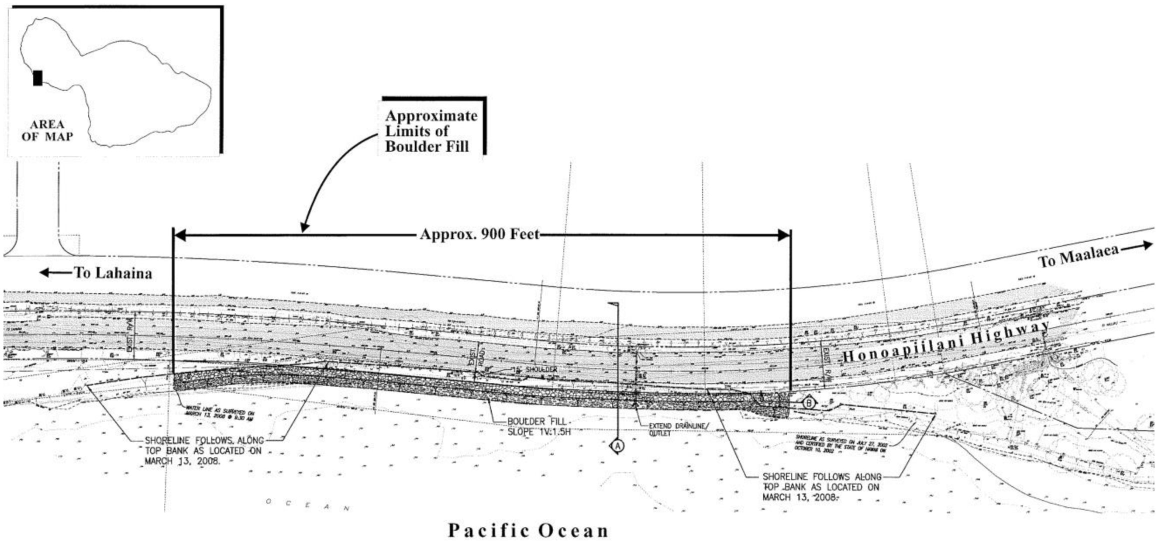

Figure 2. Honoapiʻilani Highway Project area.

Project Description

The proposed action involves the placement of large boulders along an approximate 900-ft (274-m) section of shore to mitigate erosion damage to the highway shoulder (Figure 2, above). Project plans involve the use of boulders ranging in size between 1.5 and 2.5 tons to stabilize the shore slope. Boulder fill will extend approximately 40 ft (12 m) from the existing Honoapiʻilani Highway guardrail (Figure 3) and provide protection from seasonal high surf and waves, replacing the existing cobble shore with a boulder slope. The boulders will be underlain by smaller rocks and geotextile fabric. The boulder slope will reduce run-up and overtopping compared to present conditions. However, minor overtopping by storm waves may be experienced when exceptional waves impinge on this coastline. An existing 24-inch drain line beneath the roadway will be extended out through the boulder structure.

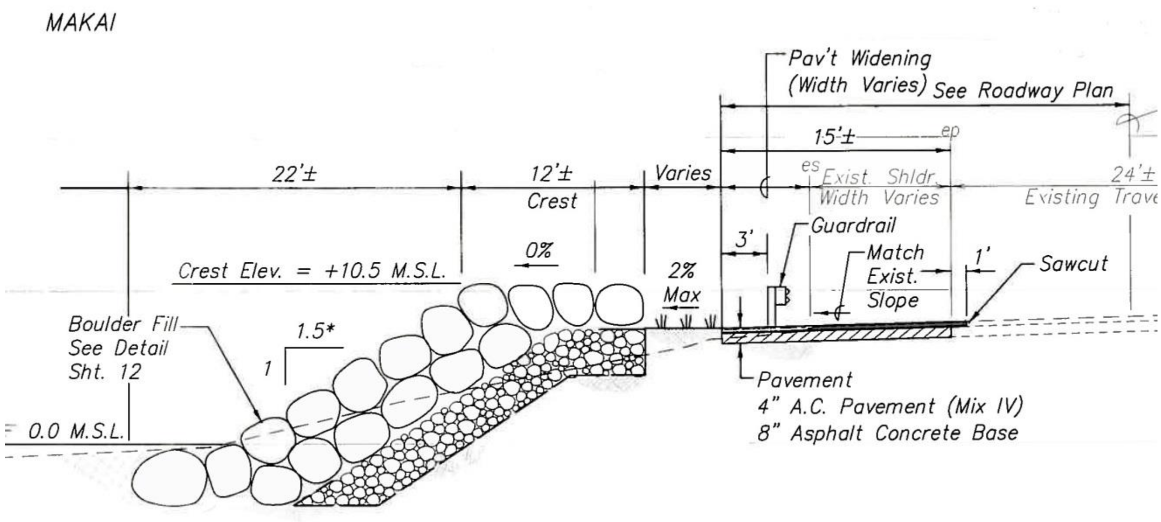

Figure 3. Typical cross-section of boulder fill proposed for Honoapiʻilani Highway.

Affected Biological Assemblages

Based on the Project design (Figs. 2 and 3, above), *AECOS* marine biologists surveyed two areas in 2015: 1) a direct impact area extending from the Honoapiʻilani Highway guardrail to approximately 40 ft (12 m) offshore along the 900-ft (274-m) Project length; and 2) an indirect impact area extending a variable distance of from 40 ft (12 m) to 80 ft (24 m) further offshore. The direct impact area included the slope from the *makai* edge of Honoapiʻilani Highway through the supralittoral (uppermost, wave splash) zone, the littoral (intertidal) zone, and a narrow section of the sublittoral (shallow subtidal) zone. Most of the direct impact area is supratidal (the area regularly splashed, but not submerged).

The 2015 survey found the bottom in the direct impact area to be mixed basalt and limestone substrata comprising cobbles, boulders, and sand. The assemblage of algae and animals that live in the direct impact area are well adapted to cope with the extreme conditions of submergence and exposure by tidal change and varying wave conditions.

Macroinvertebrates observed in the direct impact area include black-foot *ʻopihi* (*C. exarata*), false limpet (*Siphonaria normalis*), *pipipi* (*Nerita picea*), and several sea urchins (*Colobocentrotus atratus*, *Echinometra mathaei*, and *E. oblonga*). Less frequently observed invertebrates in the direct impact area include: sea cucumbers (*Actinopyga mauritiana* and *Holothuria whitmaei*), collector urchin (*Tripneustus gratilla*), thin shelled rock crab, *ʻaʻama* (*Grapsus tenuicrustatus*), brittle star (*Ophiocoma erinaceus*), variable worm snail (*Serpulorbis variabilis*), humpback cowry (*Cypraea mauritiana*), and spotted drupe (*Drupa ricina*). No corals occur in the direct impact area.

Candidate Macroinvertebrates for Relocation

To avoid and minimize impacts to marine resources that occur in the Project area, NOAA-NMFS recommended relocating, as practicable, any coral colonies and other macroinvertebrates (e.g., sea urchins, sea cucumbers) that occur within the direct footprint of the Project. Based on our 2008 and 2015 surveys in the Project vicinity, approximately 20 different macroinvertebrates are potential candidates for relocation and these are listed in Table 1. No corals were observed in the 2015 survey of the direct impact area (*AECOS*, 2015), and therefore none are expected to be relocated. However, in the unlikely event that any coral heads are encountered, Attachment A provides separate protocols for coral transplantation.

Table 1. Potential candidate macroinvertebrates for relocation based on surveys of the intertidal and inshore reef flat off the Project site (*AECOS*, 2008, 2015).

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name, *Hawaiian name*	Status	2008 survey Abundance	2015 survey Abundance
GASTROPODA	MOLLUSKS			
PATELLIDAE				
Cellana exarata	black-foot *ʻopihi*	End	C	C
Cellana sandwicensis	yellow-foot *ʻopihi*	End	O	R
Cellana talcosa	giant *ʻopihi*	End	R	
SIPHONARIIDAE				
Siphonaria normalis	false limpet	Ind	R	O
NERITIDAE				
Nerita picea	black nerite, *pipipi*	End	A	A
Theodoxus neglectus	speckled nerite	End	U	
LITTORINIDAE				
Littoraria pintado	dotted periwinkle	Ind	C	O
MURICIDAE				

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name, *Hawaiian name*	Status	2008 survey	2015 survey
			Abundance	
Drupa ricina	spotted drupe	Ind	R	R
CYPRAEIDAE				
Cypraea mauritiana	humpback cowry, *leho ahi*	Ind.		R

Table 1 (continued).

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name, *Hawaiian name*	Status	2008 survey	2015 survey
			Abundance	
GASTROPODA (continued)				
CONIDAE				
Conus flavidus	yellow cone shell	Ind	R	
ECHINODERMATA, ECHINOIDAE	SEA URCHINS			
DIADEMATIDAE				
Echinothrix diadema	blue black urchin, *wana*	Ind		O
Echinothrix calamaris	banded urchin, *wana*	End	R	
ECHINOMETRIDAE				
Colobocentrotus atratus	helmet urchin, *hāʻukeʻuke kaupali*	Ind	R	C
Echinometra mathaei	rock-boring urchin, *ʻina kea*	Ind	C	C
Echinometra oblonga	oblong urchin, *ʻina*	Ind	U	C
TOXOPNEUSTIDAE				
Tripneustus gratilla	Collector urchin, *hāwaʻe maoli*	Ind		R
ECHINODERMATA, HOLOTHUROIDAE	SEA CUCUMBERS			
HOLOTHURIIDAE				
Actinopyga mauritiana	white spotted cucumber, *loli*	Ind		R
Holothuria whitmaei	teated cucumber; *loli*	Ind		R
Holothuria atra	black sea cucumber, *loli okuhi kuhi*	Ind	R	

STATUS – End = endemic (native to Hawaiʻi only); Ind = indigenous (native to Hawaiʻi and elsewhere in the Pacific.

Macroinvertebrate Relocation Plan

The relocation protocols below are designed to reduce stress on the marine organisms and increase survivorship during and following relocation.

Materials

A list of materials needed for the relocation process is provided in Table 2.

Table 2. Materials needed to relocate macroinvertebrates.

Equipment	**Task**
gloves	protect hands from reef and marine organisms
bladed chisel or similar tool	remove organisms that adhere to rock
transport container (5-gallon bucket with lid)	transport organisms from Project site to relocation site
field forms	record organisms relocated
underwater camera	photograph relocated macroinvertebrates

Macroinvertebrate Removal Methods

For each relocation event (see proposed schedule in Implementation and Management section, below), a marine biologists will be responsible for locating macroinvertebrates in the direct impact area. A marine biologist will be responsible for verification and documentation of macroinvertebrate identification and enumeration

Biologists will wear gloves and remove macroinvertebrates with care in order to avoid and minimize damage to the skeleton and live tissue of the organisms and minimize injury to the biologists. Macroinvertebrates that adhere to boulders and rocks (e.g., helmet urchins, ʻ*opihi*, etc.) will be loosened (either by hand or with a bladed tool). Once an organisms is identified and tallied, it will be placed in a temporary storage container. A plastic 5-gallon bucket with lid, filled with seawater can be used. As practicable and depending on the size of organisms, transport containers should not be over-populated. Similar species should be grouped in the same container. For example, one transport container should hold urchins and another should hold sea cucumbers.

Marine organisms can be very sensitive to a drop in the dissolved oxygen (DO) in the water of the transport container. Thus, organisms cannot be held in transport containers out of the ocean for a prolonged period of time without refreshing the water or replacing DO. Lids should be placed on the transport containers during transport and staging conducted in shallow water to minimize exposure to solar radiation and heating of the container. Transport containers can either be placed on flat surface of a vehicle and driven to the relocation site or carried (walked) along the beach.

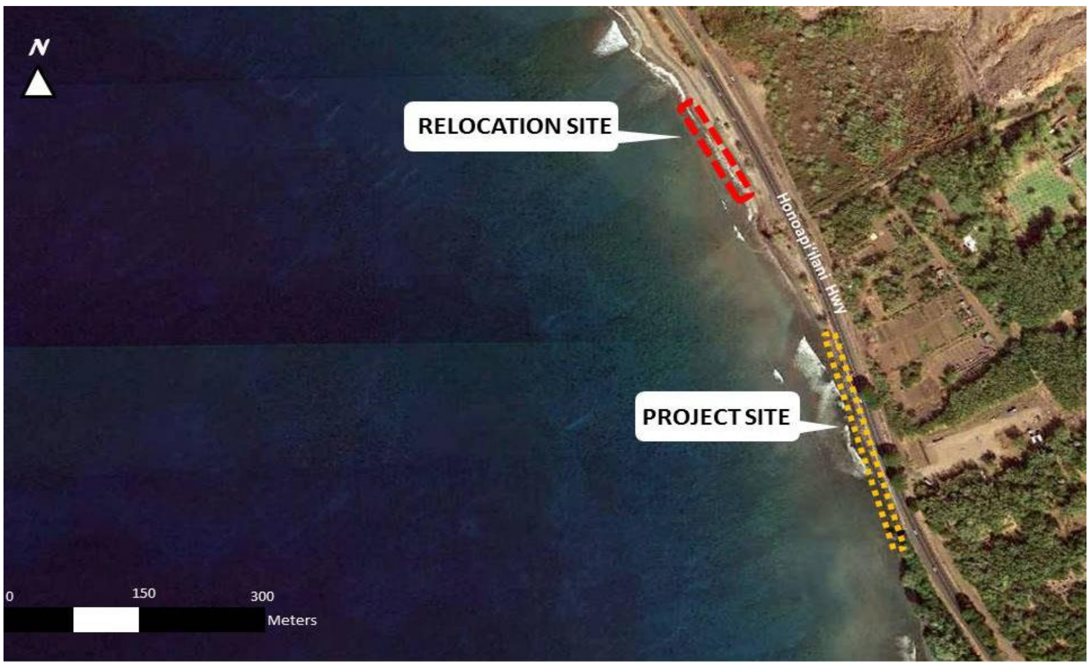

Figure 4. Location of Project site and recommended relocation site further north along the coast.

Macroinvertebrate Relocation Site

Figure 4 (above) shows the location of the Project and a recommended receiving site for invertebrate relocation. This receiving site is approximately 680 ft (200 m) north of the Project site. The relocation site must have similar environmental conditions to those at the donor (removal) site with respect to depth, wave energy, light quality, and biological assemblages. NOAA's benthic habitat categorization of both the relocation and Project sites is pavement, with 10-50% macroalgae cover (Battista et al, 2007). In addition to the aforementioned criteria, the proximity of the relocation site to the Project site is a consideration. The approximately 680-ft (200-m) separation of the sites should be adequate to minimize re-entering of the work area by relocated invertebrates but be close enough to limit the amount of time organisms spend in transport containers.

Implementation and Management

Ownership

It is anticipated that *AECOS*, Inc. biologists, in coordination with contractor personnel, will carry out the relocation and that *AECOS* will be the primary responsible party for relocating and maintaining the records of the relocation event. In the unlikely event that any corals are observed during the first (preconstruction) relocation effort, they can be transplanted at that time as per the protocol outlined in Attachment A.

Relocation Schedule

Initial relocation will precede commencement of Project in-water work by one week. Due to the mobility of the macroinvertebrates present in the Project area, *AECOS* biologists will return roughly once a month throughout the course of the 9-month work plan, for a total of 10 visits. However, the first return visit will occur within two weeks of the initial effort in order to assess the rate at which the work area is repopulated with invertebrates moving in from outside of the cleared zone. Subsequent visits may need to be adjusted based upon these early results. In as much as the actual area requiring vigilance is likely to shrink as the Project unfolds, scheduling visits closer together at the outset and farther apart towards the end would seem justified. Each effort will occur over the course of one day.

Contractor Personnel Training

This effort at reducing adverse impacts on nearshore assemblages of bottom-dwelling invertebrates is unique in Hawaiʻi. To date, all such efforts have been directed at relocating living coral colonies (see Attachment A for example references). In a sense, this effort is experimental. It is therefore important that accurate data gathering (that is, collection/relocation information) be achieved. Per discussions with NOAA during the EFH consultation, relocation of macroinvertebrates by contractor personnel is acceptable between visits by the biologists, as described herein. Thus, training of contractor personnel to locate, identify, record, and relocate any macroinvertebrates discovered between visits by the biologists will be necessary. Results of these activities by the contractor must be transmitted to the biology team soon after each event (at least weekly) to enable the biology team to adapt their schedule of return visits. The biology team will provide the contractor's assigned personnel with photo-identification sheets of the macro-invertebrates in the Project location and hands-on training in collection and transportation of these organisms to the relocation area. Contractor personnel should be prepared to photograph any collected macroinvertebrate the identity of which is not recognized.

Data Collection

We alluded above to the possibility of relocated organisms returning to the work area between relocation events. In fact, for species that are resource limited (that is, the population size at a given place is close to the maximum number of individuals that can be supported there), relocating individuals into such a new area will create a pressure on all members of the population to disperse. For littoral and sublittoral animals, dispersal is limited to movement up or down the coast. The chance that any particular individual returning to where it was removed from is slim, but with or without the pressure to disperse out of the relocation area, individuals from areas adjacent to the Project can be anticipated to move into previously "cleared" areas. To the extent that dispersal pressure created in the relocation area radiates as far south as the work area, this pressure will enhance movement into the work area for resource-limited species. For this reason, it is helpful to obtain counts of individuals by species from segments of the work area to reveal something about dispersal into the work area and to base revisits adaptively on these results.

The recording of relocation data should be by collection/transport date and by collection location. The Project area will be divided into 9 segments of 100 feet each. Temporary flags or some other marker will be used to differentiate the segments, to be numbered 1 through 9 from north to south. Semi-permanent markers (such as painted marks on the roadway) can be used to re-establish temporary flags. Contractor personnel must record the segment number from which each macro-invertebrate is collected. Presumably, contractor involvement will be limited to clearing the area where in-water work will be occurring just in advance of work in that area. The contractor will be required to perform the checking once daily, first thing in the morning, before any in-water work commences.

Reporting Requirements

A form will be developed for use by the biologists and the assigned contractor personnel to be completed for each relocation event. The form will allow for recording of number of each type of macro-invertebrate collected and collection location (Project segment). The contractor must transmit each completed form to the biology team soon after each event, within the work week of the contractor survey(s). If no macro-invertebrates are collected/relocated, the form should convey the segment(s) searched and zero count(s).

After completion of the Project and relocation efforts, *AECOS* will prepare a final summary report. The summary report will include the following components:

- Information on each transplanted organism—species (when possible), photographs, size, general condition, and Project segment from which it was removed;
- Photographs of the area surrounding both Project and relocation sites.
- The total number of organisms moved by species;
- In the unlikely event that corals are relocated, information on each coral colony relocated—coral species, size measurements, percent live tissue, and general condition (See Attachment A).

After completion of the project, the applicant or the appropriate representative agent will provide a report that will include a quantitative and qualitative description of relocation efforts during the Project activities to NOAA.

References

AECOS, Inc. (*AECOS*). 2008. Biological and water quality surveys for Honoapiʻilani Highway improvements at Olowalu, Maui, Hawaiʻi. Prep. for: Sato and Associates. *AECOS* No. 1176: 33 pp.

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Hawaiʻi Department of Transportation (HDOT). 2010. Final environmental assessment (FEA) for Honoapiʻilani Highway shoreline protection at

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University of Hawaii Coastal Geology Group (UHCGG). 2008. Maui Shoreline Study Erosion Maps. Available online at URL: http://www.soest.hawaii.edu/coasts/index.html ; last accessed: May 27, 2015

Attachment A

Coral Relocation Protocol for Olowalu HDOT Project Site.

Introduction

Surveys conducted in the direct impact area of the Project resulted in no coral colonies found. In the unlikely event that a living coral is observed during any relocation event, *AECOS* biologists will transplant that coral following the protocols described in this attachment. These protocols have been developed from recent resource agency-accepted coral transplantation plans in Hawaiʻi: Keauhou Small Boat Harbor on Hawaiʻi (*AECOS*, 2013a), Mānele Small Boat Harbor on Lanaʻi (*AECOS,* 2013b), Kawaihae Small Boat Harbor on Hawaiʻi (*AECOS*, 2012a), Lahaina Small Boat Harbor on Maui (*AECOS*, 2012b), and Kaunakakai Boat Harbor on Molokaʻi (*AECOS*, 2012c). The protocols are designed to reduce stress on the live coral heads and increase survivorship following transplantation. Additionally, the removal and reattachment of the corals will be undertaken on a schedule that avoids peak coral spawning periods and follows guidelines provided in the Transplanting Methods section below.

Affected Biological Assemblage

In 2015, no coral was observed in the direct impact area. In the indirect area further offshore, biologists encountered 26 colonies of four different coral species: *P. lobata*, *P. compressa*, *Poc. damicornis*, and *Poc. meandrina*. The two most common species are *Poc. damicornis* and *Poc. meandrina*. All colonies encountered occur at least 44 ft (14 m) seaward from the highway guardrail. Table A1 provides the coral species, size, and distance from the highway guardrail. Corals in this area are small, with the two smallest size classes (1 - 5 cm and 6 – 10 cm) most commonly encountered. Two colonies in the 21 to 40-cm size class were encountered, one lacking visible live tissue. All coral colonies in this area occur attached to loose rubble or boulders.

Coral Transplant Receiving Sites

Past experiences with coral transplantation in Hawaiʻi identified factors such as existing coral cover, water motion, and sedimentation as important considerations in selecting a receiving site (Jokiel et al., 1997). Receiving sites should have similar environmental conditions to those at the donor (removal) site with respect to depth, light quality, and community composition. Based upon these criteria, the coral receiving site is the same as the macroinvertebrate relocation site (see above), but further of the shore. In both the relocation and Project sites, the sea floor here is classified as pavement, with 10-50% macroalgae cover.

Table A1. Corals observed in indirect impact area of Olowalu Project site.

Coral taxa	Size class (cm)	Distance from guardrail (m)
Poc. damicornis	11 - 20	22
Poc. damicornis	11 - 20	22
Poc. damicornis	6 - 10	20
Poc. damicornis	6 - 10	20
Poc. damicornis	1 – 5	20
Poc. damicornis	1 – 5	20
P. lobata	6 – 10	20
P. lobata	11 - 20	20
P. lobata	21 - 40	20
Poc. meandrina	6 – 10	20
P. compressa	6 – 10	20
Poc. damicornis	1 – 5	18
Poc. damicornis	1 – 5	18
Poc. damicornis	6 - 10	18
Poc. meandrina	6 - 10	14
Poc. damicornis	1 - 5	15
Poc. damicornis	6 - 10	15
Poc. damicornis	1 – 5	16.7
Poc. damicornis	1 – 5	16.7
Poc. meandrina	1 – 5	18
Poc. meandrina	1 – 5	18
Poc. meandrina	6 – 10	19.2
Poc. meandrina	21 – 40 (100% dead)	21.2
Poc. meandrina	11 – 20	21.2
Poc. damicornis	1 – 5	13.9
Poc. meandrina	6 – 10	14.6

Materials

A list of materials needed and the location (donor site, receiving site, or transport between the two) is provided in Table 2. A marine biologist will be present to oversee the coral transplantation operations and will be responsible for verification and documentation of measurements and coral identification.

Table 2. Materials needed to implement coral transplantation plan.

Equipment	Task	Location
gloves	protect hands from reef and marine epoxy	D, R, T
chisels	remove coral colonies	D, R
transport container (5-gallon bucket)	transport corals from donor site to storage container	T
wire brushes	clean attachment site substratum and scuff coral base	R
nails	stabilizing epoxy on substratum for coral placement	R
wire brushes	clean attachment site substratum and scuff coral base	R
Z-spar ® or Splash® marine epoxy	attach coral colonies/fragments to prepared substratum	R
putty knife	mix and apply marine epoxy	R
monofilament line and/or cable ties	temporarily secure coral colonies in crate or on substratum at receiving site	R, T
numbered metal tags	mark individual colonies for monitoring	R
underwater camera	photograph relocated corals	D

Legend:
D - coral donor site
R - coral receiving site
T - transport between donor and receiving sites

Coral Removal Methods

AECOS biologists will be responsible for all coral removal. All corals will be verified, colony diameter (greatest length) will measured, location noted, and a photograph taken before the removal process begins. Each coral colony, removal will be done so carefully to avoid or minimize damage to the skeleton and live tissue. All corals observed in the 2015 survey occur on loose rubble or boulders, which can be easily lifted from the substratum. No chisels or hand tools will be required for relocating these coral heads, and the entire colony can be removed in one piece. Contact with live coral tissue must be limited to increase survivorship of transplanted colonies. If a coral colony breaks during removal, fragments will be transplanted with the parent colony.

Once the transportation basket is full of donor coral heads, it will transported to the receiving site (either placed on flat surface of vehicle and driven, or walked along beach). Fabric padding can be used to secure the position of colonies in the container prior to transport. Corals will not be held in transport containers out of the ocean for any prolonged period of time. Fabric can be placed over transport containers during transport and staging conducted in shallow water to minimize exposure to intense solar radiation

Coral Attachment Methods

AECOS marine biologists will specify the receiving location for coral head and perform labeling and documentation, as described below. Coral colonies will be set out in clustered species groups for ease in differentiating between transplanted corals and corals that already exist at the receiving site. However, individual placements need to allow for taking photos from all sides of a colony. Most colonies observed in the receiving site (*AECOS*, 2015) occur on loose rubble and rocks that could be moved in entirety.

The use of attachment methods with adhesive is not anticipated. In the unlikely event that attachment support is needed, *AECOS* biologists will use the following protocol. The base of the coral colony and transplant location will be cleaned with a wire brush to remove loose debris. Chisels, hammers, or other tools may be used to level or sculpt the limestone attachment spot to fit the base of the transplant. Marine epoxy (Splash® or Z-Spar® have been used successfully) will be mixed and placed on the receiving site. Masonry nails may be used to add stability as needed. Nails can be driven into cleaned substratum, epoxy placed over the exposed nail head, and then the coral set into the epoxy. Marine epoxy must not come in contact with live coral tissue, although preventing this may not be possible when attaching fragments. Personnel mixing epoxy must change gloves before handling coral colonies. Coral colonies are to be attached by gripping at the base and gently pushing or rocking the underside into the epoxy. Fragments are to be set upright in epoxy with the broken edge facing down and should be placed near parent colony for ease of monitoring. Ample marine epoxy must be used to firmly secure the colony or fragment in place. It is critical that the epoxy be brought as closely to the edge of the living tissue as practicable, covering the exposed skeleton to reduce the opportunity for bio-eroding organisms to invade the living coral tissue. To avoid fracturing the curing epoxy, once coral colonies are set in epoxy, they are not to be shifted. In the likely event that coral transplants require additional support during the epoxy curing phase; personnel may temporarily secure the coral in place with cable ties or monofilament line. In such cases, the securing agent is removed following the curing of the epoxy.

Each colony is to be marked with an identification tag with a unique ID code to facilitate monitoring (use the same tag placed on each coral when initial colony information was collected). Depending on colony morphology and shape of the attachment location, tags will be attached near the margin of the colony base or attached with marine epoxy separately to the side of the coral colony. Tags are not to be attached to live coral tissue or in locations that could impede future coral growth.

Transplantation should avoid peak spawning times. Peak reproduction of Hawaiian corals occurs during summer months, although reproduction continues year round for some brooders. *Porites lobata* spawns June to August, two to three days after the full moon. *Montipora patula* spawns July to September, from 20:05 to 23:10 on the new moon's 1st quarter and 3rd quarter phase. *Pocillopora damicornis* spawns year-round, with all phases of the moon. The majority of larvae are released at night, but some are released throughout the day (Kolinski and Cox, 2003). In as much as no or very few colonies can be anticipated to require moving away from the Honoapiʻilani Highway shoreline protection project, transplantation, if needed, will occur as soon as possible upon discovery, regardless of spawning potential.

Reporting Requirements

Following the relocation event, survey information will be compiled in a report. Photographs, GPS coordinates, and a map of coral transplants and control coral colonies will be included in the report.

The summary report will include the following components:

- Photographs of each transplanted and control coral colony (showing ID tag);
- Information on each transplanted and control coral colony—coral ID code, size measurements, percent live tissue, and general condition;
- Photographs of the area surrounding both transplanted and control coral colonies;
- Any natural changes or impacts to either the transplant or control corals;
- The total number of coral colonies monitored, both transplants and controls;
- An estimate of the total area of live coral, both transplants and controls.

References

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