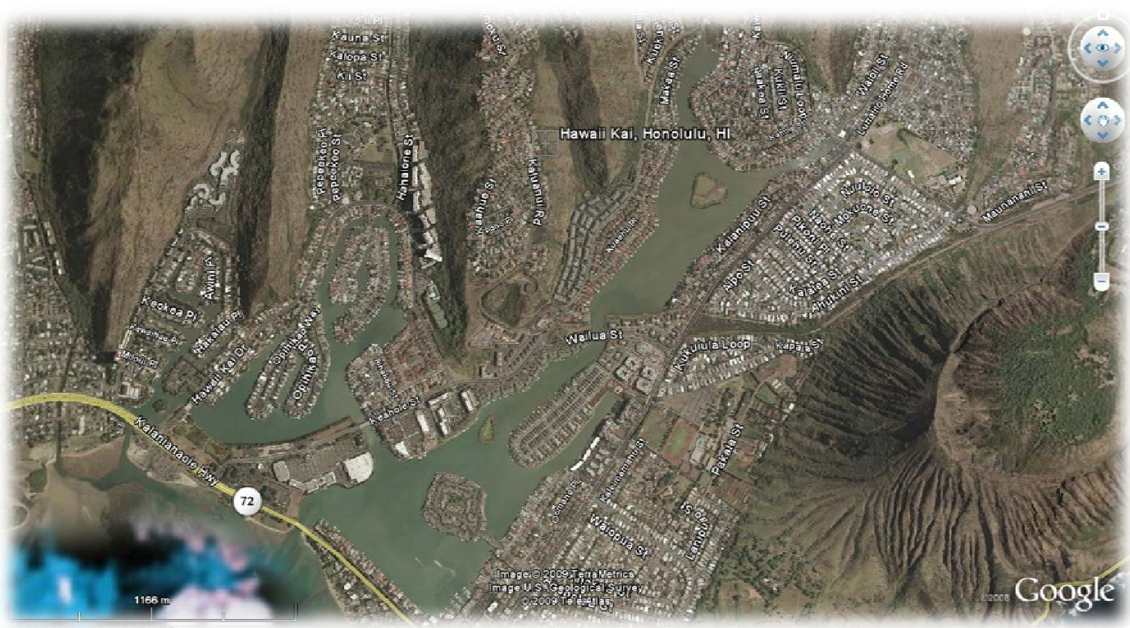
AECOS No. 1150

Marine biological and water quality resources at Hawaiʻi Kai Marina, Hawaiʻi Kai, Oʻahu



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October 4, 2010

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Introduction

The Hawaii Kai Marina Community Association is proposing maintenance dredging at the Hawaii Kai Marina (Fig. 1). The project consists of two distinct activities: (1) dredge 10 areas within the marina to previously permitted depths and dispose of the dredged material; and (2) dredge the entrance channel to previously permitted depth and nourish an adjacent beach with the dredged sand.

The following departmental approvals and permit applications will be required to conduct the project: Conservation District Use Permit (CDUP) from the Department of Land and Natural Resources-Office of Coastal and Conservation Lands (DLNR-OCCL), U.S. Department of Army Standard Individual Permit, Clean Water Act (CWA) Section 401 Water Quality Certification (WQC) from the Hawaiʻi Department of Health-Clean Water Branch (HDOH-CWB), City and County of Honolulu Grading Permit, a federal consistency determination from the Department of Business, Economic Development and Tourism, Office of Planning, Coastal Zone Management Program (CZM), a Special Management Area (SMA) permit from the City and County of Honolulu-Department of Land Utilization, a shoreline setback variance from the City and County of Honolulu-Department of Land Utilization, and testing to show the dredged material meets the Special Waste criteria from the HDOH-Solid and Hazardous Waste Branch

[1] Report prepared for Anchor Environmental for use in the preparation of an Environmental Assessment.

(HDOH-SHWB). An initial step of the permitting process is to prepare an Environmental Assessment (EA) to determine resources in the area and potential impacts of the project as proposed. This report describes existing marine biological resources and water quality of the marina and vicinity of the marina mouth in Maunalua Bay. This information will be used to assess the potential effects of the dredging project.

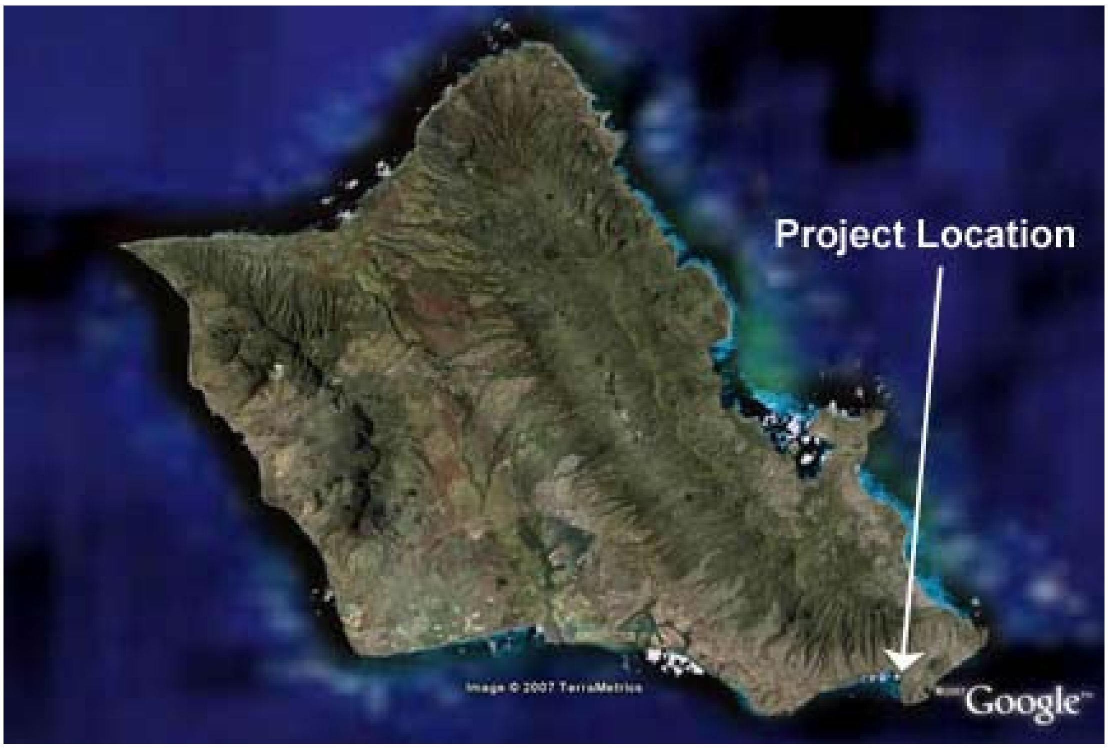

Figure 1. Island of Oʻahu showing location of Hawaiʻi Kai Marina.

Background Information

The reef and the shoreline of Maunalua Bay in the project vicinity have been extensively modified since the 1930s (WOA, 1988). Development of the Hawaii Kai Marina (marina) began in 1959 by modifying Kuapā Pond (USACE, 1975). Kuapā Pond itself was "created" by the ancient Hawaiians (legend has it, with the help of the *menehune*) by modifying an extensive wetland (Fig. 2; Kumu Pono Associates, 1998). The wetland system was created around 11,600 years ago by the flooding of a valley (older embayment) at the end of the last glacial period, with the rise in sea level resulting from worldwide glacial melt (Stearns, 1985). Erosion of the adjacent headlands led to a build-up of sediment between the wetlands and Maunalua Bay, forming a barrier beach restricting water flow between the wetland and Maunalua Bay (Nixon, 1994).

Figure 2. Map of Kuapā Pond in the early 1900s (Fig. 5 from Kumu Pono Associates, 1998).

The Early Hawaiians used the lagoon as a fish pond and built a stone wall to reinforce the naturally accreted barrier beach. They also created cuts in the wall which allowed water flow between the ocean and the lagoon. The fish ponds were considered private property by the Hawaiian government. In 1851, the pond covered 212 ha (523 ac; Kumu Pono, 1998). In 1921, the water area was 122 ha (301 ac) with swamp land occupying another 50.6 ha (125 ac; Kumu Pono, 1998). Today the marina is approximately 108 ha (268 ac), ranging in depth from 1.5 to 2.4 m (5 to 8 ft) below mean sea level (MSL; USACE, 1975).

Maunalua Bay

Maunalua Bay encompasses the area off the coast of Oʻahu between Koko Head and Diamond Head. The bay is lined by a fringing reef extending about 915 m (3,000 ft) offshore. Between the shore and reef margin is a low-relief flat and seaward of the fringing reef is a wide shelf of sand bottom with scattered limestone outcrops.

Water Quality

AECOS (1979) noted that, even prior to dredging of Kuapā Pond to construct the marina, the nearshore waters of Maunalua Bay were turbid due to outflow of water from Kuapā Pond and the resuspension of fine material accumulated on the reef flat. Subsequent to the development of the pond into a marina, boat traffic has served to keep materials in suspension. Therefore, it was concluded that high particulate loading in the water column of the bay near the marina entrances has been the norm for at least 50 years (now closer to 80 years).

The waters of Maunalua Bay between Paikō Peninsula and Koko Head are classified in the Hawaiʻi Water Quality Standards (HDOH, 2009) as a Class A "embayment" and as a "Class II nearshore reef flat." It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Other uses are permitted so long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. Class A waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control.

The Hawaiʻi Department of Health (HDOH) monitors water quality in the bay at four nearshore stations (Fig. 3; 229-Hawaii Kai, 279-Maunalua Beach Park, 202-Kuliouou Beach Park, and 277-Paikō Beach) and three offshore stations (441, 442, and 443-Maunalua Bay Ocean Monitoring Sites). Water quality samples were collected irregularly at these stations and data are available as follows: 229–May 1992 to October 2008, 279–July 2006 to November 2008, 202–May 1973 to November 2008, 277–July 2006 to November 2008, Maunalua Bay 441–October 1979 to October 1997, Maunalua Bay 442–January 1982 to October 1997, and Maunalua Bay 443–January 1983 to October 1997. Table 1 summarizes the results of these tests. No nutrient data are available for the nearshore stations.

The nearshore stations in Table 1 have been arranged from east (Hawaiʻi Kai) to west (Paikō Beach). Mean temperature is higher in the shallower waters of Stas. 229, 279, and 202 and may represent a greater effect of solar radiation. Mean salinity is lowest at Sta. 202, likely due to fresh water inputs from Kuliʻouʻou Stream. pH is fairly consistent at the four stations throughout the sampling period, with the greatest variation seen at Sta. 202, again, likely due to fresh water inputs from the stream. The mean percent saturation of dissolved oxygen (DO) at Sta. 277 is low. Geometric mean turbidity levels are very high at Stas. 229 and 279, quite high at Sta. 202, and elevated at Sta. 277.

Figure 3. Satellite image showing approximate locations of HDOH nearshore water quality sampling stations in Maunalua Bay near Hawaiʻi Kai Marina (USEPA, 2009).

Mean temperature, salinity, and pH at the Maunalua Bay offshore stations (Stas. 441, 442, and 443) are representative of open coastal and oceanic water, as are the low geometric mean turbidity levels. Mean salinities at these offshore stations are somewhat lower and mean pH levels are slightly higher compared with the nearshore means. The differences in salinity may reflect the effect of solar radiation in shallow water (reef flat) locations, resulting in heating effects and higher evaporation rates (leading to higher salinities) and the high turbidities measured at the nearshore stations are caused by the resuspension of fine materials on the reef flat. The higher and less variable pH levels of the offshore stations demonstrate the buffering properties of seawater. The concentrations of nutrients (nitrogen inorganics, total nitrogen, and total phosphorus) are low in the offshore waters, but the concentration of phytoplankton (as measured by chlorophyll α) is slightly elevated.

Table 1. A summary of selected water quality parameters for the waters of Maunalua Bay (various dates between 1973 and 2008) near Hawaiʻi Kai (data collected by HDOH; USEPA, 2009).

Shoreline Stations

Station		Temp. (ºC)	Salinity (psu)	pH	DO sat. (%)	Turbidity† (NTU)
Hawaiʻi Kai 229						
	mean	**25.0**	**34.5**	**8.0**	**83**	**9.0**
	range	21.35 - 26.69	15 - 36.45	7.65 - 8.18	60 - 110	3.33 - 24.4
	count	*48*	*304*	*32*	*31*	*29*
Maunalua Beach Park 279						
	mean	**24.8**	**34.6**	**8.0**	**77**	**10.3**
	range	22.59 - 26.92	27.2 - 36.18	7.8 - 8.28	65 - 92	3.85 - 32.4
	count	*11*	*11*	*11*	*11*	*11*
Kuliouou Beach 202						
	mean	**25.0**	**33.4**	**7.9**	**77**	**7.4**
	range	21 - 28	12.36 - 36.01	6 - 8.28	53 - 95	1.1 - 27
	count	*35*	*12*	*34*	*12*	*35*
Paikō Beach 277						
	mean	**24.2**	**35.3**	**8.0**	**68**	**3.9**
	range	21.46 - 26.75	32.68 - 36.9	7.56 - 8.23	44 - 94	1.46 - 11.1
	count	*31*	*31*	*31*	*30*	*31*

Offshore Stations

Station		Temp. (ºC)	Salinity (ppt)	pH	Turbidity† (NTU)	TSS† (mg/L)
Maunalua Bay 441						
	mean	**24.6**	**33.9**	**8.2**	**0.3**	**23**
	range	20 - 27.7	30 - 35.2	7.1 - 8.6	0.1 - 10	1 - 223
	count	*121*	*121*	*115*	*121*	*120*
Maunalua Bay 442						
	mean	**24.7**	**33.8**	**8.2**	**0.2**	**20**
	range	21 - 27.7	30.4 - 35.7	7.6- 8.5	0.1 - 2.8	1 - 187
	count	*109*	*109*	*105*	*109*	*108*
Maunalua Bay 443						
	mean	**24.5**	**33.9**	**8.2**	**0.2**	**17**
	range	21 - 27.8	28.5 - 37	7.6 - 8.5	0.1 - 2.8	0 - 192
	count	*96*	*96*	*93*	*96*	*95*

† geometric mean

Table 1 (continued).

Offshore Stations

Station		NO_3+NO_2† (mg N/L)	NH_4† (mg N/L)	Total Nitrogen† (mg N/L)	Total Phosphorus † (mg P/L)	Chl α† (µg/L)
Maunalua Bay 441						
	mean	**0.01**	**0.07**	**0.12**	**0.01**	**3.2**
	range	0 - 0.18	0 - 0.23	0 - 1.1	0.001 - 0.073	0 – 25
	count	*120*	*117*	*118*	*123*	*106*
Maunalua Bay 442						
	mean	**0.01**	**0.06**	**0.10**	**0.01**	**2.4**
	range	0 - 0.08	0 - 7	0.06 - 0.30	0.005 - 0.039	0 - 3.7
	count	*52*	*104*	*109*	*108*	*95*
Maunalua Bay 443						
	mean	**0.01**	**0.06**	**0.12**	**0.01**	**2.2**
	range	0 - 0.05	0 - 0.7	0 - 0.5	0.002 - 0.128	0 - 2.5
	count	*96*	*90*	*90*	*96*	*88*

† geometric mean

Marine Biota

Seaward of the reef off Maunalua Bay Beach Park, the bottom of Maunalua Bay is largely sand with scattered limestone outcrops. The limestone outcrops were surveyed for the proposed Maunalua Bay Ferry Terminal (Brock, 1988) and the following description is taken largely from that report. A limestone mound biotope commences approximately 900 m (2,953 ft) from shore in 3.5 m (11.5 ft) of water and extends seaward at least an additional 300 m (984 ft) to a depth of 6 m (20 ft) or more. The limestone outcrops range in size from 10 x 15 m (33 x 50 ft) to more than 30 x 80 m (98 x 262 ft). The patches are spaced from 30 to over 100 m (98 to 328 ft) apart and are separated by sand bottom. Benthic communities in this biotope are sparse; little shelter is available and sand scour is likely frequent. Coral cover on the limestone mounds was less than 4% and macroalgae coverage was less than 8%. Species of corals reported from this survey are *Porites lobata*, *Pocillopora meandrina*, *Montipora capitata*, *M. patula*, and *Cyphastrea ocellina*.

The reef flats off Maunalua Bay Beach Park (located to the north of the entrance channel) and off Portlock Beach (located to the south) were surveyed by *AECOS* biologists in November 2007 and October 2009 (Fig. 4). Table 2 presents a list of organisms observed by *AECOS* biologists on the reef flat in these surveys.

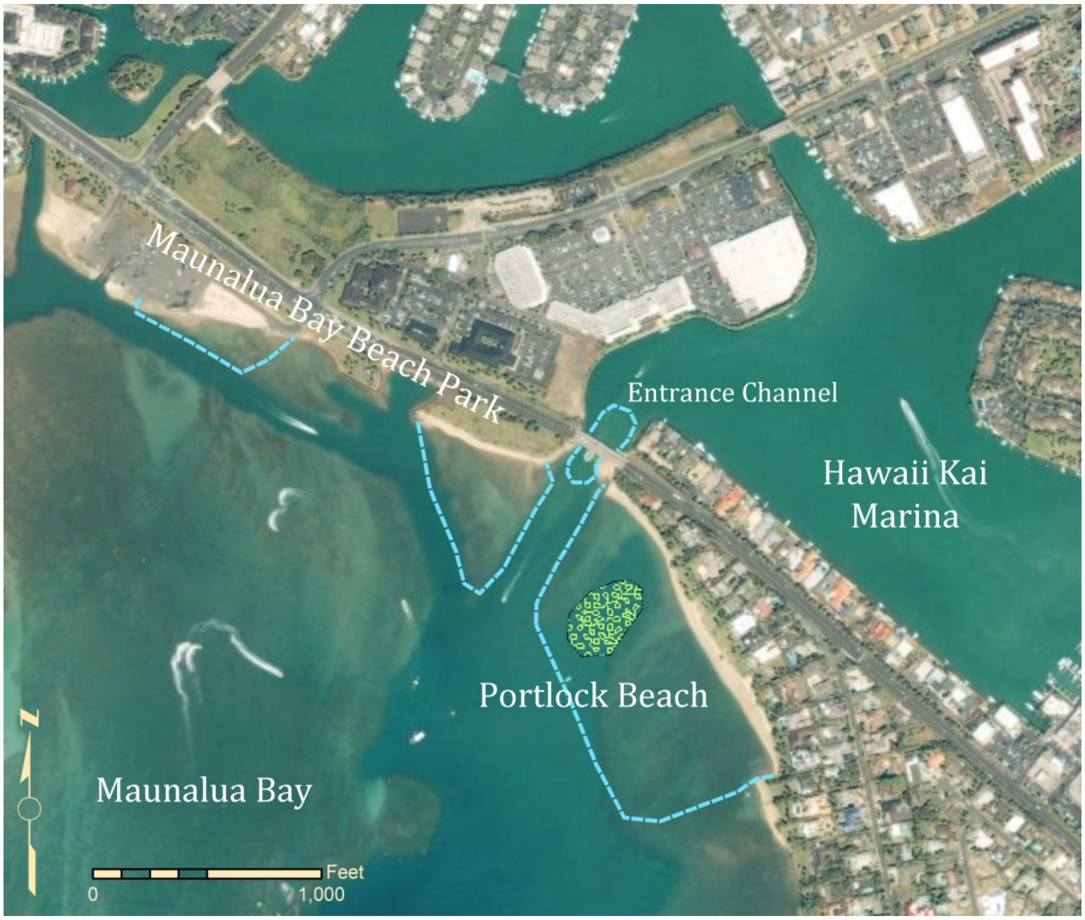

Figure 4. Areas surveyed (outlined by blue dashed lines)in channel and on nearshore reef remnant November 2007 and October 2009*;* approximate area of seagrass bed (green) off Portlock Beach also shown.

Reef Flats off Maunalua Bay Beach Park and Portlock Beach - The reef flat remnants off Maunalua Bay Beach Park and Portlock Bach are highly-eroded, low-relief limestone platforms. The shallow (less than 1 m or 3 ft) reef areas are covered with a veneer of sand and silt. Some sections are exposed at low tide. The benthic communities close to shore are highly disturbed and dominated by sessile filter and suspension feeding organisms.

A study by ECI in 1975, cited in Brock (1988), found small colonies of the corals, *Cyphastrea ocellina* and *Pocillopora damicornis*, and abundant colonies of *Porites compressa* and *P. lobata* on the reef flat off Maunalua Bay Beach Park and Portlock Beach. The algae, *Acanthophora spicifera* was present in 1975, along with *Dictyosphaeria cavernosa*, which was growing along the boulders of the western edge of the entrance channel. In 1975, ECI indicated that algae growth approached 100% in some areas, dominated by *Codium edule*, *Halimeda* sp., and *Enteromorpha* sp. The 1975 study found 53 species of fish (dominated by *Stethojulis balteata* or *ʻomaka*), most associated with areas of high coral cover, particularly along the western edge of the entrance channel.

In 1988, only a few very small colonies of *Poc*. *damicornis*, *Porites compressa*, and *P*. *lobata* were reported on the reef flat off Maunalua Bay Beach Park and Portlock Beach (Brock, 1988). *A*. *spicifera* was reported as present on the reef flat, along with 8 other algal species, but having a mean coverage of only 0.8%. The 1988 survey found five species of fish on the reef flat: *Acanthurus triostegus*, *Foa brachygramma*, *Asterropteryx semipunctatus*, and *Pervagor spilosoma*.

In 2002 (Coles et al., 2002) found benthic cover on the reef flat off Portlock Beach to be an abundance of a non-native alga, *Avrainvillea amadelpha*, growing in sand and on a small limestone outcrop supporting the coral, *Pavona varians*. Native seagrass, *Halophila hawaiiana*, was present.

Today, the reef flat off Maunalua Bay Beach Park and Portlock Beach continues to be dominated by non-indigenous algae, such as *Acanthophora spicifera* (most abundant), *Avrainvillea amadelpha,* and *Lyngbya majuscule; Gracilaria salicornia* is occasionally found. The algae grow on limestone rubble, easily rolled by waves and swells. Algal growth is most dense close to shore. Other algae present on the reef flat include species that are preferred (Arthur and Balazs, 2008) by green sea turtles (*Chelonia mydas*), such as *Ulva fasciata*, *Hypnea cervicornis*, *Spyridia filamentosa*, *Cladophora catenata*, and *C*. *seriacea* (as well as the abundant *A*. *spicifera*). A seagrass bed (Fig. 4), consisting of both the endemic *Halophila hawaiiana* and the introduced *H*. *decipiens*, is located off Portlock Beach. Seagrass is another important component of the diet of green sea turtle (Arthur and Balazs, 2008).

Very few coral colonies are present on the reef flat, with the first colony appearing more than 100 m (330 ft) offshore. Coral colonies present include *Montipora capitata*, *M*. *flabellata*, *Poc*. *damicornis*, *Poc*. *meandrina*, *P*. *compressa* and *P*. *lobata*. Other reef macro-invertebrates, such as brittle stars, sea urchins, and sea anemones, are relatively uncommon. Fish biomass and diversity are very low in the nearshore areas of low relief bottom. Fifteen species of fishes were observed on the reef flat. *Arothron hispidus* (*oʻopu hue* or stripebelly puffer) and *Acanthurus nigrofuscus* (*māʻiʻiʻi* or brown surgeonfish) are common, while *Abudefduf abdominalis* (*mamo* or Hawaiian sergeant) and *Acanthurus blochii* (*pualu* or ringtail surgeonfish) are seen occasionally.

<u>Paikō Peninsula and Lagoon</u> - West of the marina is Paikō Peninsula and Lagoon (Fig. 3). The peninsula is a barrier spit built by sand and rubble transported eastward along the inner reef flat (WOA, 1998). The spit shelters the lagoon, an important habitat for various shorebirds. Paikō Lagoon is designated as a wildlife sanctuary by the Hawaiʻi Department of Land and Natural Resources (HDLNR, 2009). Consisting of all state-owned land adjacent to Paikō Lagoon and water areas within Paikō Lagoon (approximately 13.4 ha or 33 ac), the sanctuary provides the only protected waterbird habitat on the Maunalua Bay coast. Portions of Paikō Peninsula are within the *conservation district* pursuant to Hawaiʻi Land Use Law (Chapter 205, HRS), whereas a small section in the middle is within the *urban district*.

Paikō Lagoon, formerly a coastal fishpond, is fed by a freshwater springs and Kuliʻouʻou Stream. The tidal flats of the lagoon are used by shorebirds for foraging at low tide. Paikō Lagoon wildlife sanctuary provides a permanent sanctuary to the endangered Hawaiian stilt (*aʻeo*), as well as migratory shore birds, including golden-plovers, turnstones, and tattlers (Engilis and Naughton, 2002). Benthic invertebrates found in Paikō Lagoon include: crabs (*Ocypodidae, Graspus graspus*, *Thalamita crenata*, *Charybdis hawaiiensis*, *Macropthalamus telescopis*), alpheid shrimps, and polychaete worms. The lagoon supports blenny (*Istiblennius gibbifrons*), goby (*Bathygobius fuscus*), *āholehole* (*Kuhlia sandvicensis*), mollies (*Mollienesia latipinna*), mullet (*Mugil cephalus*), and *awa* (*Chanos chanos*; USACE, 1975).

<u>Kuliʻouʻou Beach</u> - Kuliʻouʻou Beach is situated between Paikō Lagoon and the channel to the west arm of the marina. It is largely a mudflat covering an old fringing reef (WOA, 1988). A dredged channel connects Kuliʻouʻou Stream with the entrance channel to the marina. Kuliʻouʻou Beach is within the *urban district* pursuant to Hawaiʻi Land Use Law (Chapter 205, HRS).

In the channel outside Paikō Lagoon, Coles et al. (2002) found a consolidated limestone reef flat outside of a sand channel. The reef flat supported abundant growth of non-native algae: mostly *Gracilaria salicornia*, *Hypnea musciformis*, and *Avrainvillea amadelpha*. Native seagrass (*Halophila hawaiiana*) was sparse, and a few propagules of *Rhizophora mangle* mangrove were present.

<u>Maunalua Bay Beach Park</u> - Maunalua Bay Beach Park (Fig. 4) was created in the 1960s from the dredged material resulting from dredging of the west channel to the marina and a connecting channel just off the shore. Presently, the shore is a mix of coral rubble, silt, and sand. A boat launching ramp is located at the eastern end of the park and a 183-m (600-ft) rock revetment lines the west end of the park. The nearshore channel is approximately 45 m (148 ft)

in width and 2.5 m (8.2 ft) in depth. Presently, this channel serves as a collection point for the discharge of freshwater and terrigenous materials from Paikō Lagoon, Kuliʻouʻou Stream, and the west channel into the marina (Brock, 1988). A description of the fringing reef off the beach park is provided above (p. 8 to 9). Maunalua Bay Beach Park is within the *urban district* pursuant to Hawaiʻi Land Use Law (Chapter 205, HRS).

Portlock Beach - Portlock Beach lies directly east of the main entrance channel to the marina (Fig. 5) and is a 650-m (2,140-ft) long, narrow sand beach. Portlock Beach is within the *urban district* pursuant to Hawaiʻi Land Use Law (Chapter 205, HRS). Inland of the beach is an upscale residential area. Beyond Portlock Beach, towards Kawaihoa Point (Koko Head), the shoreline is artificially stabilized with revetments and seawalls and by low cliffs and benches cut in the tuff of the headland. The sand on Portlock Beach is actively eroding; longshore currents move the sand westward into the marina entrance channel. The main portion of Portlock Beach is presently receding at -0.17 ±0.11 m/yr (-0.56 ±0.35 ft/yr; Coastal Geology Group, 2009).

The nearshore bottom immediately off Portlock Beach is sand with occasional coral rubble. No fish, corals, or large invertebrates inhabit this area, although sea urchins and burrows of small invertebrates are present. A description of the fringing reef off this beach is provided above (p. 8 to 9).

Marina Entrance Channel

According to WOA (1988), when Kalanianaʻole Highway was built in the late 1930s, the main entrance channel from Kuapā Pond to Maunalua Bay was widened to 12 m (40 ft) and another channel to the west arm of the marina constructed to provide better water exchange. The entrance channel was built at a natural break in the reef, probably a drainage channel for the brackish water of Kuapā Pond initially formed during a lower stand of the sea (*AECOS*, 1979). The entrance channel was again dredged in the 1940s to facilitate landing craft operations and to service the military installation during World War II. As part of the development of the Hawaiʻi Kai community, the entrance channel was widened to 76 m (250 ft) and dredged to 1.9 m (6.2 ft) to accommodate potential runoff from a 100-year storm (PODCO Permit 820D issued 04/14/67). At that time, an access channel from Kuliʻouʻou Stream to the entrance channel was dredged parallel to the shore and the second channel to the west arm of the marina was dredged. The material from this dredging project was used to construct Maunalua Bay Beach Park and the boat launching area. Since the 1960s, the entrance channel has largely filled in and, despite maintenance dredging once every ten years, now more closely resembles the 12 m- (40 ft-) wide channel that was first created in the 1930s.

Figure 5. Portlock Beach looking northwest towards the main entrance channel to the Hawaii Kai Marina (under highway bridge).

Biota

The bottom of the entrance channel consists largely of shifting sands and silt and does not provide suitable habitat for most reef organisms. Table 2 presents a list of organisms observed in the entrance channel in the November 2007 and October 2009 surveys made by *AECOS* biologists. The hard surfaces, such as areas where the channel bisects the reef flat and concrete pilings of the bridge, are colonized by a variety of flora and fauna, primarily introduced fouling organisms. The pilings, in particular, are heavily covered with *Carijoa riisei*, an introduced octocoral, and *Amathia distans* (bushy bryozoan). *Gracilaria salicornia* (gorilla *ogo*), an introduced red alga, is also attached to the pilings.

Dascyllus albisella (*ʻaloʻiloʻi* or Hawaiian domino damselfish), *Acanthurus triostegus* (*manini* or convict tang), *Forcipiger flavissimus* (*lauwiliwili* *nukunukuʻoiʻoi* or yellow longnose butterflyfish), and juvenile wrasses (Labridae family) were observed in the entrance channel in the recent surveys.

Table 2. Checklist of organisms observed in the main entrance channel to Hawaii Kai Marina and on the adjacent reef flat in November 2007 and October 2009.

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name	Abundance	Status	Location
BLUE-GREEN ALGAE				
CYANOPHYTA				
Lyngbya majuscula		C	Ind.	REEF
ALGAE				
RHODOPHYTA				
Anotrichium tenue		O	Ind.	REEF
Acanthophora spicifera	*limu ʻakiʻaki*	A	Ind.	REEF
Avrainvillea amadelpha	leather mudweed	C	Nat.	REEF
Gracilaria parvispora		R	End.	REEF
Gracilaria salicornia	gorilla *ogo*	O	Nat.	REEF
Galaxaura rugosa		R	Ind.	REEF
Gelidium pluma		R	End.	CHAN.
Hydrolithon reinboldii		O	Ind.	REEF
Hypnea cervicornis		O	Ind.	REEF
Hypnea musciformis	hookweed	R	Ind.	REEF
Spyridia filamentosa		R	Ind.	REEF
Spirocladia hodgsoniae		O	End.	REEF
CHLOROPHYTA				
Bryopsis hypnoides		R	Ind.	REEF
Cladophora catenata		R	Ind.	REEF
Cladophora seriacea		R	Ind.	REEF
Caulerpa taxifolia		U	Ind.	REEF
Chaetomorpha antennina		R	Ind.	REEF
Halimeda discoidea		O	Ind.	REEF
Neomeris sp.		R	Ind.	REEF
Ulva fasciata	*limu pālahalaha*	U	Ind.	REEF
Ventricaria ventricosa	sailor's eyeballs	R	Ind.	REEF

Table 2 (continued).

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name	Abundance	Status	Location
PHAEOPHTYA				
Dictyota ceylanica	Ind.	O		REEF
Padina australis		U	Ind.	REEF
FLOWERING PLANTS				
MAGNOLIOPHYTA				
Halophila decipiens	Caribbean seagrass	C, U‡	Nat.	REEF
Halophila hawaiiana	Hawaiian seagrass	C, U‡	End.	REEF
INVERTEBRATES				
PORIFERA, DEMOSPONGIA				
unid.	blue sponge	O	--	CHAN.
NIPHATIDAE				
Gelloides fibrosa	grey encrusting sponge	O	Nat.	CHAN.
SUBERITIDAE				
Terpios zeteki	variable terpios	R	Nat.	CHAN.
CNIDARIA, HYDROZOA				
PENNARIIDAE				
Pennaria disticha	Christmas tree hydroid	R	Nat.	CHAN.
CNIDARIA, SCYPHOZOA				
CARYBDEADAE				
Carybdea alata	box jellyfish	R	Ind.	REEF
CNIDARIA, ANTHOZOA				
ACTINARIA				
ACTINIDAE				
Gyractis sesere	Sesere's anemone	R	Ind.	REEF
CNIDARIA, ANTHOZOA				
SCLERACTINIA				
POCILLOPORIDAE				
Pocillopora damicornis	lace coral	R	Ind.	REEF
Pocillopora meandrina	cauliflower coral	R	Ind.	REEF
PORITIDAE				
Porites lobata	*pōhaku puna*, lobe coral	R	Ind.	REEF
Porites compressa	finger coral	R	End.	REEF
ACROPORIDAE				
Montipora capitata	rice coral	R	Ind.	REEF
Montipora flabellata	blue rice coral	R	End.	REEF

Table 2 (continued).

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name	Abundance	Status	Location
CNIDARIA, ANTHOZOA				
CERIANTHARIA				
ACONTIFERIDAE				
Isarachnanthus bandanensis	ghost tube anemone	R	Ind.	REEF
ANNELIDA, POLYCHAETA				
CHAETOPTERIDAE				
Chaetopterus sp.	parchment worm	R	Ind.	CHAN.
SABELLIDAE				
Sabellastarte spectabilis	feather duster worm	O	Ind.	CHAN.
BRYOZOA, GYMNOLAEMATA				
unid.	unidentified bryozoan	R	--	CHAN.
VESICULARIIDAE				
Amathia distans	bushy bryozoan	R	Ind.	CHAN.
MOLLUSCA, GASTROPODA				
CONIDAE				
Conus lividus	spiteful cone	R	Ind.	REEF
MOLLUSCA, GASTROPODA				
DORIDACEA				
CHOROMODORIDAE				
Choromodoris decora	decorated nudibranch	R	Ind.	REEF
MOLLUSCA, BIVALVIA				
ANOMIDAE				
Anomia noblis	jingle shell	R	Nat.	CHAN.
OSTREIDAE				
Dendostrea sandvicensis	Hawaiian oyster	U	Ind.	CHAN.
TEREDINIDAE				
unid.	shipworm	R	--	CHAN.
ARTHROPODA, CRUSTACEA, DECAPODA				
CALLIANASSIDAE				
Corallianassa borradailei	Borradaile's ghost shrimp	R	Ind.	REEF
GRAPSIDAE				
Grapsus tenuicrustatus	*ʻaʻama*, thin shelled rock crab	R	Ind.	CHAN.
ECHINODERMATA, OPHUIROIDEA				
AMPHIUROIDAE				
Ophiactis sp.	sponge brittle star	R	Ind.	CHAN.

Table 2 (continued).

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name	Abundance	Status	Location
OPHIOCOMIDAE				
Ophicoma dentata	toothed brittle star	R	Ind.	CHAN.
ECHINODERMATA, ECHINOIDEA				
TOXOPNEUSTIDAE				
Tripneustes gratilla	*ʻhāwaʻe poʻo hina*, collector urchin	R	Ind.	REEF
CHORDATA, ASCIDACEA				
ASCIDIIDAE				
Ascidea sydneiensis	yellow-green sea squirt	R	Nat?	CHAN.
Phallusia nigra	black sea squirt	R	Nat?	CHAN.
DIADEMNIDAE				
Diademnum sp.	colonial tunicate	R	--	CHAN.
FISHES				
MURAENIIDAE				
Echidna nebulosa	*puhi kapa*, snowflake moray	R	Ind.	REEF
KUHLIIDAE				
Kuhlia sandvicensis	*āholehole*, zebra-headflagtail	R	Ind.	REEF
MULLIDAE				
Mulloidichthys flavolineatus	*weke ā*, yellow stripe goatfish	R	Ind.	REEF
Upeneus arge	*weke pueo*, bandtail goatfish	R	Ind.	REEF
CHAETODINTIDAE				
Chaetodon miliaris	*lau wiliwili,* milletseed butterflyfish	R	Ind.	REEF
Forcipiger flavissimus	*lauwiliwilinukunukuʻoiʻo*, yellow longnose butterflyfish	U	Ind.	CHAN.
POMACENTRIDAE				
Abudefdef abdominalis	Hawaiian sergeant	O	End.	REEF
Dascyllus albisella	*ʻaloʻiloʻi*, Hawaiian dascyllus	U	End.	CHAN.
LABRIDAE				
Stethojulis balteata	*ʻōmaka*, belted wrasse	U	End.	REEF
Thalassoma trilobatum	*ʻawela*, Christmas wrasse	R	Ind.	REEF

Table 2 (continued).

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name	Abundance	Status	Location
SCARIDAE				
Chlorurus sordidus	*uhu*, bullethead parrotfish	R	Ind.	REEF
GOBIIDAE				
Asterropteryx semipunctatus	halfspotted goby	R	Ind.	REEF
ZANCLIDAE				
Zanclus cornutus	*kihikihi* , Moorish idol	R	Ind.	REEF
ACANTHURIDAE				
Acanthurus blochii	*pualu*, ringtail surgeonfish	O	Ind.	REEF
Acanthurus triostegus sandvicensis	*manini*, convict surgeonfish	C	End.	CHAN.
TETRAODONTIDAE				
Arothron hispidus	*ʻoʻopu hue*, stripebelly puffer	C	Ind.	REEF

KEY TO SYMBOLS USED:

Abundance categories:

P – Present – identified but abundance not assessed
R –Rare – only one or two individuals observed.
U – Uncommon – several to a dozen individuals observed.
O – Occasional – seen irregularly and always in small numbers.
C – Common – observed everywhere, generally not in large numbers.
A – Abundant – observed in large numbers and widely distributed.

Status categories:

End. – Endemic – species found only in Hawaiʻi
Ind. – Indigenous – species found in Hawaiʻi and elsewhere
Nat. – Naturalized – Not native to Hawaiʻi; introduced and surviving in the wild.

Location:

CHAN. – Entrance channel
REEF – All reef flats

Notes:

† – species presence inferred from non-living material or evidence
‡ - common offshore of Portlock Beach, uncommon offshore Maunalua Bay Beach Park

Results of a survey conducted in 1988 and reported in the Environmental Assessment (EA) for the Maunalua Ferry Terminal (WOA, 1988) indicated the presence of burrows of *Alpheus mackayi* (snapping shrimp), and larger crab species in the entrance channel. The authors assumed *Psilogobius mainlandii* (Hawaiian shrimp goby), a species commensual with *A. mackay*, also reside in the soft sediments. They surmised that tilapia (Cichlidae family), *kaku* (Sphyraenidae family), and *pua* (author is likely referring to *Rhinecanthus* *rectangulus* or *humuhumunukunukuapuaʻa*) swam along the channel edges and reported that fishermen saw *nehu* (*Encrasicholina purpurea*) and caught small *papio* (Carangidae family) there.

Hawaii Kai Marina

Hawaii Kai Marina (the marina) consists of three major parts: a large "east" arm, and the two smaller "middle" and "west" arms (Fig. 6). The margins of the marina are largely hardened by seawalls and numerous storm drains discharge into the marina. Several islands have been created in the marina from the material of the initial and subsequent dredging projects. The marina and Maunalua Bay are connected through two channels under Kalanianaʻole Highway and the diurnal tides promote water exchange throughout the marina.

Figure 6. Satellite photograph of Hawaiʻi Kai Marina and environs showing the three arms, two rim islands, and two channel openings to Maunalua Bay.

Prior to its development as a marina, Kuapā Pond was an embayment isolated from Maunalua Bay by a barrier beach. Over time, the feature became a brackish water lake with wetlands. The basin served to settle out terrigenous sediments washed downstream by runoff, protecting Mauanalua Bay and its coral reefs by filtering the water. If left in its natural state, Kuapā Pond would have eventually filled in with sediments.

Hawaiʻi Kai Marina still serves as a "sink" for sediments coming from the surrounding watershed. In fact, the urban storm drain system built throughout the watershed transports runoff quickly and directly into the marina and ultimately into Maunalua Bay. The process of accretion that was occurring prior to the development of Kuapā Pond into a marina continues, requiring regular maintenance dredging.

Hawaii Kai Marina is considered a Class II "artificial basin" by HDOH and must meet the basic water quality criteria for all state waters (HDOH, 2009). Maunalua Bay (from Paikō Peninsula to Koko Head) is considered a Class A "embayment." Maunalua Bay is a Water Quality-Limited Segment listed by the Hawaiʻi Department of Health pursuant to Subsection 303(d) of the Federal Clean Water Act (HDOH, 2008).

<u>Permitting history</u> - Table 3 lists the state and federal dredging-related permits issued and activities authorized in the marina and near the entrance channels to Maunalua Bay since 1959. The most recent permit issued was a 10-year maintenance dredging permit from the USACE (PODCO 93-017) on January 26, 1994. This round of permitting is to obtain a new 10-year maintenance dredging permit to replace that one that expired in 2004.

Table 3. Known dredging-related permits issued to Hawaiʻi Kai Marina since 1959.

Date	Authorizing Agency	Permit & Authority	Activities Authorized (and conducted, if known)
1959 PODCO 557	USACE	Department of Army, Section 10	Dredging of entrance channel to state boat ramp in Maunalua Bay
1961 PODCO 626	USACE	Department of Army, Section 10	Dredging of state boat ramp and channel area in Maunalua Bay
1962 PODCO 627	USACE	Department of Army, Section 10	Dredging of Portlock area in Maunalua Bay
1965 PODCO 792D	USACE	Department of Army, Section 10	Dredging of 1330 cy of area adjacent to Kalanianaole Bridge
1967 PODCO 820	USACE	Department of Army, Section 10	Dredging of 37,000 cy of entrance channel under Kalanianaole Bridge

Table 3 (continued).

Date	Authorizing Agency	Permit & Authority	Activities Authorized (and conducted, if known)
1974 CDUA-0A-1/10/74-517	DLNR	Conservation District Use Permit (CDUA)	Maintenance dredging of Kupuā Pond
1975 PODCO 1217D	USACE	Department of Army, Section 10	Dredging of Hahaione Spillway (probably issued to City & County of Honolulu)
1977 PODCO-O 1077-D	USACE	Department of Army, Section 10	5-year maintenance dredging of 750,000 cy in marina and entrance channel (200,000 to 250,000 cy was suction dredged from marina in 1981)
1983 PODCO 1077D	USACE	Department of Army, Section 10	Maintenance dredging of 10 designated areas in marina.
1986 PODCO GP 82-1-J	USACE	Department of Army, Section 10	Dredging of 3000 cy of area adjacent to Kalanianaole Bridge. (Entrance channel was dredged with a dragline bucket. Results were poor and silt moved back within 4 months)
1988 PODCO 2036	USACE	Department of Army, Section 10	Dredging of Kawaihae Street spillway
1994 PODCO 93-017	USACE	Department of Army, Section 10	Maintenance dredging of marina and entrance channel. (In 1996, 53,600 cy was dredged from marina with bucket & barge. Material was disposed on Rim Islands 1 and 2).
2001 CDUA	DLNR	CDUA	Dredging of entrance channel, nourishment of Portlock Beach, and construction of temporary groin. (In 2002, 7,500 cy was dredged from entrance channel, placed on Portlock Beach, and 90 ft temporary groin built)

Water quality

To characterize water quality of Hawaii Kai Marina and contribute to establishing baseline water quality in the project area, *AECOS* established 11 sampling stations within the marina and 6 near the entrance channel (Fig. 7) and completed a sampling event on November 13, 2007 at the beginning of the rainy season. Samples were collected from just below the water surface at each station and temperature, salinity, pH, and dissolved oxygen (DO) were measured in the field. Water samples for all other analytes (turbidity, total suspended solids, nitrate-nitrite, ammonia, total nitrogen, total phosphorus, and chlorophyll α) were collected in appropriate containers, preserved on ice, and taken to *AECOS* in Kāneʻohe, Oʻahu (Log No. 23551) for laboratory analyses.

Measurable rainfall prior to the sampling event included nearly 16.5 cm (6.5 in) November 4 to 5, 2007 and 1.3 cm (0.5 in) on November 12, 2007 (NOAA-NWS, 2001). Tidal predictions for Hanauma Bay (located near the marina) on November 13, 2007 include a higher high water (HHW) tide of 2.2 ft at 0511, a higher low water (HLW) tide of 0.4 ft at 1328, a lower high water (LHW) tide of 0.5 ft at 1640, and a lower low water (LLW) tide of 0.1 ft at 2200 at Honolulu (NOAA0NOS, 2010). Table 4 lists the field instruments and analytical methods used to evaluate these samples. The results of this sampling event are given in Table 5.

Figure 7. Locations of water quality stations, November 13, 2007 sampling event.

Temperatures measured at all of the stations are fairly typical for embayments in Hawaiʻi. The most notable observation is that afternoon temperatures are higher than measurements made in the morning. pH also demonstrates an increasing trend as the day progresses and this is likely due to photosynthesis, which removes dissolved carbon dioxide (a weak acid) from the water column, resulting in higher pH values. Fig. 8 demonstrates the correlation between pH and DO in the waters of the marina. The waters of the marina are saturated with oxygen and are supersaturated at almost half of the stations, especially in the

Table 4 Analytical methods and instruments used for November 13, 2007 water quality sampling of Hawaiʻi Kai Marina.

Analysis	Method	Reference	Instrument
Temperature	EPA 170.1	USEPA (1983)	YSI Model 550A DO meter
Salinity	Refractive index		Handheld refractometer
pH	EPA 150.1	USEPA (1983)	Hannah pocket pH meter
Dissolved Oxygen	EPA 360.1	USEPA (1983)	YSI Model 550A DO meter
Turbidity	EPA 180.1	USEPA (1993)	Hach 2100N Turbidimeter
Total Suspended Solids	EPA 160.2	USEPA(1993)	Mettler H31 balance
Nitrate + Nitrite	EPA 353.2 Rev. 2.0	USEPA (1993)	Technicon AutoAnalyzer II
Ammonia nitrogen	SM 4500-NH3 B/C	Grasshoff et al. (1999)	Technicon AutoAnalyzer II
Total Nitrogen	persulfate digestion	Grasshoff et al. (1999)	Technicon AutoAnalyzer II
Total Phosphorus	persulfate digestion	Grasshoff et al. (1999)	Technicon AutoAnalyzer II
Chlorophyll α	SM 10200 H	Standard Methods (1998)	Turner Model 112 fluorometer

afternoon. This is also due to photosynthesis by phytoplankton (algae) in the water. Salinity values are typical for oceanic waters (average 34 psu); the salinity was lowest at Sta. 2 (30 psu), indicating freshwater input near the mouth of Kamiloiki Stream at the very upper end of the marina. Turbidity and TSS levels were high at all 17 stations.

Total nitrogen (TN) concentrations (consisting of organic, inorganic, and particulate moieties) were elevated at all stations inside of the marina and the entrance channel (Stas. 1 through 13), but were relatively low at the stations in Maunalua Bay (Stas. 14 through 17). Nitrate-nitrite nitrogen (NO_3+NO_2) concentrations followed this same pattern, but ammonia nitrogen (NH_3) concentrations were elevated at five stations inside the marina (Stas. 1 through 5), but very low or non-detectable at the remaining stations inside of the marina, the entrance channel stations, and the Maunalua Bay stations (Stas. 6 through 17). Total phosphorus (TP) concentrations, also consisting of organic, inorganic, and particulate moieties, were elevated at 9 stations inside the marina (Stas. 2 through 8, 11, and 12). Chlorophyll α (chl α) levels were elevated at most stations inside the marina (Stas. 2 through 9) and the entrance channel (Stas. 12 and 13).

Table 5. Water quality measured on November 13, 2007 at 17 stations in Hawaiʻi Kai Marina.

Station	Time	Temp. (°C)	Salinity (PSU)	pH	DO (mg/l)	DO sat. (%)
1	0850	25.9	34	7.98	5.43	81
2	0905	26.6	30	8.12	6.79	100
3	0915	26.0	34	8.25	6.63	99
4	0925	26.4	32	8.28	7.22	107
5	1000	26.5	32	8.17	6.23	93
6	1030	26.1	34	8.21	6.46	97
7	1035	25.7	34	8.31	7.14	106
8	1050	26.9	34	8.30	7.27	110
9	1125	26.3	34	8.23	5.77	87
10	1130	26.4	34	8.31	5.93	89
11	1140	27.0	34	8.23	5.56	84
12	1155	26.6	34	8.35	6.61	100
13	1155	26.6	34	8.33	6.67	101
14	1315	27.4	34	8.38	7.93	121
15	1320	28.6	36	8.44	8.91	140
16	1335	27.2	34	8.28	6.83	104
17	1335	26.8	34	8.27	6.59	100

	Turbidity (ntu)	TSS (mg/l)	NH_3 (µg N/l)	NO_3 + NO_2 (µg N/l)	TN (µg N/l)	TP (µg P/l)	Chl α (µg/l)
1	2.42	7.6	13	106	380	28	1.67
2	6.16	13	28	680	1230	71	5.80
3	4.98	13	16	340	903	77	7.88
4	5.98	13	22	240	919	63	9.77
5	4.54	11	14	92	443	32	6.02
6	5.30	12	<1	194	559	47	4.14
7	4.44	12	<1	250	647	47	5.81
8	6.44	16	<1	197	755	52	8.94
9	3.36	13	2	75	301	27	3.61
10	3.20	7.0	<1	88	357	21	2.86
11	4.88	9.8	3	77	259	30	2.92
12	4.96	10	<1	40	374	31	3.52
13	5.60	12	<1	121	286	29	3.48
14	3.05	12	2	35	245	23	1.70
15	3.42	14	<1	8	171	16	0.92
16	7.60	17	<1	24	210	25	1.85
17	9.24	22.0	<1	7	191	29	1.72

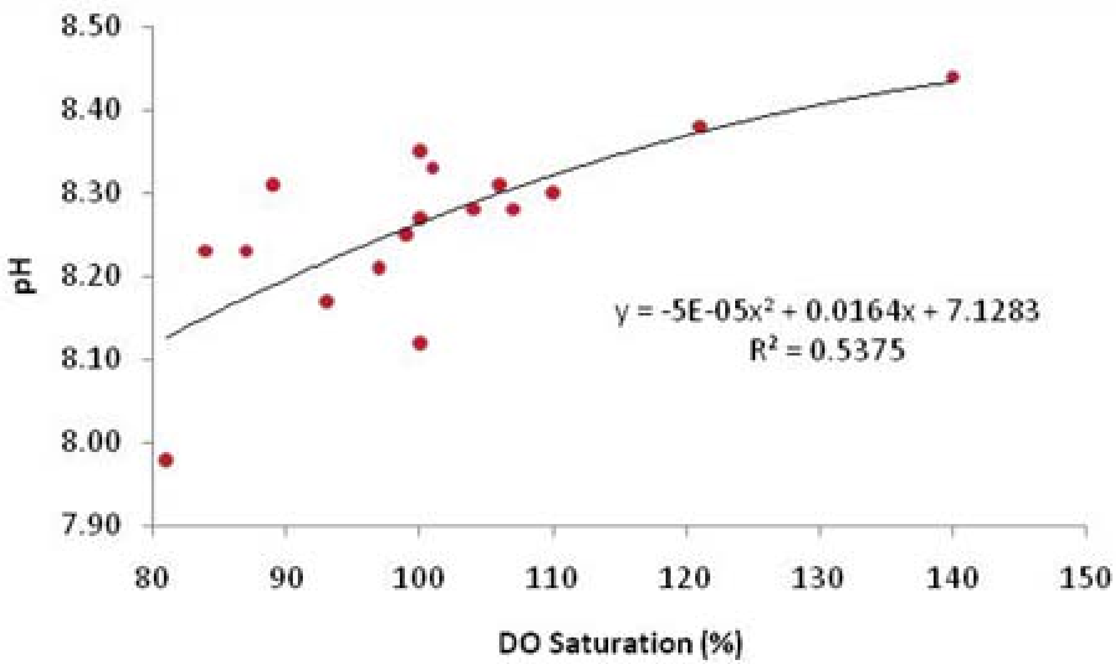

Figure 8. Trend showing correlation between increasing pH and DO for the November 13, 2007 sampling event.

Biota

Prior to its development as a marina, Kuapā Pond was a brackish fishpond used to raise *ʻamaʻama* or mullet (*Mugil cephalus*), *ʻawa* or milkfish (*Chanos chanos*), and *āholehole* or *Kuhlia xenura* (Sakoda, 1975). Fish still inhabit the marina and the following fish species have been reported from the marina (USACE, 1975): *Apogon* sp. (cardinal fish), *Holocentrus diadema* (squirrel fish), *Zebrasoma flavescens* (yellow tang), *Z. veliferum* (sailfin tang), *Scarus* sp. (parrot fish), *Kuhlia sandvicensis* (*āholehole*), *Scomberioides sancti-petri* (*lae*), *Aetobatus narinari* (eagle ray), several species of butterfly fish from the Chaetodontidae family, and schools of *Stolephorus [Encrasicholina] purpureus* (*nehu*).

A survey in 2002 by the Bishop Museum found that the sampling stations in Kuapā Pond (Hawaiʻi Kai Marina) showed the highest percentage (40%) of introduced or cryptogenic species (collectively termed nonindigenous species or NIS) determined in Hawaiʻi (Coles et al., 2002). Hard surfaces within the marina are moderately fouled with suspension feeders commonly found in Oʻahu waters.

The Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR) commented on the 1993 permit application to perform maintenance dredging in the marina that dredging activities "are not likely to further diminish aquatic resource values in the marina (Kuapā Pond) which is a highly developed and modified area. Some turbidity can be expected during dredging, but impacts adverse to the existing resident aquatic resource populations in the marina should be minimal and temporary" (DLNR, 1993).

Dredged Material Disposal Areas

Several areas have been identified for disposal of material generated from dredging the marina. To the extent that the entrance channel deposits comprise good quality sand, this sand will be used to nourish one or more beach locations in Maunalua Bay close to the entrance channel. All other dredged material will need to be put onto land in a location that avoids unmanaged return to the marina or other state waters.

Rim Island 1

Rim Island 1 was originally created by stockpiling dredged material from the surrounding marina. The island initially consisted of a berm surrounding an interior depression, but the depression was partially filled in with dredged material in 1995 and 1996. The central part of the islet remains a depression with pickleweed (*Batis maritima*; Fig. 9) and potentially a wetland. However, open, standing water is not present. The islet is maintained (including watering) as a picnic destination for marina users.

Rim Island 2

Rim Island 2 was created by stockpiling dredged material from the surrounding marina. The perimeter of the island is a berm some 2 m (6 ft) high, which surrounds a depression that is near, and in places below, sea level and intermittently contains standing water in an open flat, surrounded by a pickleweed flat (Fig. 10).

The Hawaiian stilt (*Himantopus mexicanus knudseni*) is a federally-listed endangered species. The US Fish and Wildlife Service (USFWS) has documented that shallow water and open mudflat areas on Rim Island 2 are suitable for stilt feeding and loafing (USFWS, 2003).

Figure 9. Central part of Rim Island 1 (note sprinkler heads) supporting yellowish-green *Batis* in low areas.

Yacht Club Site

The Yacht Club site is an unused upland parcel located between Hawaii Kai Drive and Keahole along the south side of the marina. The site could accommodate approximately 3,058 m^3 (4,000 yd^3) of dredged material from the marina dredging. The return water from the dredged material would need to captured or treated before reaching the marina.

Species of Special Concern

Federal and State of Hawaiʻi listed species status follows species identified in the following referenced documents: Department of Land and Natural Resources (HDLNR, 1996) and U.S. Fish & Wildlife Service (USFWS, 2005a, 2010). Based on preferred habitats and sighting information, the following

Figure 10. Rim Island 2 showing central depression with open water and mud flats. Houses behind are separated by marina waters beyond the rim at far sides of pond.

species listed under the Endangered Species Act (ESA) are known to occur, or could reasonably be expected to occur, in the vicinity of the proposed action: *aeʻo* or Hawaiian stilt (*Himantopus mexicanus knudseni*) and *honu* or green sea turtle (*Chelonia mydas*). Hawaiian stilts nest on Rim Island 2 within the marina and forage on the mudflats of Paikō Lagoon. Green sea turtles may occasionally enter the Hawaii Kai Marina and feed on the reef flat and rest on the beaches surrounding the entrance channel. *Koholā* or humpback whale (*Megaptera novaeangliae*) are present in the deeper waters of Maunalua Bay and *ʻilio holo i ka uaua* or Hawaiian monk seal (*Monachus schauinslandi*) and *honuʻea* or hawksbill sea turtle (*Eretmochelys imbricata*) may be found in Maunalua Bay or farther offshore.

There is no designated or proposed critical habitat for any listed species within or adjacent to the project area (NMFS, 1998). Seagrass beds and coral reefs, which occur in Maunalua Bay near the entrance channel to Hawaii Kai Marina, are designated as special aquatic sites under the Clean Water Act. The taking of corals is prohibited by the State (DLNR, 2002) and three species of coral known to occur in the vicinity of the project area (*Cyphastrea ocellina*, *Montipora patula*, and *Psammocora stellata*) are proposed for protection under Federal law (NMFS, 2010).

Hawaiian stilt

The *aeʻo* or Hawaiian stilt (*Himantopus mexicanus knudseni*) is a slender wading bird currently found on all the main Hawaiian islands except Kahoʻolawe (USFWS, 2005b). In 1967, the Hawaiian stilt was listed as an endangered species under the Endangered Species Act (USFWS, 2005a, 2010). The Hawaiian Waterbirds Recovery Plan (USFWS, 2005b) was completed in 1978, revised in 1985, and in May 2005 a draft recovery plan was published. Estimates of historical population sizes are not known, but extensive wetlands and aquatic agricultural lands provided habitat. Loss of this habitat resulted in a decrease in stilt numbers. Additionally, the Hawaiian stilt was a popular game bird, and hunting contributed to local population declines until waterbird hunting was prohibited in 1939 (Schwartz and Schwartz, 1949). Currently, Oʻahu supports the largest number of silts in the Hawaiian Islands (USFWS, 2005b).

Hawaiian stilt prefer to nest on freshly exposed mudflats interspersed with low growing vegetation. The nesting season of the Hawaiian stilt normally extends from mid-February through August, but varies among years, perhaps depending on water levels (USFWS, 2005b). Stilt are opportunistic feeders and eat a variety of invertebrates and other aquatic organisms available in shallow water and exposed flats. Being a wading bird, feeding typically occurs in shallow flooded wetlands. Within the marina, Rim Island 2 is used by the Hawaiian stilt for foraging on an irregular basis, and is also known to be a nesting site (David, 2004).

Green sea turtle

The most common sea turtle in the Hawaiian Islands is the *honu* or green sea turtle (*Chelonia mydas*), an occasional inhabitant of the shallow waters of Maunalua Bay. In 1978, the green sea turtle was listed as a threatened species under the Endangered Species Act (USFWS, 2005a, 2010). The National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and USFWS, 1998a) developed a recovery plan for U.S. Pacific populations of the green sea turtle that aids in management decisions to protect the population for its recovery.

The green sea turtle diet consists primarily of benthic macroalgae (Arthur and Balazs, 2008), which the reefs of the main Hawaiian Islands provide in abundance. The shallow, nearshore reef environment along the south shore of Oʻahu is primarily an ancient limestone platform covered by algae with very little coral cover. Red macroalgae make up 78% of the turtle diet and green macroalgae make up 12% (Arthur and Balazs, 2008). The single most consumed algal species is *Acanthophora spicifera* (prickly seaweed), which is a non-native species introduced to Hawaiʻi in 1950 (Huisman et al., 2007). Of the many benthic marine algae and plants considered as food resources of the Hawaiian green sea turtle (Russell et al., 2003), the proposed project vicinity supports growth of *Codium* sp., *Pterocladiella* sp., *Acanthophora spicifera*, *Hypnea musciformis*, and *Halophila* spp. Except for *A*. *spicifera*, these species are in low quantities for most of the area surveyed and are not likely a substantial foraging resource for green sea turtle.

Traditionally, sea turtles rest in deeper water during the day where they use reef features to shelter themselves (Smith, 1999) and come to shallow water of the reef flats to feed at night (Balazs et al., 1987). Before acquiring the status of threatened under the Endangered Species Act, sea turtles would flee upon encountering human swimmers in Hawaiʻi. In recent years, however, green sea turtle here have become exceedingly tolerant of human presence and now regularly come to shallows to feed during the day as well as the night (Balazs, 1996).

Turbid (murky) water does not appear to deter green sea turtle from foraging and resting areas. Construction projects on the south shore of Oʻahu at Hawaii Kai and off of Kapolei have found sea turtles adaptable and tolerant of construction-related disturbances (Brock, 1998a, b). The entrance channel into Pearl Harbor, which is periodically dredged and regularly trafficked by large ships and submarines, is home to a resident population of green sea turtle (Smith, 1999).

Green sea turtle nesting is primarily limited to a few beaches of the Northwestern Hawaiian Islands with 90% of nesting occurring at French Frigate Shoals (Balazs et al., 1992); Oʻahu is not considered a primary nesting island for green sea turtles (NMFS-USFWS, 1998a). The green sea turtle is not known to nest or haul-out on Portlock Beach or Maunalua Bay Beach Park. Offshore and about 500 m (1,640 ft) west of the blinker buoy marking the Hawaiʻi Kai boat entrance channel is a green sea turtle resting area known as "Turtle Canyon" (WOA, 1988). This area experiences regular daily boat traffic.

Hawksbill sea turtle

The *honuʻea* or hawksbill sea turtle (*Eretmochelys imbricata*) was listed as endangered under the Endangered Species Act in 1970 (USFWS, 2005a, 2010). Compared with green sea turtle, hawksbill turtle is uncommon in marine waters of Hawaiʻi. Of 545 sea turtles rescued in the state between 1990 and 2008, less than 3% were hawksbill, while more than 95% were green sea turtle (PIFSC-NMFS, n.d.). *Honuʻea* feeds primarily on sponges, but is also known to take macroalgae (Balazs, 1978). Sponges occur with some regularity in the marina entrance channel, although these are unlikely to be a foraging resource for hawksbill turtle.

Unlike the Pacific green sea turtle, hawksbill turtle do not currently nest in the Northwestern Hawaiian Islands. The number of adult nesting female hawksbill on the main Hawaiian Islands has been estimated at roughly 100 individuals (King et al., 2004). Nesting in Hawaiʻi is known to occur on Molokaʻi, Oʻahu, Maui, and Hawaiʻi, with the majority occurring on the east coast of the island of Hawaiʻi (Balazs et al., 1992). Oʻahu is not considered a primary nesting island for hawksbill sea turtle (NMFS-USFWS, 1998b). During peak nesting season, late July to early September (NMFS and USFWS, 1998b), adult turtle may be more likely to transit the project area on their way to or from nesting beaches. Hatching takes place about 60 days later (September to November).

Hawaiian monk seal

The *ʻilio holo i ka uaua* or Hawaiian monk seal (*Monachus schauinslandi*) was listed as endangered in 1976 (USFWS, 2005, 2010), is endemic to the Hawaiian Islands, and is the only pinniped found in Hawaiian waters (USFWS, 2005). The species has a recovery priority number of one, based on the high magnitude of threats, the high recovery potential, and the potential for economic conflicts while implementing recovery actions. The Hawaiian monk seal, one of the rarest seals on Earth, has experienced a steady population decline from a population estimate of around 1,400 in the late 1990s to a population of approximately 1,000 individuals in 2006 (NMFS, 2007).

Although most monk seals are primarily found in the Northwestern Hawaiian Islands, individuals are also found in lower numbers throughout the Main Hawaiian Islands, where documented births and sightings suggest that numbers are increasing (Baker and Johanos, 2004). Monk seal feed on fish, crustaceans, and octopus, and haul out on beaches to rest, digest, and escape predators.

Monk seal primarily pup in the remote Northwestern Hawaiian Islands, but also pup in the main Hawaiian Islands, including the island of Maui, Kauaʻi, and Oʻahu. Monk seal births have been documented in all months of the year, but are most common between February and August, peaking in March and April. Crucial threats to the remaining population are food limitation, marine debris entanglement, and shark predation. Other threats include: infectious disease, fisheries interactions, male aggression, habitat loss, and human interaction.

No monk seals have been recorded hauling-out on Portlock Beach or Maunalua Bay Beach Park.

Humpback whale

The *koholā* or humpback whale (*Megaptera novaeangliae*) was listed as endangered under the Endangered Species Act in 1970 (USFWS, 2005a, 2010). Prior to protection, the Pacific humpback whale population was estimated to have fewer than 1,000 individuals (Rice, 1978). Today, there are over 7,000, and of these, an estimated 5,000 individuals migrate to waters of Hawaiʻi (HIHWNMS, 2004). Humpback whale feed on krill and fish in their summer feeding grounds in the northern North Pacific and are not thought to feed while migrating or while in residence in Hawaiian waters (NMFS, 1991). Mating and calving generally take place over the shallow banks between Maui, Lanaʻi, and Kahoʻolawe, with adults and calves commonly sighted in these waters.

The waters of Maunalua Bay are within the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS), which encompasses approximately 4,178 km^2 (1,218 nautical mi^2) of coastal and ocean waters out to the 183-m (600-ft) isobath. The sanctuary protects the winter breeding, calving, and nursing grounds of the north Pacific humpback whale population.

Stony corals

All stony coral species are protected under state law (HLDNR, 2002). State law prohibits the breaking or damaging, with any implement, any stony coral from the waters of Hawaiʻi, including any reef or mushroom coral. It is also unlawful to take, break or damage, with any implement, any rock or coral to which marine life of any type is visibly attached. In February 2010, 83 species of corals world-wide were petitioned to be listed as threatened or endangered under the Endangered Species Act (NMFS, 2010). Of the 83 species, 75 occur in the Indo-Pacific region and 9 occur in Hawaiʻi (*Acropora paniculata*, *Cyphastrea agassizi*, *Cyphastrea ocellina*, *Leptoseris incrustans*, *Montipora dilatata*, *Montipora flabellata*, *Montipora patula*, *Pocillopora elegans*, and *Psammocora stellata*).

The petition for listing states that these species are classified as vulnerable, except for *M. dilatata*, which is classified as endangered by the International Union for Conservation of Nature (IUCN). *M. dilatata* is also on the Species of Concern list (NOAA-NMFS, 2007). NOAA has initiated a status review of the species to determine if listing under the ESA is warranted (NMFS, 2010); results are anticipated in late 2010 (NOAA-NMFS Endangered Species Division, pers. comm).

Small colonies of various species of coral occur offshore Portlock Beach and Maunalua Bay Beach Park. Of the species proposed to be listed (NMFS, 2010), *Cyphastrea ocellina*, *Montipora patula*, and *Psammocora stellata* are found in Maunalua Bay in the survey areas shown in Fig. 4.

Seagrasses

Hawaiʻi has one endemic seagrass, *Halophila hawaiiana*, one indigenous seagrass, *Ruppia maritima*, and one non-native seagrass, *Halophila decipiens*. *Halophila hawaiiana* and *H. decipiens* are very similar in appearance with both growing to a height of approximately 2.5 to 2.8 cm (1.0 to 1.5 in), but *H. decipiens* differs in having small marginal spines. In general, seagrasses thrive in areas with low sedimentation, adequate water flow, and low wave energy (Hemminga and Duarte, 2000). Both species of *Halophila* are consumed by green sea turtles (Russell et al., 2003). The general degradation of seagrass beds by eutrophication, sedimentation, chemical poisoning, collecting and gleaning, trampling, anchoring, etc. is a widespread threat to the recovery of depleted sea turtle stocks (NMFS and USFWS, 1998a).

Seagrass beds are classified as special aquatic sites in the federal Clean Water Act (Subpart E of 40 CFR Part 230). Special aquatic sites include: sanctuaries and refuges, wetlands, mud flats, vegetated shallows (seagrass beds), coral reefs, and riffle and pool complexes. When a project requiring a Clean Water Act Section 404 permit (regulating the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other waters of the U.S.) is proposed to be conducted in a special aquatic site, as part of the permitting process, all alternatives that do not result in the discharge in a special aquatic site are presumed to have less adverse impact.

Scattered patches of seagrasses (*Halophila hawaiiana* and *H. decipiens*) are present in sandy areas offshore Portlock Beach and Maunalua Bay Beach Park as shown in Fig. 4.

Impacts Assessment

The nearshore and reef flat biological assemblages of Maunalua Bay in the vicinity of the Hawaiʻi Kai marina are poorly developed and suggest a highly disturbed environment. Maunalua Bay appears to be negatively affected by a variety of environmental disturbances, including freshwater input and sedimentation, from landward sources. For example, a storm in 1988 created a turbid cell of water extending 4.8 km by 3.2 km (3 mi by 2 mi) and remained in Maunalua Bay for more than 45 days (Brock, 1988).

Dredging and dewatering operations have the potential to increase turbidity in the vicinity of the project site (in the marina, entrance channel, and immediately offshore the dewatering site), but these activities are not likely to affect offshore areas in Maunalua Bay. The material to be dredged in the entrance channel is primarily sand, which generates minimal turbidity when disturbed as sand particles quickly settle out of the water column. The material to be dredged from the marina consists of finer particles, which may stay suspended in the water column for a long period of time; however, due to the low flushing rate in the marina, these particles will likely resettle on the bottom before entering Maunalua Bay. A system to dewater the dredged material should be developed and the effluent monitored to ensure that the water quality of Maunalua Bay is not affected.

Entrance Channel

Dredging and dewatering operations have the potential to cause a short-term increase turbidity in the vicinity of the project site. The material to be dredged in the entrance channel is primarily sand. The sand particles will quickly settle out of the water column and be deposited again on the bottom. However, a silt curtain should be placed around the dredging area to reduce turbidity outside of the project area.

Dredging of channel sand will lead to the loss of some benthic organisms. However, benthic organisms inhabiting the sand bottoms of other channels on the reef flat will quickly recolonize the dredged entrance channel without any foreseeable long-term impact.

No significant adverse impacts are expected to any species that are currently listed as endangered, threatened, or proposed for listing under either the Federal or State endangered species programs that are within the immediate vicinity of the entrance channel. Federal and State of Hawaiʻi listed species status follows species identified in the following documents: Department of Land and Natural Resources (HDLNR, 1996) and U.S. Fish and Wildlife Service (USFWS, 2005, 2010). Additionally, no significant adverse impacts to live coral or seagrass beds are expected from the project.

Marina

Dredging and dewatering operations have the potential to cause a short-term increase in turbidity in the vicinity of the project site. The material to be dredged from the marina consists of finer particles, which may stay suspended in the water column for a longer period of time. Due to the low flushing rate of the marina, these particles will likely resettle on the bottom before entering Maunalua Bay. The biological community in the marina has adapted to turbid conditions and, therefore, is not likely to be negatively impacted by a temporary increase in turbidity and suspended sediments by dredging. The biological community in the nearshore waters of Maunalua Bay has also adapted to turbid water quality conditions and a high load of suspended sediments in the water column, so a short-term pulse of sediments from dredging should not have a long-term impact on the biological community.

Sessile benthic infauna existing within the areas of the marina proposed to be dredged will experience direct mortality, although the existing population is not expected to be large (USACE, 1975). Only a small portion of the marina bottom is slated to be dredged and benthic organisms inhabiting the remaining marina bottom should quickly recolonize the dredged areas without any foreseeable long-term impact.

No significant adverse impacts are expected to any marine species that are currently listed as endangered, threatened, or proposed for listing under either the federal or state endangered species programs that are within the immediate vicinity of the entrance channel. Federal and State of Hawaiʻi listed species status follows species identified in the following documents: Department of Land and Natural Resources (DLNR, 1998) and US Fish and Wildlife Service (USFWS, 2005, 2010). Additionally, no significant adverse impacts to live coral or seagrass beds are expected from the project.

Recommendations

A best management practice plan (BMPP) should be prepared and implemented to minimize turbidity and to avoid, minimize, or mitigate potential pollution events from equipment maintenance, leaks, and spills. A water quality monitoring program should be prepared and implemented to ensure permit requirements are met during dredging and disposal operations.

Impacts to Protected Species

A discussion of potential impacts to listed species from project activities is presented below. The proposed project is not anticipated to have any significant impacts on protected species.

1. Collision with project-related vessels (sea turtles and marine mammals);
2. Entrainment or impingement by dredging equipment and activity (sea turtles);
3. Exposure to elevated noise levels of dredging equipment (sea turtles and marine mammals); and
4. Loss of foraging habitat (green sea turtle).

1. <u>Collision with project-related vessels</u>: Sea turtles and marine mammals must surface to breathe, and they are known to rest or bask at the surface. When at or near the surface within the project area, these animals are at risk of being struck by vessels (or the propellers) as the vessels transit to and from the project site. Green sea turtle is known to forage and transit though the nearshore waters of Maunalua Bay near the entrance channel to the marina, where vessel collisions could be a potential impact. Vessel collisions are not anticipated to increase with the proposed project, as no significant change in vessel traffic is anticipated ass an outcome of the project.

To reduce the chance of vessel collisions, any vessels associated with construction traveling during winter whale season (November to May) should follow best management practices (BMPs) to avoid protected species. These BMPs should include: 1) keep vessels at least 91 m (100 yd) from whales and at least 46 m (50 yd) from other marine mammals and sea turtles; 2) reduce vessel speeds to 19 km/hr (10 knots) or less when in the proximity of marine mammals and 9 km/hr (5 knots) or less when in areas of known or suspected turtle activity; and 3) use of silt curtains to create barriers, preventing turtles from entering an area of potential harm (D. Hubner, NOAA-NMFS, pers. comm., HIHWNMS, 2008).

2. Entrainment or impingement by dredging equipment and activity: The dredging method may use a hydraulic dredge that suctions sediment from the bottom as slurry (sand/water mixture), and could cause entrainment or impingement to marine animals. Entrainment occurs when an organism is sucked into the dredge intake. Impingement occurs when an animal becomes held fast against the dredge head by suction. Both entrainment and impingement could result in an animal drowning or being injured.

Recommended BMPs include the use of an excluder device on dredging equipment, as similarly recommended for the Waikiki Beach Maintenance Project (Tosatto, 2010). Also, the NMFS Protected Resources Division BMPs require construction crews to watch for sea turtles and marine mammals 30 minutes prior to beginning work, and to halt or postpone that work when those animals are within 46 m or 50 yd (Tosatto, 2010). It is expected that sea turtles and marine mammals will avoid the area during dredging operations, and therefore the risk of entrainment or impingement of sea turtles and marine mammals is unlikely.

3. Exposure to elevated noise levels of dredging equipment: Hydraulic dredges can produce underwater noise that is continuous and of high enough intensity to affect marine life adversely. Effects vary with the frequency, intensity, and duration of the sound source, and the hearing characteristics of the exposed animal. The sound generated from dredging activities is not anticipated to be substantial enough to cause an acoustic disturbance to protected species in nearshore waters. Project plans should ensure that sound emanation from the project site is below the temporary threshold shift (TTS) of 180 to 190 dB re 1 microPascal/m (rms) for marine mammals (NOAA, 2005). Currently, no acoustic thresholds have been established for sea turtles. Current research suggests that sea turtles may be less acoustically sensitive than cetaceans, relying more heavily on visual cues, rather than auditory input (Hazel et al., 2007, Ridgeway et al., 1969). Therefore, application of the marine mammal thresholds is considered conservative for sea turtles.

4. Loss or degradation of forage habitat: The nearshore area off Portlock Beach and Maunalua Bay Beach Park consists of a limestone platform covered by turf-forming macroalgae with very little coral present. Green sea turtle forages across the shallows and are the only listed marine species known to forage in the area. As such, they are the only ESA species potentially impacted by this

stressor. Dredging is proposed for the entrance channel, which does not support seagrasses or macroalgae. Since very little macroalgae and no seagrasses nor corals are present in the footprint of the beach proposed for nourishment with the dredged sand, this action will not affect forage resources for sea turtles or environment used by seagrasses.

5. <u>Other potential impacts:</u> The proposed project will have no impact on the Hawaiian stilt because dredged material will not be deposited on Rim Island 2. "Turtle Canyon," located offshore the entrance channel, experiences regular daily boat traffic, and the dredge operation will not contribute to a significant increase in vessel numbers or vessel speeds. Green sea turtle may haul-out and rest on the widened beach that is to be created from the dredged material. Because no nesting (green or hawksbill sea turtles) beaches are close to the project area and hatchlings quickly move to the open ocean, it is unlikely hatchlings will transit the project area. The primary food resource for hawksbill turtles, sponges, occur, but are uncommon, in the project area. No corals or seagrasses are found in the entrance channel or within the footprint of the beach proposed to be nourished.

Invasive species occur in Maunalua Bay, including introduced algae, *Acanthophora spicifera*, *Gracilaria salicornia*, and *Avrainvillea amadelpha*. Invasive algal removal efforts on Oʻahu have focused attention on Paikō Lagoon and Maunalua Bay. Best Management Practices can minimize the chance of additional introductions and reduce the chance of contributing to existing populations of invasive species. The dredge barge should be inspected by a trained biologist prior to relocating the barge to the site for dredging operations. If invasive species are found, the barge hull should be cleaned to minimize introductions.

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