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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

October 31, 2007

Mr. Laurence K. Lau, Director
Office of Environmental Quality Control
Department of Health
Leiopapa A Kamehameha Building
235 South Beretania Street, Room 702
Honolulu, HI 96813-2437

Dear Mr. Lau:

Re: Final Environmental Impact Statement (FEIS) for Kalaeloa Artificial Reef off Ewa Beach, Oahu

The Department of Land and Natural Resources, Division of Aquatic Resources is notifying you of our acceptance of the FEIS for the Kalaeloa Artificial Reef project, in fulfillment of the requirement of Chapter 343, Hawaii Revised Statutes. Enclosed is our Acceptance Report for the subject FEIS.

Pursuant to Section 11-200-23, Title 11, Chapter 200, Environmental Impact Statement Rules Hawaii Administrative Rules, our determination of the subject FEIS should be published in the next issue of The Environmental Notice by the Office of Environmental Quality Control. To comply with publishing requirements, the following documents are also enclosed:

- Four (4) copies of the FEIS
- Completed Publication Form
- Completed FEIS Distribution List
- Project Summary

Should you have any questions, please contact Mr. Paul Murakawa, Aquatic Biologist, Division of Aquatic Resources, at 587-5404.

Very truly yours,

for LAURA H. THIELEN, Chairperson
Board of Land and Natural Resources

Enclosures

cc: Paul Murakawa, DAR
Dr. Charles Morgan, Planning Solutions, Inc.

ACCEPTANCE REPORT: FINAL ENVIRONMENTAL IMPACT STATEMENT (FEIS) FOR KALAELOA ARTIFICIAL REEF OFF EWA BEACH, OAHU

A. PROPOSED ACTION

The proposed action by the Division of Aquatic Resources (DAR) consists of the following:

- Establish an artificial reef site on the seafloor offshore from the 'Ewa District of the Island of Oahu. Located between depths of 60-120 feet in an area that is mostly devoid of coral and valuable marine habitat, the 108-acre area is sized such that it can accommodate multiple artificial-reef structures.
- Construction of the first increment of artificial reef within the artificial reef site boundaries. For this purpose, at least two separate piles (sets) of concrete Z-blocks will be emplaced on the ocean floor approximately 50-100 feet apart. A total of approximately 700-800 blocks will be used and these will cover a seafloor area of about 8,000 square feet. This will provide shelter and surface area that will improve marine habitat quality at the site.

Completion of this project is consistent with the DAR mission within the State Department of Land and Natural Resources. The Department believes it will provide direct benefits for Oahu's fishing and marine recreational activities as well as substantial enhancements to the offshore marine environment.

B. PROCEDURE

1. An Environmental Impact Statement Preparation Notice (EISPN) for the proposed project was published in The Environmental Notice of March 8, 2006, by the Office of Environmental Quality Control. DAR distributed the EISPN to various City, State, and Federal agencies, organizations and individuals listed in Table 8.1 of the FEIS for their review and comments.

2. The 30-day consultation period for comments and requested to be a consulted party expired on April 9, 2006. Ten comment letters on the EISPN were received during this period. DAR responded to substantive comments and included the appropriate information in Table 8.2 of the Draft Environmental Impact Statement (DEIS).

3. Notice of the DEIS was published in The Environmental Notice of March 8, 2007. The 45-day public review period expired on April 23, 2007. Seventeen comment letters were received during this period. Five comment letters were received after the 45-day public review period. All substantive comments were responded to by DAR, and both comments and responses have been included in Appendix G of the FEIS.

C. EIS CONTENT

The FEIS complies with the content requirement set forth in Section 11-200-18 of the Environmental Impact Statement Rules.

D. RESPONSES TO COMMENTS

DAR responded to significant environmental comments that were raised during the public review and consultation process. These comments and responses are found in appendices D, E, F, and G, and revisions were appropriately made throughout the text of the FEIS.

E. UNRESOLVED ISSUES

None

F. DETERMINATION

The Department of Land and Natural Resources has determined this FEIS to be acceptable under the procedures established in Chapter 343 of the Hawaii Revised Statutes.

APPROVED BY _____
for Laura H. Thielen, Chairperson
Board of Land and Natural Resources

Final Environmental Impact Statement

KALAELOA ARTIFICIAL REEF

The State of Hawai‘i
Department of Land & Natural Resources
Division of Aquatic Resources

PREPARED BY:

PLANNING SOLUTIONS

OCTOBER 2007

Final Environmental Impact Statement

KALAELOA ARTIFICIAL REEF

SIGNATORY CERTIFICATION:

This Final Environmental Impact Statement and all ancillary documents were prepared under my direction or supervision, and, to the best of my knowledge, the information submitted fully addresses the document content requirements as set forth in HAR §11-200-18.

Laura H. Thielen — Date: 10/24/07

The State of Hawai'i
Department of Land & Natural Resources
Division of Aquatic Resources

PREPARED BY:

PLANNING SOLUTIONS

OCTOBER 2007

PROJECT SUMMARY

Project:	**Kalaeloa Artificial Reef**
Applicant	Department of Land and Natural Resources State of Hawai‘i Division of Aquatic Resources 1151 Punchbowl Street, Room 330 Honolulu, Hawai‘i 96813 Contact: Paul Murakawa Phone: (808) 587-5404
Approving Agency	Department of Land and Natural Resources State of Hawai‘i 1151 Punchbowl Street, Room 130 Honolulu, Hawai‘i 96813 Contact: Laura H. Thielen Phone: (808) 587-0400
Location	Seafloor within State Waters off Kalaeloa, ‘Ewa District, Island of O‘ahu
Tax Map Keys	None
State Land Use District	Conservation
County Zoning	None (no jurisdiction)
SMA/ Shoreline Setback	None (no jurisdiction)
Proposed Action	Establishment of a new seabed area (approximately ~~224~~ 108 acres) for the construction of artificial reefs and the emplacement of the first increment of reef-building material within that area.
Required Permits & Approvals	Conservation District Use Permit, Section 401 Water Quality Certification, Department of the Army Permit, Coastal Zone Management Consistency Determination
Associated Actions Requiring Environmental Assessment	Use in the State Conservation District, use of State lands and funds.
Consultant	Planning Solutions, Inc. 210 Ward Ave, Suite 330 Honolulu, HI 96814 Contact: Perry White (808) 550-4483

NOTES ON FORMAT USED TO DEPICT REVISIONS

The following notation has been used to depict substantive differences between this document and the *Draft Environmental Impact Statement*:

- Insertions are noted by a **double underline**;
- Deletions are noted with a ~~**strike-through**~~.

In order to maintain legibility, formatting changes (such as revised headers and footers), updates to the table of contents with new page numbers and cross-references, changes to the publication date, revisions to the title page to reflect the fact that the document is a "Final" EIS, rather than a "Draft" EIS, and other non-substantive changes are not marked.

SUMMARY

S-1.0 PROJECT DESCRIPTION

S-1.1. PROPOSED ACTION (ALTERNATIVE 1)

The State of Hawai‘i Department of Land and Natural Resources, Division of Aquatic Resources (DAR) is proposing to complete the following activities:

- Establish an artificial reef site on the seafloor offshore from the ‘Ewa District of the Island of O‘ahu that is properly placed and of sufficient size to accommodate substantial creation of artificial-reef structures. For this purpose, DAR has delineated an approximately ~~224~~108-acre area located between depths of 60 and 120 feet that is mostly devoid of coral and valuable marine habitat. DAR is applying for a Conservation District Use Permit (CDUP) to formally designate the site to be used for the construction of artificial reefs (hereinafter the project is called the Kalaeloa Artificial Reef).
- Construct the first increment of artificial reef within the site boundaries. At least two separate piles (sets) of concrete Z-blocks will be emplaced on the ocean floor approximately 50 to 100 feet apart. A total of approximately 700-800 blocks will be used for the first increment; these will cover a seafloor area of about 8,000 square feet and provide shelter and surface area that will improve marine habitat quality at the site.

Completion of this project is consistent with the DAR mission within the State Department of Land and Natural Resources. DAR believes the reef will provide direct benefits for O‘ahu’s fishing and marine recreational industries as well as substantial enhancements to the offshore marine environment. It is consistent with a 2004 Memorandum of Agreement (MOA) executed by DAR, HASEKO (Ewa), Inc. (HASEKO), and the Department of the Army. The MOA allows HASEKO to fulfill one of the Special Conditions imposed by the Department of the Army permit for its proposed Ocean Pointe Marina[1].

S-1.2 ALTERNATIVES EVALUATED IN DETAIL

The alternatives that are evaluated in detail in this EIS include:

Alternative 1: Kalaeloa Artificial Reef (Proposed Action). The proposed action consists of establishing a ~~224~~108-acre site for artificial reef deployment and emplacement of the first increment of reef within it. Through the EIS scoping process, DAR has concluded that the selected site, which is located west of the Honouliuli Wastewater Treatment Plant (WWTP) outfall and east of the offshore tanker unloading facilities, is the best of the alternatives considered and is, in fact, the only potential artificial reef site of the desired size off the ‘Ewa coast that is feasible in terms of biological characteristics, permitting issues, and compatibility with existing offshore uses.

Alternative 2: Other Marine Habitat Enhancement. The 2004 MOA provides that, should permitting an artificial reef site off ‘Ewa prove infeasible or should DAR decide not to continue pursuing the artificial reef, the funding that HASEKO has committed to emplacing the first reef increment would be given to DAR to be used toward reef development or other activities that would directly benefit marine habitat along O‘ahu’s leeward coast. While DAR does not consider this alternative desirable, as it would not fulfill many of its project objectives, it is a feasible alternative to the proposed action in the event that the acquisition of the permits for the proposed action is not possible or is significantly delayed. Should this occur, DAR anticipates that it would apply the funding (which totals $150,000) toward purchasing and deploying additional artificial reef structures at DAR’s existing Wai‘anae Artificial Reef, or toward another project that would enhance

[1] HASEKO currently plans to name the marina the “Hoakalei Marina.” For consistency with the EIS preparation notice prepared for this project, we will continue to use the name “Ocean Pointe Marina” in this document.

recreational fishing opportunities for residents of the ‘Ewa coast. The latter would have to be developed with the input of the local community and fishermen. Because these alternate actions are as yet undetermined, it is not possible to include a detailed analysis of their impacts in this *EIS*. Rather, Chapter 4 discusses some general effects that could result from the funding being applied toward recreational fishing activities in the project area. Specific future activities conducted with the funding would need to be permitted separately.

No Action Alternative “No Action” consists of DAR not pursuing an artificial reef off Kalaeloa and not applying the funds dedicated by HASEKO to an activity that would benefit marine life off O‘ahu’s leeward coast. This is unacceptable because it would not meet any of the objectives that DAR has identified for the project, and it would violate the terms of the 2004 Memorandum of Agreement signed by DAR, HASEKO, and the Department of the Army. No Action is analyzed in this EIS solely to fulfill the procedural requirements of HRS Chapter 343.

S-2.0 SIGNIFICANT BENEFICIAL & ADVERSE IMPACTS

S-2.1 PROBABLE IMPACTS OF THE ACTION ALTERNATIVES

The effects of the proposed action alternatives are summarized in Table S-1 below. Where applicable, the impacts of the first increment versus the reef at full build-out are discussed. While the proposed action covered in this EIS only involves designation of the site and construction of the first increment, the site would be permanently set aside for reef development, and thus the impacts of subsequent increments are considered as well. As can be seen from the table, the proposed action will not result in significant adverse impacts to the physical or human environment.

S-2.2 PROBABLE IMPACTS OF THE NO ACTION ALTERNATIVE

“No Action”[2] as defined above would not affect marine habitat off O‘ahu’s leeward coast. Neither would it fulfill DAR’s vision of establishing artificial reef habitat off Kalaeloa. It would constitute a violation of the 2004 MOA and is not an acceptable course of action.

S-3.0 CONSISTENCY WITH LAND USE POLICIES AND PLANS

DAR’s proposed Kalaeloa Artificial Reef project is in the Resource (R) subzone of the State Conservation District and is consistent with the objectives of that subzone. Since it is seaward of the certified shoreline, the proposed reef site is outside of the jurisdiction of the City and County of Honolulu. The reef will be constructed and operated in accordance with applicable environmental regulations. A discussion of its consistency with applicable regulations and plans is included in Chapter 6.

S-4.0 OTHER CHAPTER 343 TOPICS

S-4.1 SECONDARY AND CUMULATIVE IMPACTS

The proposed artificial reef is not directly related to other possible actions by DAR and would not lead to substantial growth or changes in the character of economic activity (e.g., the opening of new industries not previously practical) that might have secondary impacts. It would, however, enhance recreational opportunities for fishing and diving off O‘ahu’s coastline and could thereby have some indirect economic benefits to the users of the site. None of these benefits are expected to be large enough to noticeably impact the island’s economy.

[2] As provided for in HAR, §11-200-17(f)(1).

S-4.2 SHORT-TERM USES VS. LONG-TERM PRODUCTIVITY

The proposed reef site is currently mostly flat and devoid of coral, with a low abundance and diversity of marine life. The installation of an artificial reef there would greatly increase the site's long-term productivity by creating important habitat for corals, fishes, and benthic organisms where none existed previously.

S-4.3 IRREVERSIBLE & IRRETRIEVABLE COMMITMENTS

DAR is seeking to designate the chosen site to be used permanently for artificial reef development. This precludes many other uses of the site.

S-4.4 UNRESOLVED ISSUES

There are no known unresolved issues associated with the proposed project.

S-5.0 PARTIES CONSULTED

DAR distributed the EIS Preparation Notice (EISPN) to the individuals and organizations listed in Table 8.1 and requested their comments on the proposed scope of the analysis and on the completeness of the alternatives that DAR proposed to evaluate. Scoping meetings were held between offshore stakeholders in the project area as well as the 'Ewa Beach Neighborhood Board. The Draft EIS was sent to the parties listed in Table 8.3, and the public reviewed and commented on the DEIS in accordance with HRS Chapter 343.

Table S-1. Impacts Associated with the Action Alternatives

EIS Section	*Impact Topic*	*Proposed Action (Alternative 1) Preferred Site + First Increment of Reef*	*Alternative 2 Other Marine Habitat Enhancement*
4.1	**Seafloor & Bathymetry**	*First Reef Increment*. Installation of the first increment of artificial reef will modify about 0.~~08~~17% of the proposed reef site's seafloor. Within the area where the Z-blocks are deployed, the maximum relief would increase from a few inches to more than 10 feet. *Full Reef Build-out*. Full build-out of the site will cover about ~~10~~11% of the seabed at the proposed site. This would substantially increase the roughness and maximum relief present at the site.	*Adding Reef Habitat to Existing Artificial Reef:* Same as Alternative 1. Namely, the new structures would add substantial vertical relief to the area. *Other Activities to Enhance Marine Habitat:* Any other activities that DAR would fund would be defined in concert with local fishermen and other recreational user groups. Consequently, it is not possible to discuss their potential impacts on bathymetry in detail.
4.2	**Physical Oceanography**	*All Project Increments.* Because of the distance of the reef site from the -40-feet contour and because of the small magnitude of wave attenuation ~~(<2% from any one reef set)~~ to be expected, there would not be a measurable effect on surface waves at the Kalaeloa shoreline and nearshore. As discussed in Section 4.2.2, due to the heavy mixing that occurs at the proposed site, the reef is not expected to impact water temperature there detectably.	*Adding Reef Habitat to Existing Artificial Reef:* If additional reef habitat is created at another site, it should not have substantial impacts to surface waves if it is in waters at least 60 feet deep. *Other Activities to Enhance Marine Habitat:* It is not possible to estimate potential impacts of other potential activities as they have not yet been defined.
4.3	**Water Quality**	*First Reef Increment.* The artificial reef modules that would be used for the first increment of reef-building have already been constructed, so their manufacture will not affect water quality. The modules are clean concrete and will be washed down prior to deployment. Deployment of the modules could stir up what very small amounts of bottom sand exist at the site, however the sand would quickly settle. *Full Reef Build-out*. Manufacturing of modules for subsequent increments would occur on paved surfaces, using new or reused clean concrete material that is free of dust. Otherwise, the impacts are the same as for the first increment.	*Adding Reef Habitat to Existing Artificial Reef:* The impacts associated with adding structures to an existing artificial reef would be similar to those described for Alternative 1. *Other Activities to Enhance Marine Habitat:* While any other potential activities are not yet defined and would be permitted separately, DAR's objective in conducting them would be to benefit marine life. Therefore, any activity that DAR would conduct would be designed to minimize or avoid negative impacts to water quality.
4.4	**Air Quality & Climate**	*All Project Increments.* The only potential sources of emissions are the manufacture and transport of the modules to the reef site and the front-loader used to deploy the modules. All of these would be minor and temporary and would not have significant impacts to either air quality or microclimate.	*Adding Reef Habitat to Existing Artificial Reef:* The impacts would be similar to those described for Alternative 1. *Other Activities to Enhance Marine Habitat:* Of the kinds of activities that DAR might fund in lieu of an artificial reef, none would generate pollutants on a large

Table S-1. Impacts Associated with the Action Alternatives

EIS Section	*Impact Topic*	*Proposed Action (Alternative 1) Preferred Site + First Increment of Reef*	*Alternative 2 Other Marine Habitat Enhancement*
			enough scale to alter either air quality or microclimate.
4.5	**Exposure to Natural Hazards**	*All Project Increments.* The reef would not exacerbate existing natural hazards or their potential to damage life and property. In general, the Z-block modules selected for the project have exhibited good stability when exposed to storm waves.	*Adding Reef Habitat to Existing Artificial Reef:* Same as the impacts described for Alternative 1. *Other Activities to Enhance Marine Habitat:* While other activities that DAR might fund could have varying degrees of sensitivity to natural hazards, it is unlikely that any would significantly add to the danger of natural hazards in the project area.
4.6	**Marine Biota**	*First Reef Increment.* Deployment of the artificial reef would lead to substantial local increases in the abundance and diversity of fishes over current conditions. The first increment would provide shelter and elevated surface area needed for marine community development. Loss of existing corals will be avoided. *Full Reef Build-out*. Assuming live coral is relatively evenly distributed across the majority of the site, full build-out would incur an initial loss of about ~~2,800~~1,500 ft^2 of coral; this is likely an overestimate. Corals are expected to colonize much of the new substrate over time, resulting in a several-fold increase in coral coverage over current conditions. The shelter provided by the reef will also increase the abundance and diversity of other marine life.	*Adding Reef Habitat to Existing Artificial Reef:* Impacts would be similar to the impacts described for Alternative 1, except the acreage of added habitat is unknown. The benefits to marine life would be slightly less because it would add to existing habitat rather than creating habitat in a currently barren area. *Other Activities to Enhance Marine Habitat:* The primary objective of any activities that DAR would fund would be to enhance marine habitat off the leeward coast of O'ahu. Thus, the chosen activity would be expected to result in a net benefit to marine biota.
4.7	**Recreation & Tourism**	*All Project Increments.* Recreational use of the artificial reef site is expected to diversify and intensify once the reef is deployed. It will likely become a known point of interest among divers and fishermen, as well as a potential site for research and educational activities. While recreational use of the reef poses some risks to users and to the reef itself, overall it is anticipated to greatly benefit recreational users as well as marine communities.	*Adding Reef Habitat to Existing Artificial Reef:* Adding to an existing reef would not create new opportunities or locales for recreation and tourism. However, it may relieve some of the competition between user groups at the reef by allowing them to spread out. *Other Activities to Enhance Marine Habitat:* Besides benefiting marine life, a secondary objective of a DAR-funded activity would be to benefit recreational users. The form that the benefit would take is yet undetermined.

Table S-1. Impacts Associated with the Action Alternatives

EIS Section	*Impact Topic*	*Proposed Action (Alternative 1) Preferred Site + First Increment of Reef*	*Alternative 2 Other Marine Habitat Enhancement*
4.8	**Noise**	*All Project Increments.* The project does not involve activities with the potential to create high noise levels. The vessels transporting the materials will have motors, as will the equipment used to place the Z Blocks on the ocean bottom, but these will be no noisier than the motors of other oceangoing vessels using the area. Once the blocks are installed the artificial reef itself will not emit noise.	*Adding Reef Habitat to Existing Artificial Reef:* Same as those described for Alternative 1. *Other Activities to Enhance Marine Habitat:* It is unlikely that any other activity funded by DAR off the leeward coast would create significant noise beyond that associated with recreational vessels, however this will be confirmed at the time the activity is permitted.
4.9	**Archaeological, Historic, & Cultural Resources**	*All Project Increments.* There are no known shipwrecks or other archaeological remains at the site, and none are likely to be found. There is no indication that the site has significant cultural resources or is particularly valued as a fishing locale. In the event that archaeological resources are encountered at the site during pre-construction surveys, SHPD will be notified.	*Adding Reef Habitat to Existing Artificial Reef:* DAR would survey the area prior to emplacing additional reef structures, and would consult with the local community to identify any potential cultural impacts. *Other Activities to Enhance Marine Habitat:* DAR will consider any impacts to historic and cultural resources in identifying an appropriate marine habitat enhancement activity and will comply with all applicable laws.
4.10	**Socioeconomic Impacts**	*All Project Increments.* Recreational fisheries and tourism are likely to benefit from the new reef. It will enhance the resource base for fisheries and provide an additional locale for recreational diving off O‘ahu. The effect will be too small to create significant employment or to drive substantial economic growth. The project is not expected to have a localized economic effect on any particular community, as vessels visiting the site are expected to come from various ports around the island.	*Adding Reef Habitat to Existing Artificial Reef:* Adding to an existing reef would have fewer economic benefits to fishermen and divers because it would add a smaller area and would not create a new recreational venue. *Other Activities to Enhance Marine Habitat:* Other habitat enhancement activities would likely be beneficial to fisheries, however the nature and scale of the benefits are unknown at this time.
4.11	**Scenic & Aesthetic Resources**	*All Project Increments.* The proposed artificial reef will be completely submerged and will not affect surface views. It is expected to enhance scenic and aesthetic qualities of the underwater seascape by attracting colorful reef-dwelling fish and other organisms.	*Adding Reef Habitat to Existing Artificial Reef:* The effects will be similar to Alternative 1, but slightly less beneficial since they will add to already existing reef habitat rather than creating habitat where none exists. *Other Activities to Enhance Marine Habitat:* These must be evaluated when the nature of the activity is identified.

Table S-1. Impacts Associated with the Action Alternatives

EIS Section	*Impact Topic*	*Proposed Action (Alternative 1) Preferred Site + First Increment of Reef*	*Alternative 2 Other Marine Habitat Enhancement*
4.12	**Public Facilities & Navigation**	*All Project Increments.* The proposed reef site is well removed from public facilities and will not place undue burden upon them. Except during brief periods when artificial reef elements are being placed and vessels are temporarily precluded from entering the immediate area, it will not constrain navigation.	*Adding Reef Habitat to Existing Artificial Reef:* This would not increase boat traffic where none presently exists, however it would probably result in increased use of the existing reef and any nearby boat launches. Boats transiting to the site may also cross existing navigational routes. *Other Activities to Enhance Marine Habitat:* These must be evaluated when the nature of the activity is identified.
4.13	**Land Use & Ownership**	*All Project Increments.* The site is State-owned and will remain so if the project is implemented. However, the use designation of the chosen site would change. The site is located entirely within a designated military restricted area. The Navy has indicated that an artificial reef there would not compromise their operations insofar as certain precautions are taken (i.e., boats would moor to buoys rather than dropping anchor on the seafloor).	*Adding Reef Habitat to Existing Artificial Reef:* If habitat is added to an area already designated for artificial reefs, it will not affect land use or ownership. Otherwise, it would constitute a change in use. *Other Activities to Enhance Marine Habitat:* These must be evaluated when the nature of the activity is identified.

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1.0 PURPOSE AND NEED

1.1 PURPOSE AND OBJECTIVES OF THE PROJECT

The State of Hawai‘i Department of Land and Natural Resources, Division of Aquatic Resources (DAR) is proposing to undertake the following activities:

1. Establish an artificial reef site offshore from the ‘Ewa District of the Island of O‘ahu (also called Kalaeloa) that is properly placed and of sufficient size to accommodate substantial development of artificial-reef structures, and
2. Construct the first increment of artificial reef within the boundaries of the newly established site.

The proposed action is motivated by the success of the State’s existing artificial reefs and the interest of Hawai‘i’s divers and fishers in the expansion of the artificial reef system (see Appendix A). DAR expects it to achieve the following objectives:

- Create a seafloor area (at least 50 acres in extent) that can be used for the installation of hard-substrate reef habitat for marine organisms, including areas capable of providing spawning, nursery, feeding, and refuge areas for juvenile organisms.
- Increase the diversity and abundance of marine life in the vicinity of the site.
- Provide additional fishing and diving opportunities offshore of Kalaeloa.
- Minimize negative environmental risks and risks to personal and public health and safety during construction and operation of the reef.
- Establish the first artificial reef increment within the designated area.
- Establish a permitting framework at the outset that will facilitate the full build-out of the artificial reef.
- Develop the artificial reef in accordance with model design and construction guidelines that have been established through DAR’s experience at other artificial reef sites.
- Monitor fish abundance and diversity at the artificial reef in accordance with the procedures established by DAR’s existing artificial reef monitoring program.
- Ensure that the project does not cause threats to navigation or potential impacts to coastal processes.
- Provide replacement reef habitat in the first increment sufficient to satisfy Special Condition #13 of the Department of the Army permit (PODCO 2117) that was issued for construction of the Ocean Pointe Marina in accordance with DAR’s 2004 Memorandum of Agreement (MOA) with HASEKO (Ewa), Inc. (see Appendix B).

Completion of this project is consistent with the DAR mission within the State Department of Land and Natural Resources. The Department believes it will provide direct benefits to O‘ahu’s fishing and marine recreational industries as well as substantial enhancements to the offshore marine environment.

1.2 THE NEED FOR ARTIFICIAL REEFS IN HAWAI‘I: GENERAL

Hawai‘i’s populations of reef fish have been decreasing for many years, largely as a result of human activities. Population growth has exerted pressure on fish stocks and advanced technology has given commercial fisherman the ability to effectively exploit many coral reef fish species throughout their entire ranges. Human land-based activities have led to increased nutrient loading and pollution from

industrial and agricultural operations, stormwater runoff, infilling of shallow nursery grounds, and dredging of harbors. They have also introduced alien species to Hawai'i's nearshore waters. This is particularly true in the coastal waters off the island of O'ahu, on which more than 70% of the State's population resides.

In recent years the numbers of commercial and recreational fishermen have increased markedly; at the same time, reported landings from the Hawaiian inshore fisheries have declined from the beginning of the last century (Shomura 1987). In 1900, 59% of the fishery resources consumed (or 3.6 million pounds) were from Hawai'i's coral reefs; 100 years later, less than 1% (or 279,000 pounds) came from these ecosystems (data from Hawai'i reported commercial landings for the year 2000).

Despite the relatively low levels of production, the available data suggest that the Hawaiian inshore fishery remains economically important. This appears to be primarily because of increasing utilization of inshore fishery resources by recreationally oriented users. Economic studies of local marine enterprises (e.g., Van Poolen and Obara 1984, Miller 1984, Markrich 1984, 1986a, 1986b, Samples 1986) confirm that recreational fishing and non-consumptive uses of inshore fishery resources (e.g., diving, tourist submersible excursions) are of greater value than traditional commercial exploitation. An informal study conducted by the National Marine Fisheries Service (NMFS; Honolulu Laboratory; ca. 1987) concluded that Hawaiian recreational fishing produces some 4,545 metric tons of fish per year. The annual value (ca. 1985) of this mixed (i.e., inshore and pelagic) fishery was estimated at $239 million. NOAA reported that the recreational fishery catch in Hawai'i in 2004 was over 4.1 million pounds (Personal communication to Dr. Richard Brock from the National Marine Fisheries Service, Fisheries Statistics Division).

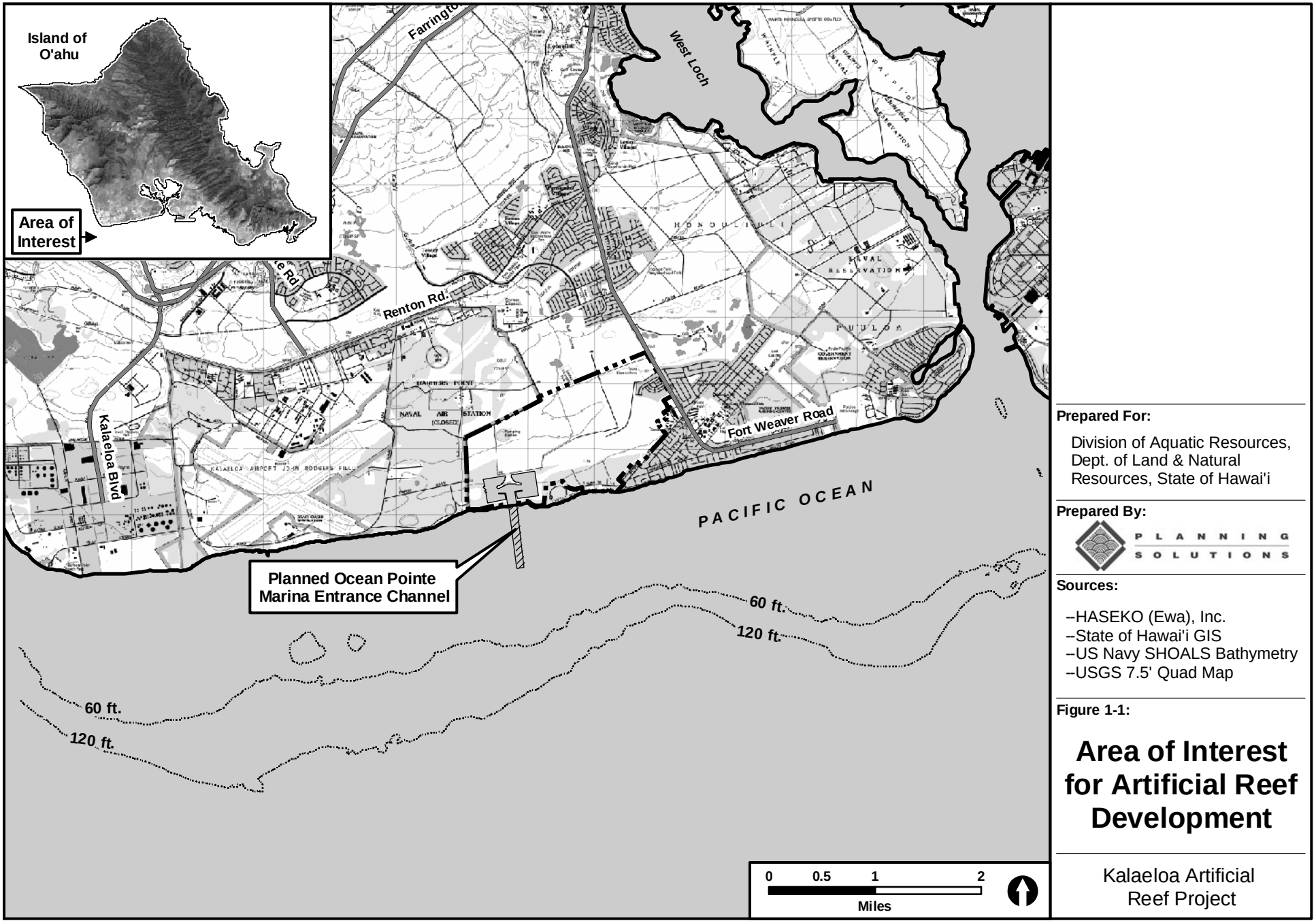
As O'ahu's population and marine recreation industries have grown over the years, there has been an ever-increasing pressure on the limited nearshore fisheries. To partially offset this, the State established its artificial reef program to promote and engage in artificial reef construction. Hawai'i began artificial reef development in the late 1950s to increase and enhance fishing opportunities for its fishermen, and DAR has continued the development of artificial reefs when possible since that time. As discussed below, these reefs have succeeded in attracting and sustaining large numbers of fish and other marine life in bottom areas that were barren and without substantial vertical relief before the emplacement of reef structures. The artificial reefs that have been established thus far address only a part of the need, however. There is a need for additional offshore areas that can be used for the development of artificial reefs.

1.3 THE NEED FOR THE PROPOSED KALAELOA ARTIFICIAL REEF

More than a decade ago DAR identified the area off Kalaeloa[3] (Figure 1.1) as a high priority for the establishment of a new artificial reef (see Appendix A). As discussed below, this area is frequently used by many recreational fishing and diving boats because it is near several places where small boats are moored or can be launched and because it is in the lee of the island, where the sea is most often calm. DAR would like to pursue the development of an artificial reef at this time, particularly because it has an opportunity to avail itself of private financial support for the permitting and first increment of artificial reef development. The opportunity stems from HASEKO (Ewa), Inc.'s (HASEKO's) need to fulfill one of the Special Conditions of its Department of the Army (DA) permit (PODCO 2117) for the Ocean Pointe Marina.[4]

[3] The original name for Barbers Point (Pukui et al. 1974).

[4] HASEKO currently plans to name the marina the "Hoakalei Marina." For consistency with the EIS preparation notice prepared for this project, we will continue to use the name "Ocean Pointe Marina" in this document.



Prepared For:

Division of Aquatic Resources, Dept. of Land & Natural Resources, State of Hawai'i

Prepared By:

PLANNING SOLUTIONS

Sources:

–HASEKO (Ewa), Inc.
–State of Hawai'i GIS
–US Navy SHOALS Bathymetry
–USGS 7.5' Quad Map

Figure 1-1:

Area of Interest for Artificial Reef Development

Kalaeloa Artificial Reef Project

Figure 1-1 Area of Interest for Artificial Reef Development 2006-05-01.mxd

Special Condition #13 of HASEKO's DA permit requires HASEKO to compensate for the loss of 1.1 acres of reef surface area expected to result from the excavation of the marina entrance channel. It requires only that the size of the artificial reef be sufficient to replace the surface area of coral reef habitat that would be adversely affected by construction of the entrance channel. However, like many of the artificial reefs that were envisioned in the early 1990s and before, the size of the required reef is relatively small. In the time elapsed since PODCO 2117 Special Condition #13 was drafted, scientific understanding of the ecology of artificial reefs has improved, and most scientists now believe that it would be far better for the replacement reef to be developed as part of a larger artificial reef complex than as a stand-alone entity. DAR believes that a habitat area of a little over an acre, while having the benefit of aggregating fish, would not provide sufficient habitat to support optimal population growth. Consequently, DAR staff scientists and independent marine biologists have expressed a desire for a larger artificial reef. The larger habitat area would be less vulnerable to over-fishing and would do more to replenish over-exploited fish species.

In light of this better understanding of artificial reef dynamics, DAR, with the participation of the U.S. Army Corps of Engineers, has signed a Memorandum of Agreement (MOA) with HASEKO (included here as Appendix B) which supports DAR's development of its proposed Kalaeloa Artificial Reef while also allowing HASEKO to satisfy its DA permit conditions. The MOA specifies the financial support that HASEKO will provide to DAR for obtaining permit approvals for the Kalaeloa Artificial Reef site and for installing the first increment of artificial reef within the permitted area.[5] DAR will be responsible for the design, construction and long-term maintenance of the artificial reef and for any subsequent permitting required for the emplacement of additional increments.

1.4 REPORT ORGANIZATION

The remainder of this EIS is organized as follows:

- Chapter 2 describes the specific items that comprise the proposed action. It also describes the alternative actions that DAR considered and explains why they were either rejected or selected for inclusion in the impact analysis.
- Chapter 3 provides an overview of the existing environment that could be affected by the project.
- Chapter 4 analyzes the environmental & social impacts that could result from the proposed action and the action alternative.
- Chapter 5 discusses the impacts associated with the alternative of "No Action."
- Chapter 6 discusses the proposed action's consistency with relevant plans, policies and controls at the County, State, and Federal level.
- Chapter 7 covers topics required by HRS Chapter 343 that do not fit neatly into any of the above chapters.
- Chapter 8 lists the parties that have been consulted during preparation of this report and includes the preliminary report distribution list.
- Chapter 9 lists the references consulted during the preparation of this report.

Appendices provide additional technical information and correspondence too detailed for inclusion in the main body of the report.

[5] In the event that the needed permits are denied or delayed, or that the first reef increment cannot be emplaced within one year following acquisition of all permits, the funds that HASEKO has set aside for the first reef increment will be granted to DAR and HASEKO would be relieved of further obligation under Special Condition 13.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

As described in Chapter 1 of this report, DAR plans to designate a site offshore of Kalaeloa for the development of artificial reef habitat and to emplace the first reef increment at the site by ~~2007~~2008. This chapter provides detailed information about the designated reef site, the construction materials and procedures that would be used, and the estimated costs and timetable for the first increment. It also describes the alternative means that DAR has considered for achieving the objectives outlined in the preceding chapter.

This chapter is organized as follows:

- Section 2.2 describes the proposed action, the establishment of a new artificial reef off the Kalaeloa shoreline.
- Section 2.3 describes the framework DAR used in considering possible alternatives and eventually selecting the proposed actions.
- Section 2.4 describes the alternatives that were selected for analysis in this environmental impact statement.
- Section 2.5 describes the alternatives that were eliminated from further analysis and the reasons for their exclusion from the impact analysis.
- Section 2.6 describes the "No Action" alternative and explains why it is not a preferred alternative.

2.2 PROPOSED ACTION: THE KALAELOA ARTIFICIAL REEF

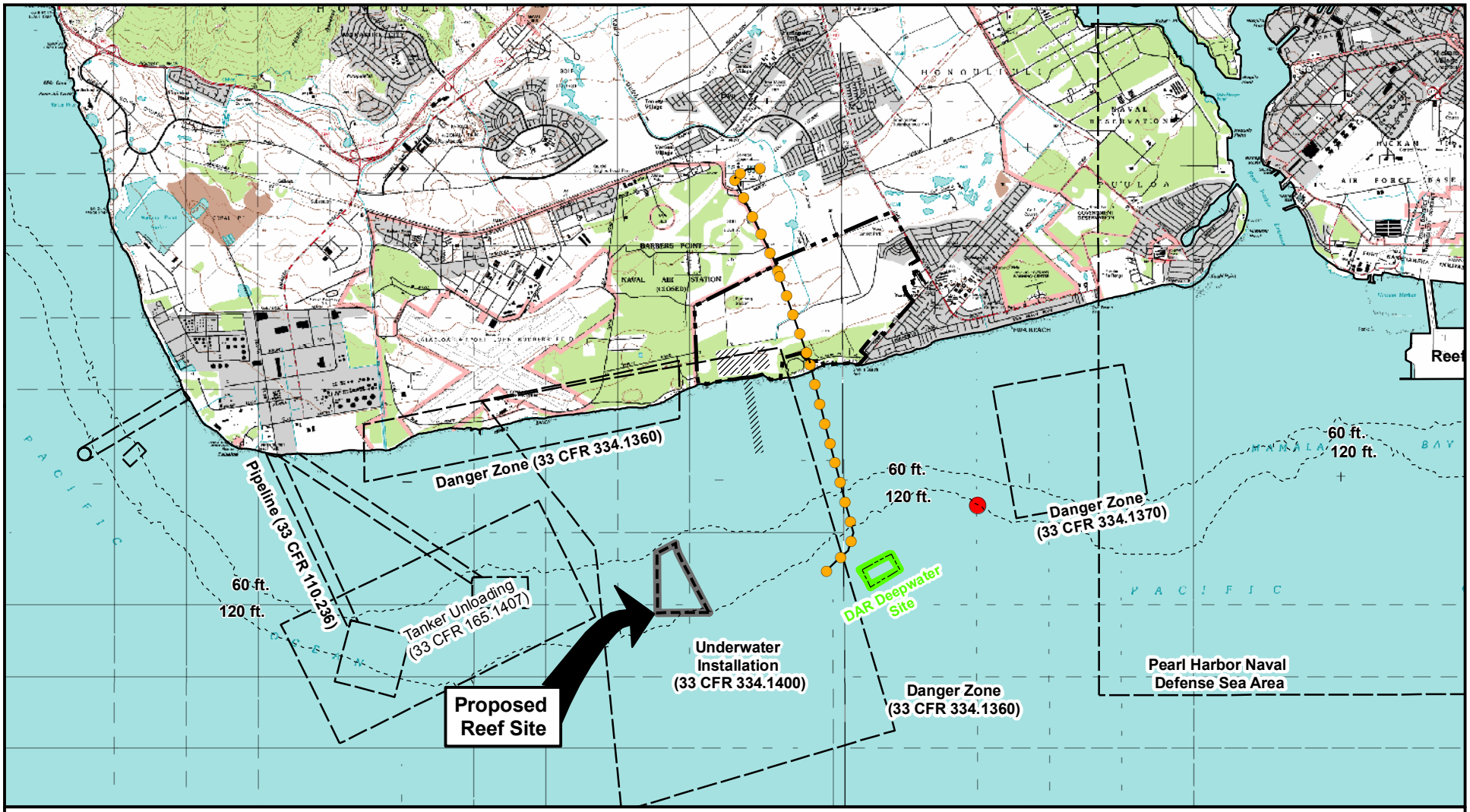
The proposal includes two actions. The first is the establishment of a seafloor site that can be used for long-term emplacement of artificial reef structures for fisheries enhancement and recreational use. The second is the emplacement of the first increment of reef structures within that site. Though the exact design of subsequent increments cannot be established at this time, it is believed that they will be similar to the design used for the first increment, and this assumption forms the basis of the analysis of the effects of complete build-out of the proposed Kalaeloa Artificial Reef.

DAR has extensive experience in the design and emplacement of artificial reef structures and has applied that experience in selecting the proposed site and arriving at the proposed design of the Kalaeloa Artificial Reef. A brief history of DAR's artificial reef development effort and its key conclusions are presented in Appendix A. A 2006 study identified possible sites for the Kalaeloa Reef and presented reef design recommendations (see Appendix C); that study helped to inform the description of the proposed action included in the following sections.

2.2.1 ESTABLISHMENT OF REEF SITE

DAR is applying for a Conservation District Use Permit (CDUP) to establish a seafloor site used for the development of artificial reef structures (see Figure 2.1). The proposed site has an area of approximately ~~224~~ 108 acres and is located west of the Honouliuli WWTP sewer outfall and east of the oil tanker offshore unloading facilities (#165.1407). The site is bounded by the following turning points (WGS84 coordinate system), listed in a clockwise order, starting from the northeastern corner:

1. 21° 17.~~1470'~~ 022' N 158° 2.~~5000'~~ 880' W
2. 21° 16.~~5000'~~ 998' N 158° 2.~~5000'~~ 820' W
3. 21° 16.~~5000'~~ 944' N 158° ~~3.0000~~2.820' W
4. 21° 16.~~9500'~~ 500' N 158° ~~3.0000~~2.580' W
5. 21° 1~~7.1370~~6.500' N 158° ~~2.6260~~3.000' W
6. 21° 16.950' N 158° 3.000' W



Prepared For:

Division of Aquatic Resources
Dept. of Land & Natural Resources

Prepared By:

PLANNING SOLUTIONS

Sources:

--HASEKO (Ewa), Inc.
--USGS 7.5' Quad Maps

Legend:

- 60 & 120 ft. Depth Contours
- Cates Aquaculture Facility
- Hono'uli'uli Waste Water Treatment Plant Outfall
- Proposed Marina & Entrance Channel
- Restricted Areas

0 0.5 1 2
Miles

Figure 2-1:

Proposed Artificial Reef Site

Kalaeloa Artificial Reef Project

Figure 2-1 Proposed Artificial Reef Site 2007-10-04.mxd

As shown in Figure 2.1, the proposed site is located within an underwater military installation (Navy Underwater Installation #334.1400). The Navy reviewed its operations and facilities in that area to confirm their compatibility with the proposed reef. They concluded, after the area proposed in the Draft EIS was reduced in size to avoid potential conflicts with existing Navy facilities in the vicinity, that the proposed reef would not interfere with their operations, provided that: 1) DAR takes care to avoid any underwater structures during reef deployment, and 2) that DAR requires all recreational users to moor to buoys that DAR will provide at the site, rather than anchoring on the bottom.

DAR conducted surveys of the proposed site in September and November 2006 to confirm that the site is suitable for reef deployment. DAR will also require recreational vessels to moor to permanent buoys rather than anchoring on the bottom to avoid damage to the reef. DAR believes that establishing a reef at the proposed site will fulfill all the project objectives and will prove compatible with other offshore uses. Thus, it is the preferred action examined in this *EIS*.

2.2.2 CONSTRUCTION OF THE FIRST REEF INCREMENT

The basic module of the first reef increment will be the concrete Z-block (Figure 2.2). As discussed in more detail in Section 2.5.3, this design is well-tested and has produced successful artificial reefs in other areas. The modules are relatively economical to produce and deploy, and DAR has deployed thousands of them in existing artificial reef sites (Brian Kanenaka, DAR, personal communication).[6] Figure 2.3 shows an actual DAR artificial reef constructed from Z-blocks. This particular reef was deployed in 1991 at the Maunalua Artificial Reef site off Hawai'i Kai.

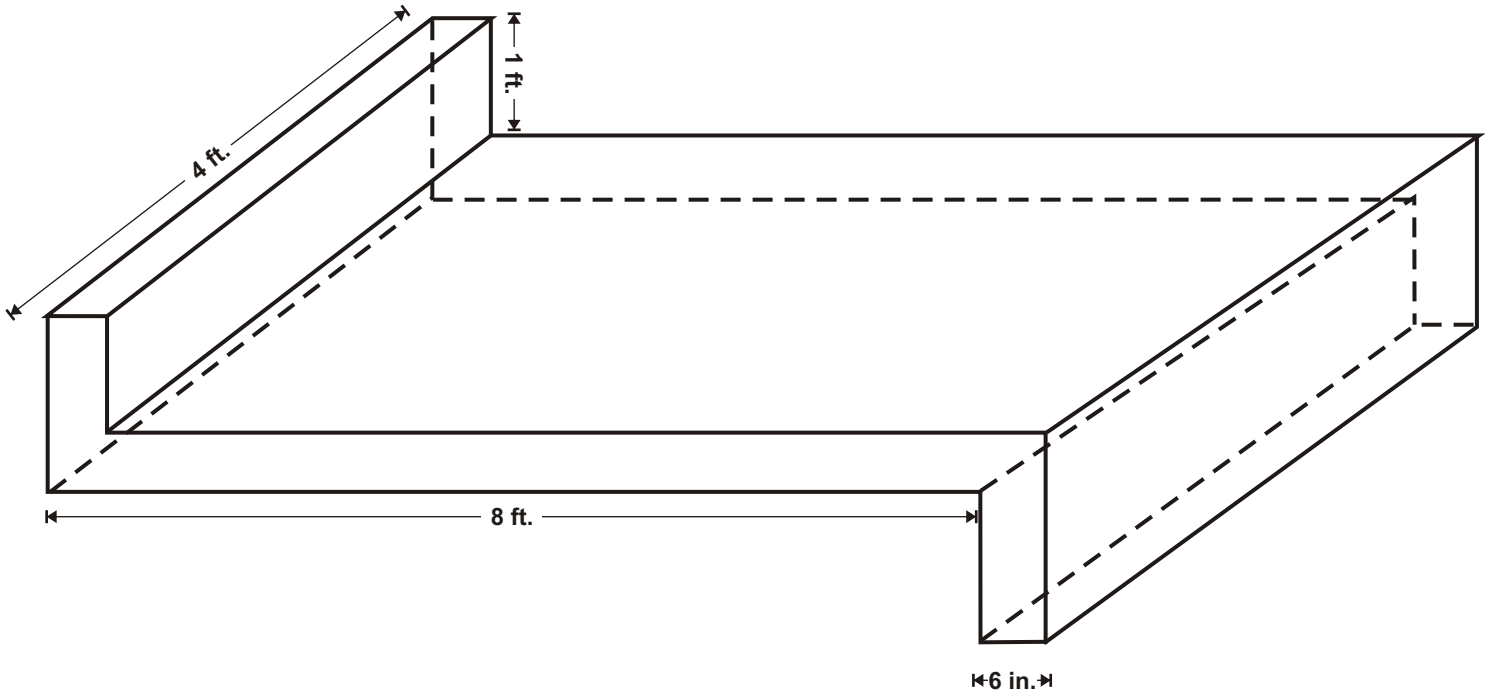
As discussed in Appendix C, a successful artificial reef must be situated on an appropriate seafloor type. For the Kalaeloa Artificial Reef, this means a substrate of consolidated limestone that is virtually free of living corals and located at some distance from any significant living coral reefs. The large, open expanse of nearly flat limestone that exists in the proposed artificial reef site provides ample locations that are suitable for artificial reef structures. Prior to deployment of the Z-blocks, the proposed reef site will be inspected by divers to confirm the specific location of the first increment. This will depend largely on the substrate, which should be relatively flat, hard, with scarce living corals, and free of man-made structures (see Section 2.3.2).

Deployment will be accomplished by stationing a barge (used to transport the modules from the harbor where they have been stored) above the intended location and using a front-end loader to push the modules off the barge, as shown in the photos below.

a) Modules loaded on barge.
Source: Division of Aquatic Resources.

b) Modules being deployed.

[6] The cost to build and deploy these modules is about $150 each.



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Dept. of Land & Natural Resources

Prepared By:
PLANNING SOLUTIONS

Source:
Division of Aquatic Resources (1991)

Figure 2-2:

The Z-Block

Kalaeloa Artificial Reef Project

Figure 2-2 The Z-Block 2005-08-29.cdr

A. Configuration of deployed Z-Blocks.

B. Example of artificial habitat created with deployed Z-Blocks.

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Division of Aquatic Resources
Dept. of Land & Natural Resources

Prepared By:
PLANNING SOLUTIONS

Source:
Division of Aquatic Resources
Dept. of Land & Natural Resources

Figure 2-3:

Artificial Reef Constructed From Z Blocks

Kalaeloa Artificial Reef Project

Figure 2-3 Artificial Reed Constructed From Z Blocks 2005-08-29.cdr

The barge will be held in place as precisely as possible so that the individual blocks will form a pile (called a "set") on the seafloor, resulting in a reef with a relatively high aspect ratio (i.e., ratio of reef height to diameter of the reef base). At least two separate sets will be emplaced to complete the first increment and will be located approximately 50-100 feet apart; this spacing will allow divers at one set to see, under normal conditions of underwater visibility, the other set (see Figure 2.4). A total of approximately 700-800 blocks (somewhat smaller than the preliminary design for subsequent increments) will be used for the first increment. A possible site for the first increment, located in what appears to be a relatively flat and smooth portion of the site in water depths of 92-94 feet, is suggested in Figure 2.5.

For the first increment, DAR anticipates installing one or two mooring buoys for boats to anchor to. The buoys will be attached to Z-blocks and deployed as part of the proposed reef sets. Pre-deployment surveys will be conducted to ensure that the modules are placed only on seafloor that is devoid of coral and benthic marine life. The buoys will be inspected and maintained as needed during DAR's periodic monitoring of the reef's marine life. Consequently, DAR anticipates minimal impacts from installation of the mooring buoys and associated anchors.

2.2.3 PRELIMINARY DESIGN OF SUBSEQUENT INCREMENTS OF ARTIFICIAL REEF

The ultimate design for the completed reef site will depend on the results of future research and the availability of appropriate materials and deployment methods. Preliminary plans call for individual sets of Z-blocks to be separated by distances of approximately 50-100 feet, as described for the first increment. Subsequent increments would progressively add sets to complement the initial two, to complete a "group" of five sets. As resources become available to DAR, additional groups would then be added to enlarge the artificial reef habitat. These additional groups would be placed a minimum of 300 feet from one another. DAR will observe the usage intensity of the first reef increment and use this information to determine the number of additional mooring buoys needed for subsequent increments.

Figure 2.5 shows a maximum theoretical configuration of groups that are consistent with these criteria. Given the configuration shown in this figure, the maximum theoretical build-out of the permitted site would include ~~25~~ 14 groups of 5 sets each, or ~~125~~ 70 sets, which would cover a seafloor area of approximately ~~22~~ 12 acres, or about ~~10~~11% of the site. Actual placement of the groups would depend upon individual site surveys to confirm appropriate seafloor types, and full build-out would likely be less than this theoretical maximum number of sets, since areas with significant coral growth or unacceptable bottom type, slopes, or roughness would not be used.

2.2.4 CONSTRUCTION SCHEDULE

Major schedule milestones for the proposed project are as follows:

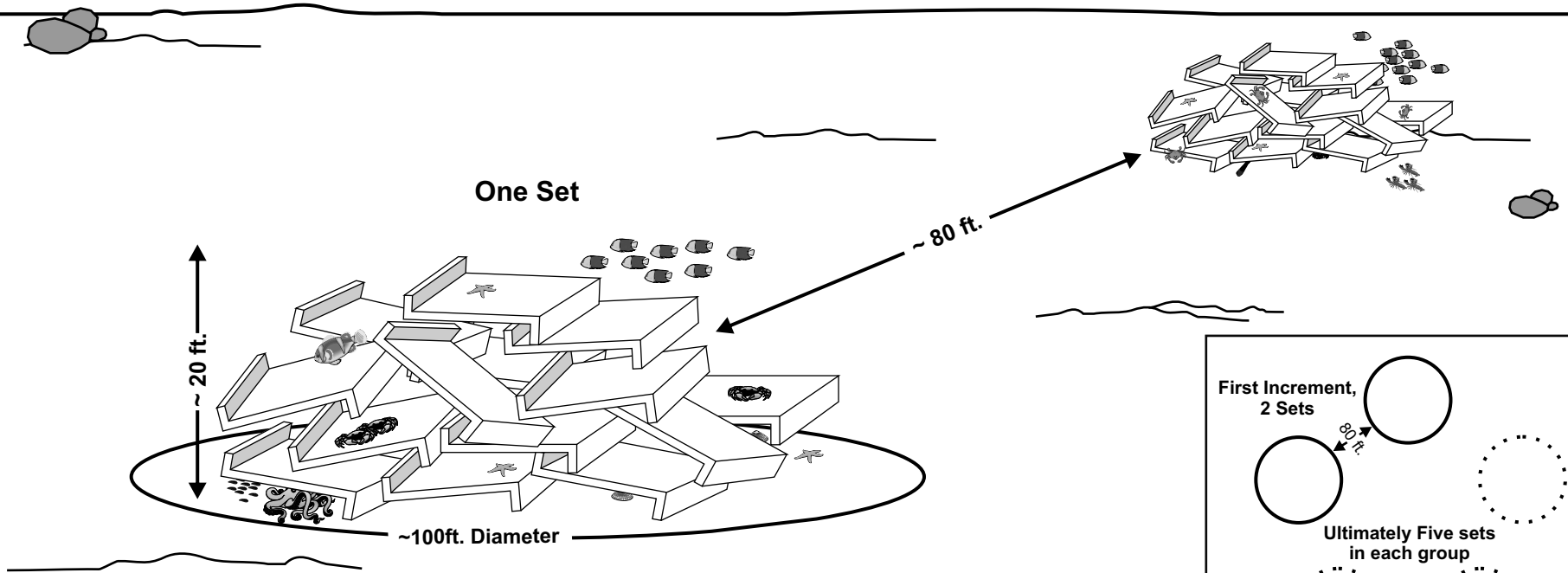
- Submit Draft EIS – ~~January~~ February 26, 2007.
- Submit Final EIS & Conservation District Use Permit (CDUP) Application – ~~March~~ November 2007
- CDUP Application Accepted – ~~April~~ December 2007.
- Obtain CDUP – ~~August~~ April ~~2007~~2008.
- Install First Reef Increment – ~~4~~th 2nd Quarter ~~2007~~2008.

2.2.5 ANTICIPATED COSTS

The estimated costs for the installation of the first increment of the Kalaeloa Artificial Reef are summarized in Table 2.1.

Table 2.1. Estimated Construction/Installation Costs: Increment 1.

Item	*Order-of Magnitude Cost*
Fabrication of Z-Blocks @ $150 per Unit	$112,500
Transportation & Deployment of Z-Blocks (700-800)	$37,500
TOTAL	**$150,000**
Source: Division of Aquatic Resources, DLNR	



Prepared For:
Division of Aquatic Resources
Dept. of Land & Natural Resources

Prepared By:
PLANNING SOLUTIONS

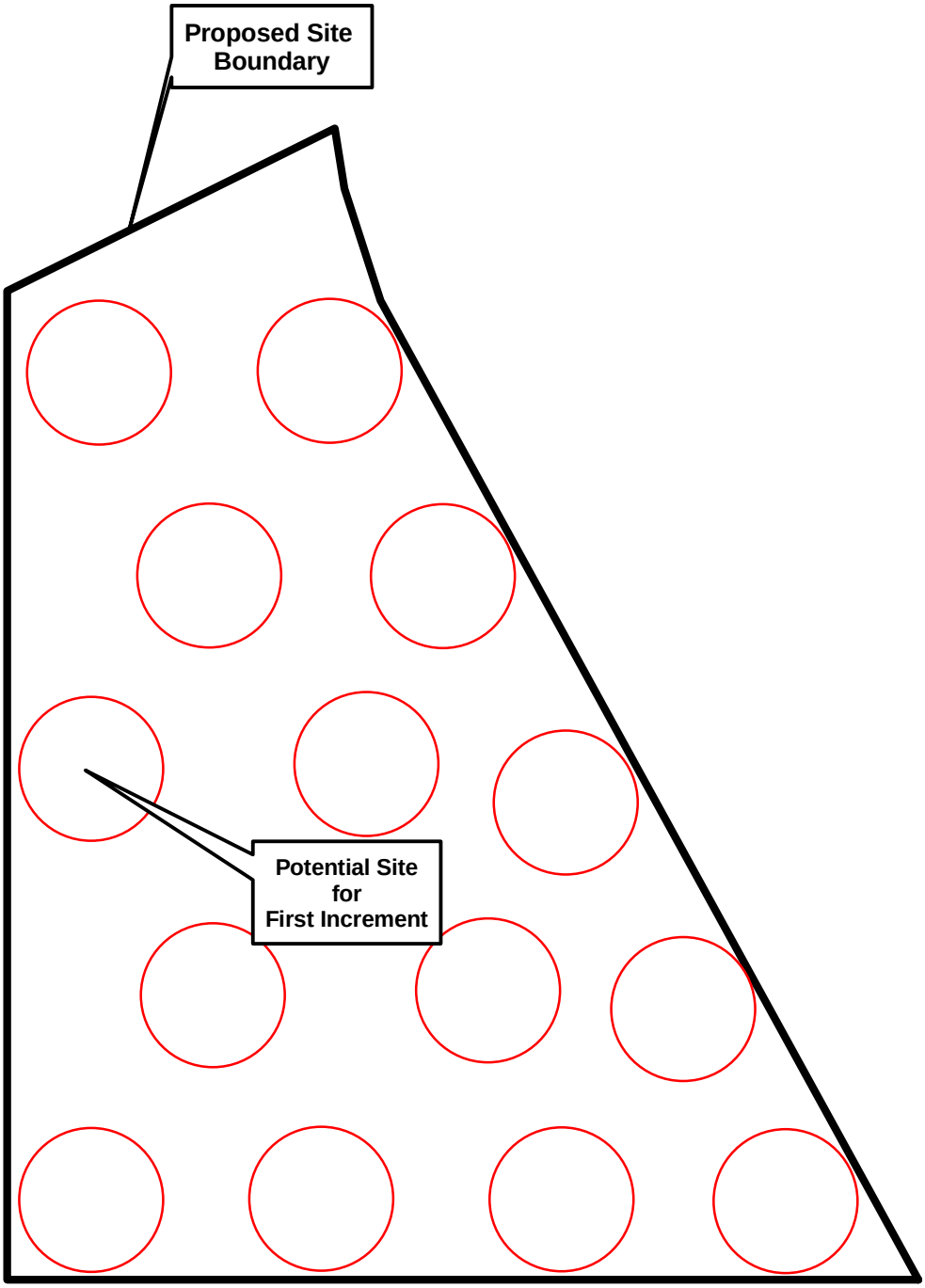
Source:
–Division of Aquatic Resources
–R. Brock

Figure 2-4:

Preliminary Plan for Reef Deployment Pattern

Kalaeloa Artificial Reef Project

Figure 2-4 Preliminary Plan for Reef Deployment Pattern 2007-01-11.cdr



Feet

0 250 500 1,000 1,500

Prepared For:

Division of Aquatic Resources; Dept. of Land & Natural Resources

Prepared By:

PLANNING SOLUTIONS

Sources:

--HASEKO Hawaii, Inc.
--US Navy SHOALS Bathymetry

Note: Circles (400-ft. dia.) denote tentative containing areas for groups of 5 reef sets

Figure 2-5:

Theoretical Full Reef Build-out

Kalaeloa Artificial Reef Project

Figure 2-5 Possible Configurations of Full Build-out 2007-10-04.mxd

2.3 FRAMEWORK FOR CONSIDERATION OF ALTERNATIVES

Hawai‘i Administrative Rules (HAR), §11-200-17 (a section in the Office of Environmental Quality Control's Environmental Impact Statement Rules) addresses the content requirements of draft and final environmental impact statements (EIS). Subsection §11-200-17(f) states:

> *(f) The draft EIS shall describe in a separate and distinct section alternatives which could attain the objectives of the action, regardless of cost, in sufficient detail to explain why they were rejected. The section shall include a rigorous exploration of the environmental impacts of all such alternative actions. Particular attention shall be given to alternatives that might enhance environmental quality or avoid, reduce, or minimize some or all of the adverse environmental effects, costs, or risks. Examples of alternatives include:*
>
> *(1) The alternative of no action;*
>
> *(2) Alternatives requiring actions of a significantly different nature which could provide similar benefits with different environmental impacts;*
>
> *(3) Alternatives related to different designs or details of the proposed action which would present different environmental impacts;*
>
> *(4) The alternative of postponing action pending further study; and*
>
> *(5) Alternative locations for the proposed project.*
>
> *In each case the analysis shall be sufficiently detailed to allow a comparative evaluation of the environmental benefits, costs, and risks of the proposed action and each reasonable alternative.*

The objectives listed in Section 1.1 of this report and the terms of DAR's 2004 Memorandum of Agreement with HASEKO (Ewa), Inc. and the Department of the Army were used to identify and define the alternatives described below for inclusion in this evaluation. In addition, the selection of the proposed action and alternatives was informed by the extensive experience that DAR has acquired in the construction and monitoring of existing artificial reefs in Hawai‘i. The following sections summarize some of the factors that collectively guided the development of alternatives for this EIS.

2.3.1 TERMS OF THE 2004 MOA

The 2004 MOA between DAR, HASEKO (Ewa), Inc., and the Department of the Army (included as Appendix B) outlines a plan by which HASEKO can fulfill Special Condition #13 of the Department of the Army Permit for the Ocean Pointe Marina by supporting DAR's efforts to develop an artificial reef site off Kalaeloa. HASEKO's commitment specifically involves funding and carrying out the work needed to identify and permit a reef site off O‘ahu's leeward coast. It also requires an additional financial commitment of $150,000.

The MOA provides for several possible uses of the additional funding, which were used to define the proposed action and some of the possible alternatives:

(1) If the needed permits are obtained and construction is allowed to proceed within one year following the granting of the permits, the additional funding will be applied toward the construction plans, materials, and work needed to emplace the first reef increment at the permitted site. This represents the proposed action described in this EIS.

(2) If a contested case hearing or legal action delays the granting of the permits, or if emplacement of the first increment can not occur within one year of obtaining all required permits, then HASEKO will provide the funding to DAR directly to be held in trust for future use in constructing the

artificial reef at Kalaeloa. This represents the alternative of "Delayed Action," which is discussed further in Section 2.5.4 below.

(3) If, despite the best efforts of all parties, the required permits are denied or if DAR decides not to go ahead with the Kalaeloa Artificial Reef project, then HASEKO will grant the funding to DAR to be used toward other marine habitat enhancement activities off O'ahu's leeward coast. In the context of this project, this option represents Alternative 2.

2.3.2 CRITERIA FOR THE LOCATION OF THE KALAELOA ARTIFICIAL REEF SITE

DAR uses the following general criteria for the selection of potential shallow-water artificial reef installations off Kalaeloa (discussed in greater detail in Appendix A and Appendix C):

- A relatively flat, hard seabed with little topographic relief;
- A lack of substantial live coral communities within the vicinity of the site;
- A location that does not lie within major shipping routes where recreational vessels can hold station for diving and fishing without posing a hazard to navigation;
- A location with some proximity to the harbors and marinas where recreational boats are moored or launched; and
- A location in water depths between 60 and 120 feet (the area highlighted by the broad band shown in Figure 1.1, such that:
  - Reef structures within the site meet the U.S. Coast Guard requirement of a minimum of 40 feet of clearance between the highest point on an artificial reef's surface and the water's surface.
  - Reef structures are accessible for safe recreational SCUBA diving and recreational fishing.
  - Reef structures are deep enough so that they will have no significant effects on coastal currents and wave action.

These criteria are met by a number of areas. However, in addition to the above artificial reef location criteria, DAR's choice is constrained by other activities that take place in the area, including military operations and commercial activities that limit or preclude the presence of an artificial reef. As shown in Figure 2.1, when these other constraints are considered only a small part of the offshore seafloor with the needed water depths is available for artificial reef development.

2.3.3 ARTIFICIAL REEF DESIGN CRITERIA

There is a large body of experience and literature concerning which materials and configurations are suitable for artificial reef development. In general, the following characteristics are advantageous from a biological perspective:

- Adequate stability to withstand wave conditions over long term;
- Non-toxic materials;
- High surface area to optimize the substrate available for biological growth;
- Good vertical relief with an abundance of shelter spaces when stacked;
- Ease of construction and deployment (i.e., manageable size, of a shape that facilitates upright landing when deployed);
- Resistant to corrosion and decay;
- Proven favorable substrate for coral growth (as documented in the literature); and
- Tested successfully in Hawaiian waters.

Other factors include cost and environmental considerations related to production and deployment. DAR has experimented with artificial reef materials and configurations for many years. The outcome of these experiments and the reasons why the proposed artificial reef design was chosen are documented in Section 2.5.3.

2.4 ALTERNATIVES TO BE EVALUATED IN THE EIS

DAR evaluated a number of alternatives to the proposed action, including alternate locations, different designs, and reefs of different sizes and configurations. Many of these alternatives were eliminated during the early planning phases of the project; these are discussed in Section 2.4.1 below. This environmental impact statement evaluates two "Action Alternatives" in detail:

- Alternative 1 is the proposed action of establishing the Kalaeloa Artificial Reef
- Alternative 2 entails applying the funding intended for the first reef increments toward marine habitat enhancement at another location off O'ahu's leeward coast.

"No Action", which involves not establishing an artificial reef off Kalaeloa and not applying the additional funding from HASEKO toward marine habitat enhancement off of O'ahu's leeward coast, was also analyzed in accordance with the requirements of Chapter 343 and HAR §11-200. A brief summary of the two action alternatives follows. "No Action" is discussed separately in Chapter 5.

2.4.1 ALTERNATIVE 1: PROPOSED ACTION

Alternative 1 consists of DAR's proposed action as described in Section 1.3. Implementation of this alternative would dedicate approximately ~~224~~108 acres of relatively barren seafloor west of the Honouliuli Wastewater Treatment Plant (WWTP) outfall to the purpose of creating improved marine habitat and enhancing fisheries for biological health and recreational use. In summary, this alternative involves:

- Dedication of a ~~224~~108-acre site offshore of Kalaeloa for artificial reef development.
- Deployment of the first increment of artificial reef, consisting of 700-800 concrete Z-blocks arranged in at least two sets.

This alternative would meet all the project objectives listed in Section 1.1 and represents an excellent solution when judged by the criteria for reef siting and materials. Because it is located within a military underwater installation (33 CFR 334.1400), DAR consulted with the Navy to confirm the reef's compatibility with the Navy's use of the site. Subsequently, the Navy granted DAR permission to utilize the site for artificial reef development (see Appendix E). DAR also consulted with Chevron to identify concerns related to the offshore tanker unloading facilities west of the site and was told that the proposed site was compatible with that facility.

2.4.2 ALTERNATIVE 2: OTHER MARINE HABITAT ENHANCEMENT

The 2004 MOA provides that, should permitting an artificial reef site off Kalaeloa prove infeasible or should DAR decide not to continue pursuing the reef, the funding that HASEKO has committed to emplacing the first reef increment would be given to DAR to be used toward reef development or other activities that would directly benefit marine habitat along O'ahu's leeward coast. While DAR does not consider this alternative desirable, as it would not fulfill several of its project objectives, it is a feasible alternative to the proposed action in the event that the permits for the proposed action are denied or significantly delayed. Should this occur, DAR anticipates that it would apply the funding (which totals $150,000) toward purchasing and deploying additional artificial reef structures at DAR's existing Wai'anae Artificial Reef, or toward another project that would enhance recreational fishing and diving opportunities for residents of the 'Ewa coast. The alternate project would have to be developed with the input of the local community and fishermen.

Because these potential actions are as yet undetermined, it is not possible to include a detailed analysis of their impacts in this *EIS*. Rather, Chapter 4 discusses some general effects that could result from the funding being applied toward recreational fishing activities in the project area. Specific future activities conducted with the funding would need to be permitted separately.

2.5 ALTERNATIVES CONSIDERED AND ELIMINATED

2.5.1 SMALLER ARTIFICIAL REEF

DAR has concluded that in order to be most beneficial to recreational fisheries and marine life the proposed artificial reef site must have an area of at least 50 acres. The preferred site is about ~~224~~108 acres. It is technically feasible to reduce the size of the preferred site so it is equal or closer to 50 acres; however DAR does not believe that this would result in significant differences in the environmental impacts associated with the project. Further, the potential benefits of the project in terms of the habitat created and the area available for recreation would be substantially reduced. Thus, DAR did not elect to pursue this alternative further in the impact analysis.

2.5.2 ALTERNATE LOCATION FOR ARTIFICIAL REEF

As discussed in Section 1.3, DAR has for a long time considered the area offshore of Kalaeloa as a good choice for artificial reef development because of the desirable conditions that exist there for artificial reef deployment and the scarcity of existing natural and artificial reef habitat. The MOA between HASEKO and DAR provides for an artificial reef offshore of leeward O‘ahu, which includes the area from Pearl Harbor to the Wai‘anae Coast. Based on its priorities for new artificial reef development, DAR narrowed the area of interest to the area depicted on Figure 1.1. Upon surveying this area (see Appendix C) and consulting stakeholders, DAR concluded that the selected site is the only one in the area of interest that would meet the project objectives. The following sub-sections summarize the reasons why DAR eliminated other potential reef sites from further consideration.

2.5.2.1 Wai‘anae Coast

As mentioned above, DAR eliminated the Wai‘anae Coast from the area of interest for the Kalaeloa Artificial Reef early in the planning process. DAR considers locating an artificial reef off the Wai‘anae Coast less of a priority for the following reasons:

- It would not provide an artificial reef close to the increasing number of recreational users off ‘Ewa, including users of the future Ocean Pointe Marina.
- It is distant from the 1.1 acres of reef habitat expected to be destroyed by the excavation of the Ocean Pointe Marina entrance channel. DAR would prefer that the replacement habitat be created closer to the habitat lost.
- DAR already owns and operates an artificial reef off the Wai‘anae Coast. Adding another could increase boat traffic and pressure on existing boat launch facilities rather than directing divers and fisherman toward the relatively underutilized ‘Ewa area.[7]
- It could increase the potential for traffic conflicts offshore of ‘Ewa. Once the Ocean Pointe Marina opens, the boaters there will seek out recreational fishing and diving opportunities elsewhere on the island if there is not a suitable site nearby, requiring them to cross the oil tanker routes to the offshore tanker unloading facility west of the site.
- The additional survey work and research that would be needed to identify reef sites off the Wai‘anae Coast would entail time and financial resources beyond that provided for in the MOA,

[7] DAR does maintain one small deepwater artificial reef off the ‘Ewa coast, about 0.25 miles makai of the Hono‘uli‘uli WWTP. While this reef may be utilized by some fishermen, it is too deep to be safely accessible to divers and therefore it is less of a recreational attraction.

which recognizes that "time is of the essence" (see Section 2.5.4). Thus, the proposed site affords DAR the greatest opportunity to avail themselves of the time and financial resources that HASEKO has contributed to the permitting process.

2.5.2.2 East of the Honouliuli WWTP Outfall

DAR considered locating the reef east of the Honouliuli WWTP sewer outfall and west of the Navy danger zone (33 CFR 334.1370) in accordance with the findings of the biological survey conducted for the project (Appendix C). This site was presented as the preferred site in the EISPN for the project primarily because, unlike the area west of the outfall, it is not located within a designated restricted area.

Subsequent consultation with the Navy and other offshore stakeholders that occurred during the EIS scoping process revealed that most stakeholders favored the alternative western site identified in the EISPN. Significant concerns arose about the compatibility of the eastern site with existing uses, particularly the safety of recreational users and marine life that would utilize the eastern reef site given the proximity of the Navy's explosive ordinance training area. The State's Aquaculture Development Program and the National Oceanic and Atmospheric Administration also noted the proximity of the eastern site to Cates International's aquaculture facility and expressed concern about any impacts the reef might have on its operations. The president of Cates International added that sharks are regularly present around the aquaculture cages, which may be of concern to recreational users of the reef. A summary of the comments and concerns voiced by offshore stakeholders in an April 13, 2006 scoping meeting are included in Appendix D. Because of the potential conflicts with these uses at the eastern site, DAR decided to eliminate it from further consideration in the EIS process.

2.5.3 DIFFERENT DESIGN FOR ARTIFICIAL REEF

2.5.3.1 Early Artificial Reef Designs

Initially, artificial reefs in the United States were constructed using scrap materials that were often indiscriminately dumped at sea. In many cases, waste disposal, not resource enhancement, was the primary goal of artificial reef construction. Reefs thus built provided some habitat improvement and increased fishery yields in otherwise barren areas, but the shape, size, long-term physical stability and biological productivity afforded by the use of such materials was suboptimal. Artificial reefs do have a secondary capacity to recycle specific types of solid waste under ecologically acceptable and resource beneficial conditions, but this habitat enhancement technology is primarily valid as a fishery management technique for marine waters.

As discussed in Appendix A and Appendix C, early attempts at the creation of artificial reefs, both in Hawai'i and elsewhere, have been achieved with a variety of recycled materials, including stripped cars, scuttled sea craft, cement filled tires, and concrete piping. These early efforts at establishing artificial reefs used the technology then available. Initially these reefs worked well, but over a long period of time they exhibited relatively poor stability and susceptibility to rapid decay.

DAR has experimented with a wide array of materials over the years since the program's inception, placing a variety of habitat configurations at reef sites on a developmental basis. These included the recycled materials mentioned above, as well as lobster shelters, "dolos armor", truck tires weighted with concrete and "pipe houses" constructed from bundles of concrete pipe. The lobster shelter's trapezoidal design caused construction difficulties. Also, during deployment the design caused the modules to land inverted, requiring divers to right them. Months later, reef fish were observed in and around the experimental artificial reef modules, but lobsters were never observed using this specially designed habitat. The concrete "dolos armor" appears to have provided excellent vertical relief at the deepwater reef off of 'Ewa Beach, O'ahu but the $1,000 cost per unit made this module design unsuitable for widespread deployment in Hawai'i's artificial reef system. Weighted truck tires, with diameters in excess of two meters also added vertical relief to the artificial reef at Maunalua Bay, but

the tires could not provide the crevice habitat vital to shallow water reef systems. At the "pipe houses", various reef fishes are using the narrow space between the pipes for shelter. Plugging the middle of the pipes and blocking the flow of water appears to deter fish from utilizing the inside of the pipes for habitat.

Unlike the Z-Blocks chosen for the first increment of the Kalaeloa Artificial Reef, the above reef designs have had comparatively low profiles and little refuge space, poor stability characteristics (such as pipes which roll and crush benthic organisms), and short life expectancies. If they remain in one location, car bodies typically decay in approximately three to five years. The lack of stability inherent in the materials used means that benthic communities which serve as a food source to many fish cannot become permanently established. Further, the lack of refuge space provided by these materials allows spear and net fishermen to overexploit resident fishes, and the absence of adequate topographical relief translates into less than maximal enhancement.

As artificial reef research and design technology have advanced, new methods have been deployed, including appropriately modified recycled materials. One method the State of Hawai'i has continued to implement is a design consisting of eight to ten used automobile tires set side by side and placed in a 1'x 2'x 6' concrete base. Other recent deployments of recycled materials include surplus barges and artificial reef constructed with boulders removed from cane fields and concrete rubble from the demolition of buildings. However, because of their durability, simplicity of deployment, and relatively high relief, Z-Blocks are generally better choices.

2.5.3.2 Recent Hawaiian Artificial Reef Research

Other work at the University of Hawai'i has focused on the enhancement of juvenile fish recruitment to the adult habitat. The use of mid-water aggregators in conjunction with small benthic reefs has been shown to increase the recruitment of juvenile fish species (Beets 1989); a carefully planned field experiment off the south shore of O'ahu has demonstrated that a combination of mid-water aggregators and benthic reefs significantly enhances the local recruitment of juvenile fishes (Brock unpublished).

Because of concern over providing substratum that is favorable for the settlement of corals (which lend further stability to the reef) and benthic forage species, studies have been undertaken to determine the impact of different materials on the resulting structure of the benthic communities. The hierarchy of preference and post settlement success for corals is:

(1) Old coralline material,
(2) Concrete,
(3) Steel,
(4) Rubber tires.

Based on the available research, in the absence of old coralline material, concrete, such as that used to construct the Z-Blocks, appears to be the appropriate material for Hawaiian artificial reefs (Fitzhardinger and Bailey-Brock 1989).

DAR presented the proposed reef project to the 'Ewa Neighborhood Board on June 8, 2006. One of the suggestions offered involved using material that DAR would dredge from the West Loch of Pearl Harbor as the structure for the reef. The cumulative experiences outlined above, as well as the lack of knowledge on the suitability of the materials that exist within West Loch led DAR to conclude that this is not a viable option. In addition, transporting materials from West Loch to coastal waters could facilitate the spread of invasive species such as *Gracilaria spp.*, which are known to exist in the Harbor (Brock 2000).

2.5.4 DELAYED ACTION

Delaying the construction of the artificial reef is technically possible. However, DAR's MOA with HASEKO and the Department of the Army is a binding agreement that commits DAR and HASEKO to pursuing the permits necessary to establish an artificial reef at a mutually desirable site off O'ahu's leeward coast. Inherent in the agreement is the understanding that "time is of the essence", as HASEKO must comply with Special Condition 13 in its Department of the Army permit prior to constructing the Ocean Pointe Marina entrance channel (which could begin as early as 2008). DAR has agreed to participate in the permitting process and to put its best efforts toward proceeding in a timely manner. In exchange, DAR will benefit from HASEKO's permitting work and financial assistance for establishing the site and emplacing the first increment of artificial reef.

If DAR were to intentionally delay the permitting of the project or the emplacement of the first increment beyond one year after obtaining all permits, HASEKO would provide DAR the funds it has agreed to commit toward the first increment of artificial reef to be placed in trust toward future construction of the reef or toward other marine habitat enhancement activities off O'ahu's leeward coast (this is the same as Alternative 2). In this instance, the benefits of artificial reef construction would not begin to accrue immediately, but the potential for possible future benefit would remain.

It is also possible that delay could occur as a result of a contested case hearing or legal action that is outside of DAR's control. In such case, the MOA also provides that HASEKO grant DAR the funds for the first increment and be relieved of further obligations. DAR can then apply the funds toward pursuing the contested case on its own or toward other marine habitat enhancement activities off O'ahu's leeward coast in accordance with Alternative 2.

In either case, delaying the permitting or construction of the proposed artificial reef would not meet the objectives of the proposed action as outlined in Section 1.1 above for the following reasons:

- It would not provide immediate additional fishing and diving opportunities for Hawai'i's people.
- It would not increase the amount of hard substrate reef habitat available for marine organisms for at least the duration of the delay. This would deny organisms additional area suitable for spawning, nursery, feeding and refuge for juvenile organisms.
- It would miss an immediate opportunity to increase the diversity and abundance of marine life off the 'Ewa shoreline, and it could potentially forfeit an opportunity to establish a large area already permitted for further artificial reef development.
- It would delay the provision of replacement reef habitat that would compensate for habitat adversely affected by construction of the entrance channel to the Ocean Pointe Marina.

In view of the foregoing, DAR believes that delay is not a viable alternative to the proposed project.

2.6 NO ACTION

"No Action" consists of DAR not pursuing an artificial reef off Kalaeloa and not applying the funds dedicated by HASEKO to an activity that would benefit marine life off O'ahu's leeward coast. This is unacceptable because it would not meet any of the objectives that DAR has identified for the project, and moreover it would violate the terms of the 2004 Memorandum of Agreement signed by DAR, HASEKO, and the Department of the Army. It cannot be overstressed that in this project, No Action is not an acceptable alternative. It is analyzed in this EIS solely to fulfill the procedural requirements of HRS Chapter 343.

3.0 OVERVIEW OF THE EXISTING ENVIRONMENT

This chapter describes existing conditions within the area that would be affected by the proposed action. The chapter is organized by topic (e.g., seabed composition, marine biota, etc.), and focuses on existing conditions on and around the proposed artificial reef site. This is because most of the environmental impacts associated with the reef would occur in this offshore area. Where applicable, the discussion is broadened to include larger geographical areas or economic sectors. The information in this chapter is intended primarily as a means of orienting readers to the general characteristics of the project area and to outline the general kinds of resources examined in the impact analysis in Chapter 4. Alternative 2 (other marine enhancement activities off O'ahu's leeward coast) is much less defined, and therefore the discussion does not focus on a specific geographical area that could be affected.

3.1 SEABED COMPOSITION

3.1.1 GEOLOGICAL SETTING

Bathymetric (underwater topography) maps of the Kalaeloa area show a seafloor comprised of a series of relatively broad, often sand-covered, wave-cut terraces in the nearshore region. Marine geologists believe that they are Quaternary coastline features formed from reef development when sea level was much lower than today (Coulbourn, Campbell, and Moberley, 1974). The terraces are covered by little or no sediment, except where they are intersected by relic drainage channels (Hampton et al. 2003). The terraces are typically separated by steeper slopes (5 to 35 degrees) forming step-like structures on the seafloor. These features probably represent wave cuts and may denote relatively persistent shoreline stands. As noted by Brock and Chamberlain (1968), there are at least five such submerged, wave-cut, step-like features present in the seabed off Kalaeloa. The proposed reef site lies between the two shallowest of these features (see Figure 3.1).

3.1.2 SEABED TYPES FOUND

There are two main biological zones or biotopes present in this area, which are based on the dominant substratum and benthic community components. These are:

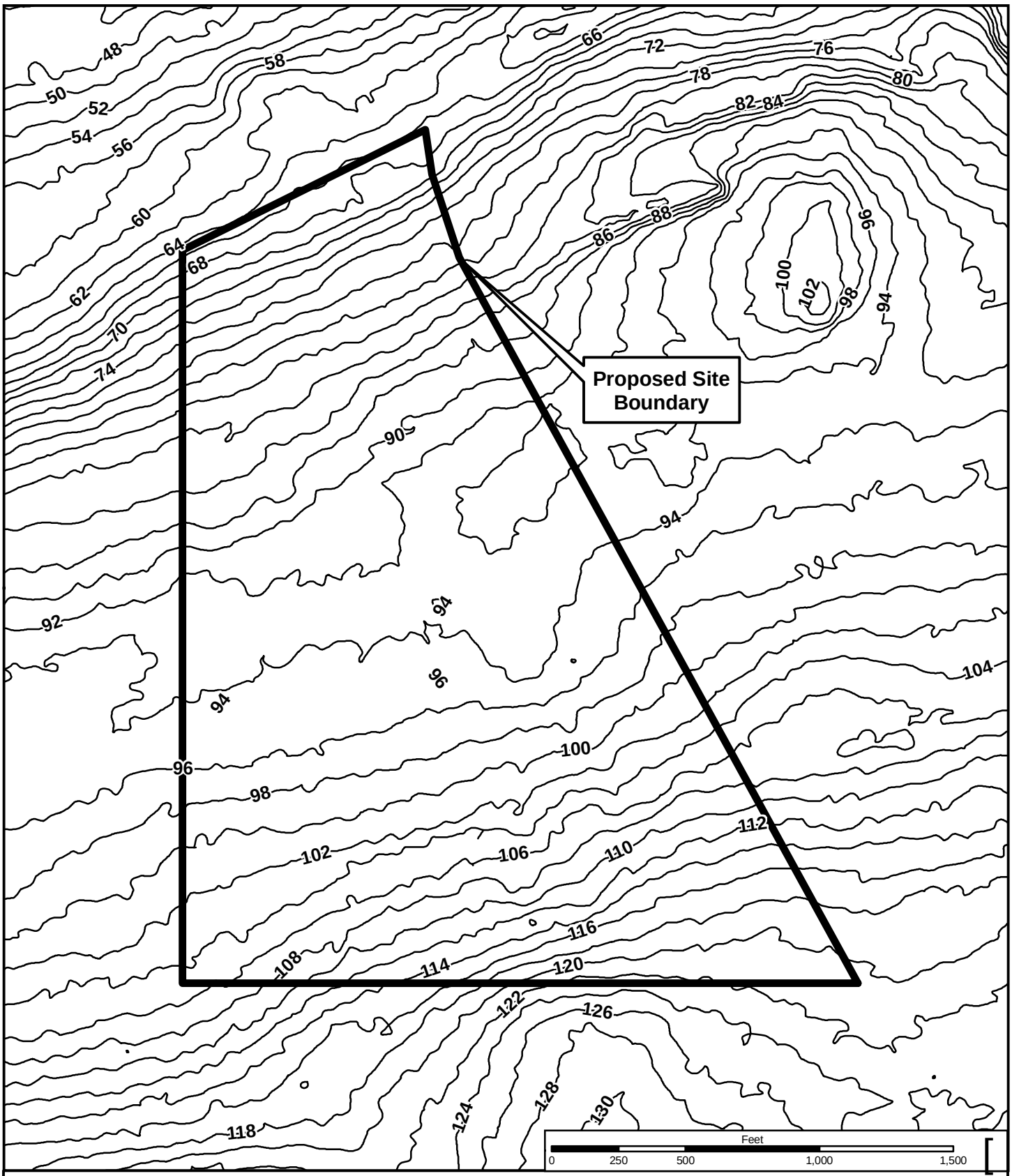
1. The biotope of deep featureless limestone that occupies at least 95 percent of the proposed artificial reef site. Mean coral coverage in this biotope is about 0.3%.[8]
2. The biotope of scattered corals, which occupies the remainder (no more than 5%) of the bottom in the proposed site. Mean live coral coverage within this biotope is about 10%.

Pre-construction surveys of the site will be conducted to ensure that artificial reef structures will be placed only in the biotope of deep featureless limestone. Marine biota associated with each of these seabed types is described in Section 3.6 below.

3.2 SEAFLOOR BATHYMETRY & ROUGHNESS

A key concern for the selection of an artificial reef site is the seafloor bathymetry. The ideal site is mostly within the depth range identified by DAR as optimal for a shallow-water reef site and is smooth and flat. Application of these criteria to the selection of the proposed site was greatly

[8] A zone of transition (ecotone) exists between the biotope of scattered corals and the biotope of deep featureless limestone. It is estimated that no more than 2% of the proposed artificial reef site is characterized by this ecotone, which exhibits a mean coral coverage of about 5%.



Prepared For:
Division of Aquatic Resources; Dept. of Land & Natural Resources

Prepared By:
PLANNING SOLUTIONS

Sources:
--HASEKO Hawaii, Inc.
--US Navy SHOALS Bathymetry

Depth (feet) Below Mean Lower Low Water
Contour Interval: 2 ft.

Figure 3-1:

Bathymetry of Proposed Site

Kalaeloa Artificial Reef Project

Figure 3-1 Site Bathymetry 2007-10-04.mxd

facilitated by the availability of high resolution bathymetry produced by the SHOALS[9] program for the entire coastal margin of the island of O'ahu (DOA 2000). As shown in Figure 3.1, the bathymetry is relatively flat or gently sloping within the proposed reef site.

The SHOALS data can also be used to estimate the roughness of the seafloor surface by grouping the data into small quadrats[10] and calculating the standard deviation of the depth measurements that occur within each quadrat. The results of these calculations for the proposed site are shown in Figure 3.2. The site exhibits large areas that are relatively smooth with low relief. As shown in Figure 3.3, about ~~75~~70% of the area has roughness values less than 6 inches and virtually all of the sea floor in the proposed site has roughness values less than one foot. Summary statistics for the bathymetry, relief, and roughness estimates determined from the SHOALS data are provided in Table 3.1.

3.3 PHYSICAL OCEANOGRAPHY

3.3.1 WINDS

The Northeastern Trade Winds are the most prevalent winds in Hawai'i, accounting for 70% of all winds. During the summer, trades occur more than 90% of the time. In the winter (January through March), trade winds may occur only 40% to 60% of the time. Strong trades are compressed as they funnel through the major channels between the islands at speeds; as a result they can reach speeds in these areas that are 5-20 knots higher than their speeds over the open ocean.

The next most common winds in Hawai'i are the Kona winds. These are stormy, rain-bearing winds that blow over the islands from the southwest or south-southwest, almost directly opposite to trade winds. Kona winds occur when a low-pressure center is within 500 miles northwest of the islands. Although strong Kona winds usually don't last for more than a day or two at a time, they can cause considerable damage to boats caught in the open ocean or anchored in SW exposed anchorages (Haraguchi 1979).

3.3.2 TIDAL CURRENTS

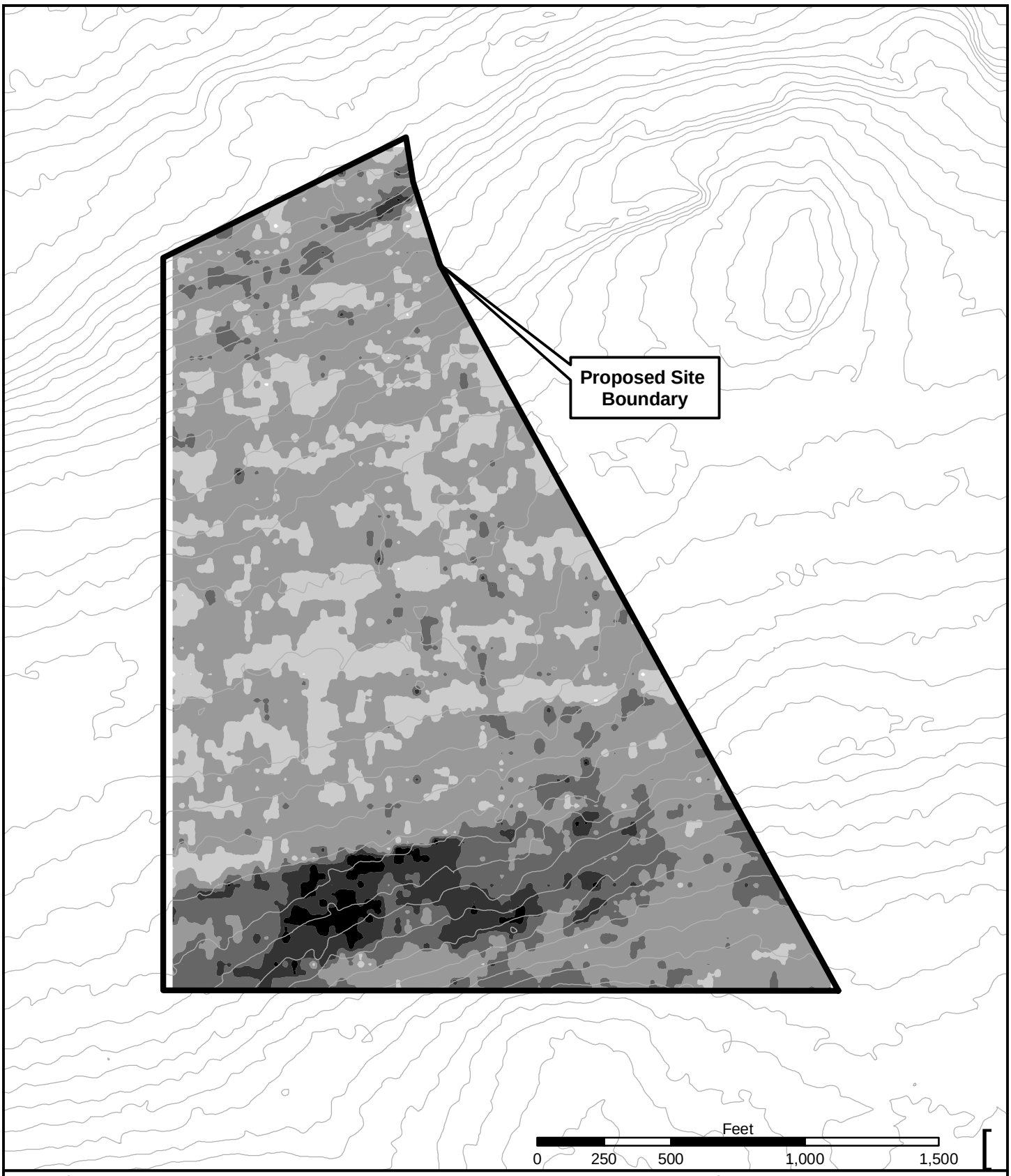
Hamilton, Singer and Waddell (1995) conducted an 18-month-long study of the current and temperature variability in Māmala Bay, the bay off Honolulu between Diamond Head and Barbers Point on the south shore of O'ahu. Very good vertical coverage was obtained at 13 current-meter mooring locations, permitting the estimation of both barotropic and baroclinic tide components. Figure 3.4 illustrates the barotropic tidal current ellipses for the principal semi-diurnal (M_2) and diurnal (K_1) constituents.

3.3.3 WIND-DRIVEN CURRENTS

The Northeastern Trade Winds are the major winds over much of the Northeastern Pacific Ocean and generate the dominant ocean current, called the North Equatorial Current. This current flows generally from northeast to southwest, averaging a speed of 0.35 knots. As the current approaches the Hawaiian chain, part of it is diverted to the north along the island chain. The result, along the southern coast of O'ahu, is normally an alongshore current flowing from east to west (see, for example, Figure 3.5).

[9] The Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) system is owned and operated by the Joint Airborne Lidar Bathymetry Technical Center, a partnership between the South Atlantic Division, US Army Corps of Engineers (USACE), the Naval Meteorology and Oceanography Command and Naval Oceanographic Office and USACE's Engineer Research and Development Center. SHOALS employs a survey technology known as Airborne Lidar Bathymetry (ALB) or Airborne Lidar Hydrography (ALH), which uses state-of-the-art LIDAR (Light Detection and Ranging) technology to rapidly and accurately measure seabed depths to a maximum depth of about 60 meters (200 feet).

[10] The quadrat size selected for these estimates is 10 X 10 meters (~33 X 33 feet).



Prepared For:
Division of Aquatic Resources; Dept. of Land & Natural Resources

Prepared By:
PLANNING SOLUTIONS

Sources:
--HASEKO Hawaii, Inc.
--US Navy SHOALS Bathymetry

Surface Roughness (in.)

0 - 2
2 - 4
4 - 6
6 - 8
8 - 10
>10 in.

Notes:
1. Roughness calculated as the standard deviation in 10 X 10 meter quadrats of SHOALS depth values

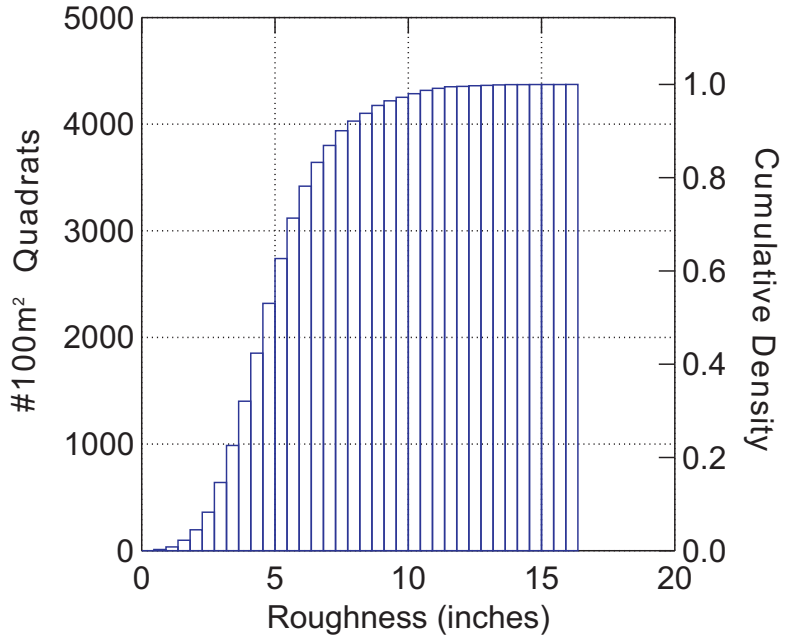
2. Contour Interval: 2 ft.

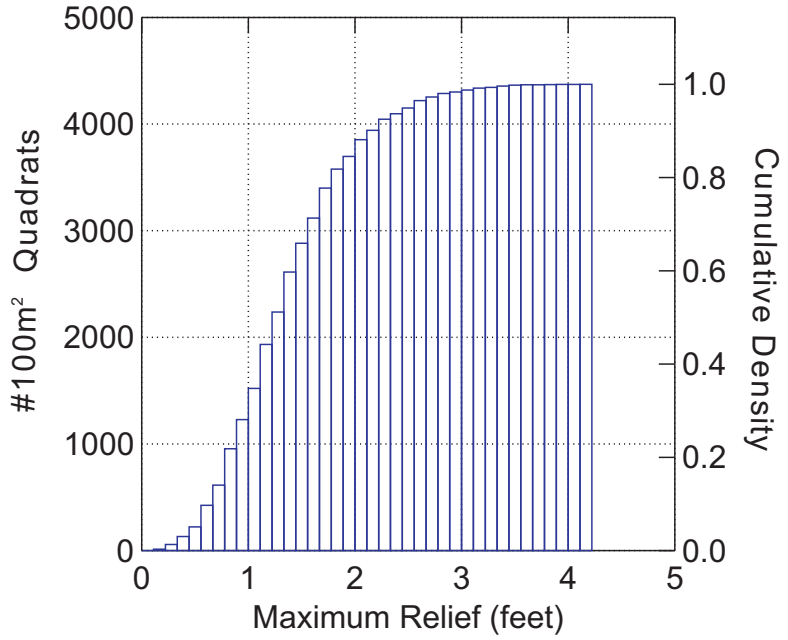
Figure 3-2:

Surface Roughness at Proposed Site

Kalaeloa Artificial Reef Project

Figure 3-2 Proposd Site Roughness 2007-10-04.mxd





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Dept. of Land & Natural Resources

Prepared By:

PLANNING SOLUTIONS

Source:

US Navy SHOALS Bathymetry

Figure 3-3:

Distribution of Site Roughness & Maximum Relief

Kalaeloa Artificial Reef Project

Figure 3-3 Distribution of Site Roughness & Maximum Relief 2007-10-04.cdr

Table 3.1. Bathymetry, Roughness, and Relief in Proposed Reef Site

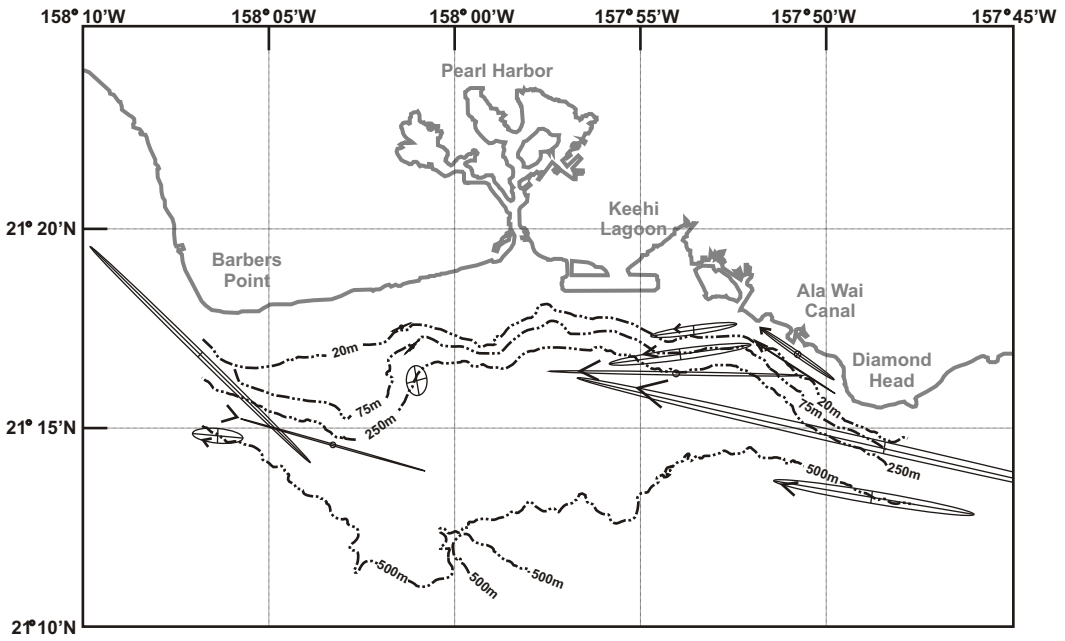
Bathymetry (feet below MLLW)	
Number of Measurements	~~92,001~~44,453
Minimum Depth	~~59.5~~63.8
Maximum Depth	~~124.2~~123.5
Mean Depth	~~97.5~~98.7
Depth Std. Dev.	~~13.6~~12.8
Roughness[1] (in.) & Relief[2] (feet.)	
Number of Quadrats[3]	~~9,240~~4,373
Mean Measurement Density (Number per Quadrat)	~~10.0~~10.1
Minimum Roughness	~~0.00~~0.53
Maximum Roughness	~~29.6~~16.2
Mean Roughness	~~5.2~~5.1
Median Roughness	4.9
Minimum Relief	~~0.03~~0.13
Maximum Relief	~~8.0~~4.2
Mean Relief	1.4
Median Relief	1.3

Source: DOA (2000).

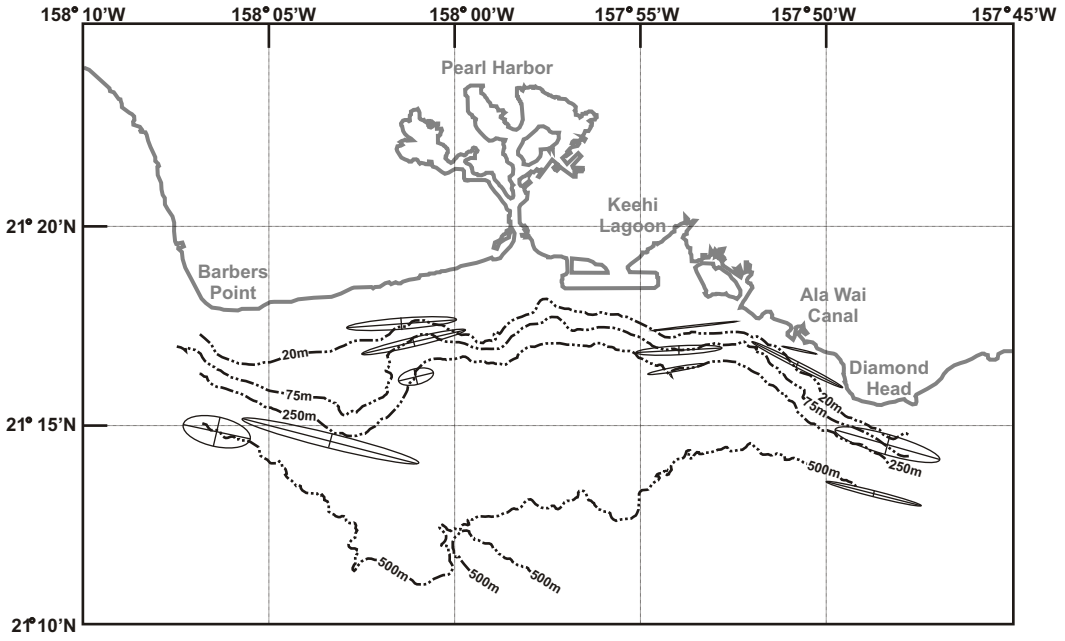
Notes: [1]Roughness estimated as the standard deviation of the depths (units, inches) in each quadrat (thus includes local roughness and general slope).

[2]Relief (units, feet) estimated as maximum range of depths in quadrat

[3]Quadrat size 10 meters X 10 meters.



Depth-Mean Tidal Current Ellipses For the M_2 Constituent



Depth-Mean Tidal Current Ellipses For the K_1 Constituent

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Dept. of Land & Natural Resources

Prepared By:

PLANNING SOLUTIONS

Source:

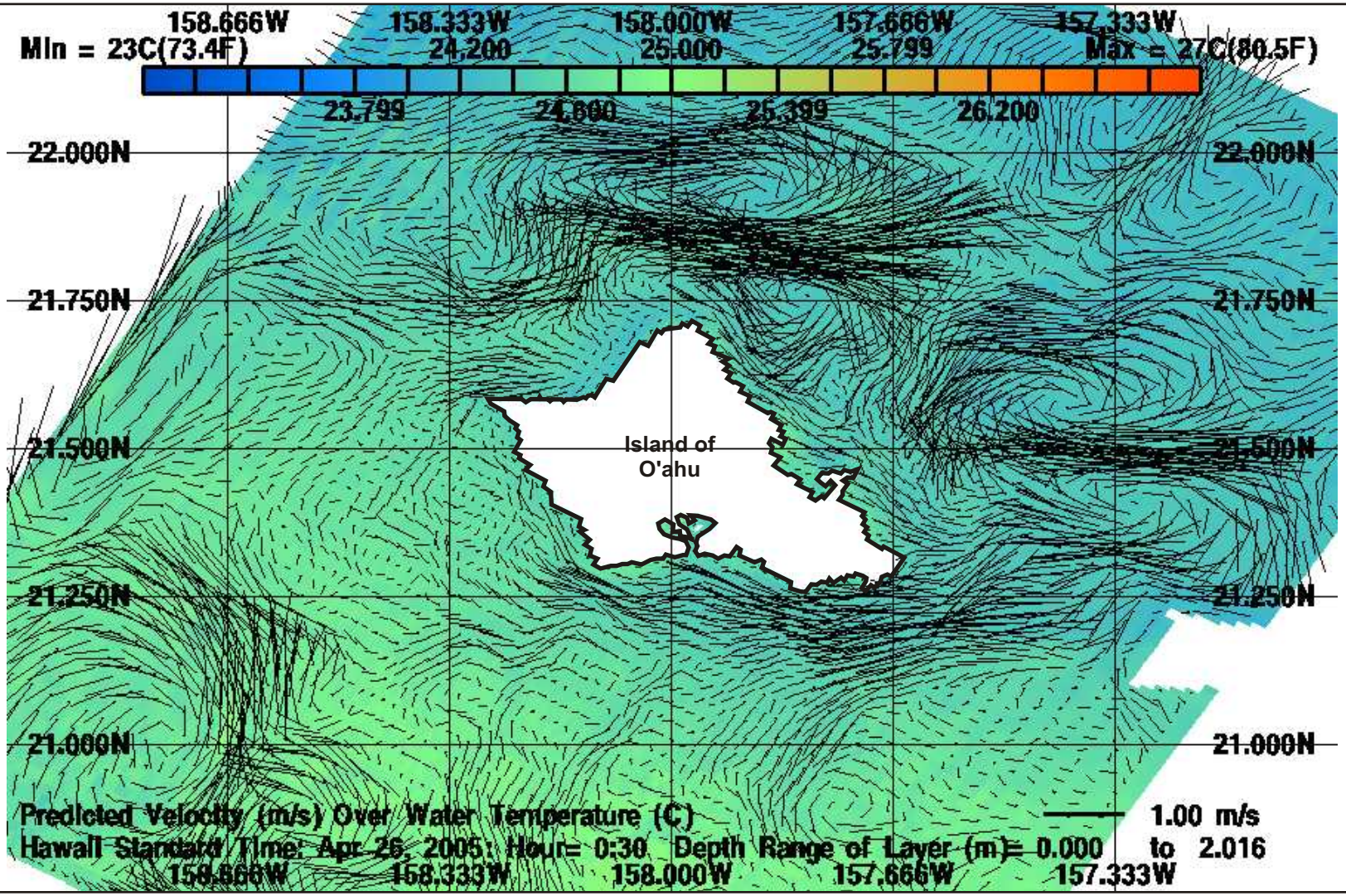
Mamala Bay Project (2000)

Figure 3-4:

Average Tidal Excursions

Kalaeloa Artificial Reef Project

Figure 3-4 Average Tidal Excursions 2006-05-02.cdr



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State of Hawai'i

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Source:
Scientific Solutions, Inc. (2005)

Figure 3-5:

Surface Currents Around O'ahu: April 26, 2005

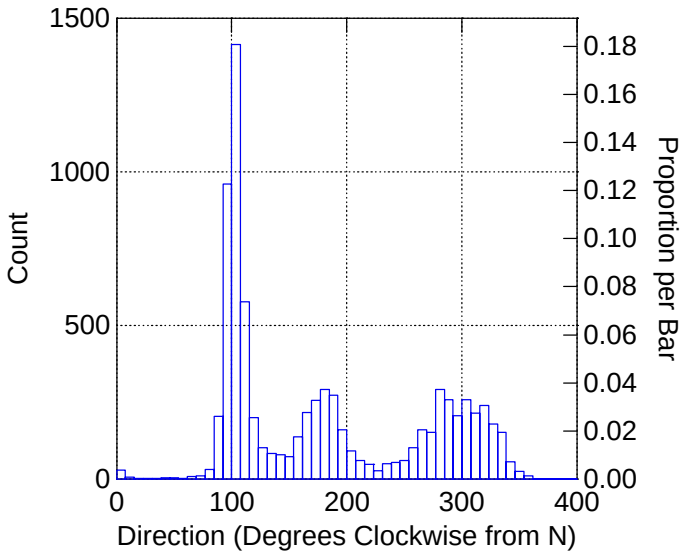
Kalaeloa Artificial Reef Project

Figure 3-7 Surface Currents Around Oahu 2006-05-01.cdr

3.3.4 SURFACE WAVES

Surface waves come from four principal sources in Hawaiian ocean waters. ~~, as shown in Table 3.2.~~ The southern shoreline of O'ahu is directly impacted by the Kona storm and Southern Swell waves and indirectly impacted by the Trade wind and North Pacific waves that are refracted around the island.

Deepwater wave data for the vicinity of the Hawaiian Islands are available from seven NOAA data buoy stations (NOAA 2007). Buoy 51027, located due south of Moloka'i, Lana'i and Maui (latitude: 20° 27'N, longitude 157° 7' 54" W), recorded wave data directly applicable to the project site between December 1994 and November 1995. Buoy 51027 was exposed to southerly waves and westerly Kona waves, and partially sheltered from tradewind seas and north swell. Wave height and period statistics from buoy 51027 are shown on Table 3.2. As shown in the following graph, these waves come from three dominant directions, representing the Trade Wind Swells (50°-150°), Kona and South Swells (150°-230°), and the North Swell (230°-360°).



The wave regime measured at this buoy is likely to be representative of the Kalaeloa reef site, except the Northern Swell would be expected to be much more attenuated at the reef site, since these waves would have to be refracted completely around the Island of O'ahu.

~~Table 3.2. Surface Waves in Hawaiian Waters~~

~~*Characteristic*~~	~~*Trade Wind Waves*~~	~~*North Pacific Swell*~~	~~*Kona Storm Waves*~~	~~*Southern Swell*~~
~~*Source*~~	~~Trade winds~~	~~N. Pacific Storms~~	~~Kona Winds~~	~~S. Pacific Storms~~
~~*Prevalent Time of Year (in Hawai'i)*~~	~~Year-round~~	~~Winter~~	~~Late Winter, early spring~~	~~Summer~~
~~*Normal Wave Heights (m)*~~	~~1 - 4~~	~~2 - 4~~	~~3 - 5~~	~~1 - 6~~
~~*Normal Wave*~~	~~5 - 8~~	~~10 - 17~~	~~8 - 10~~	~~14 - 22~~

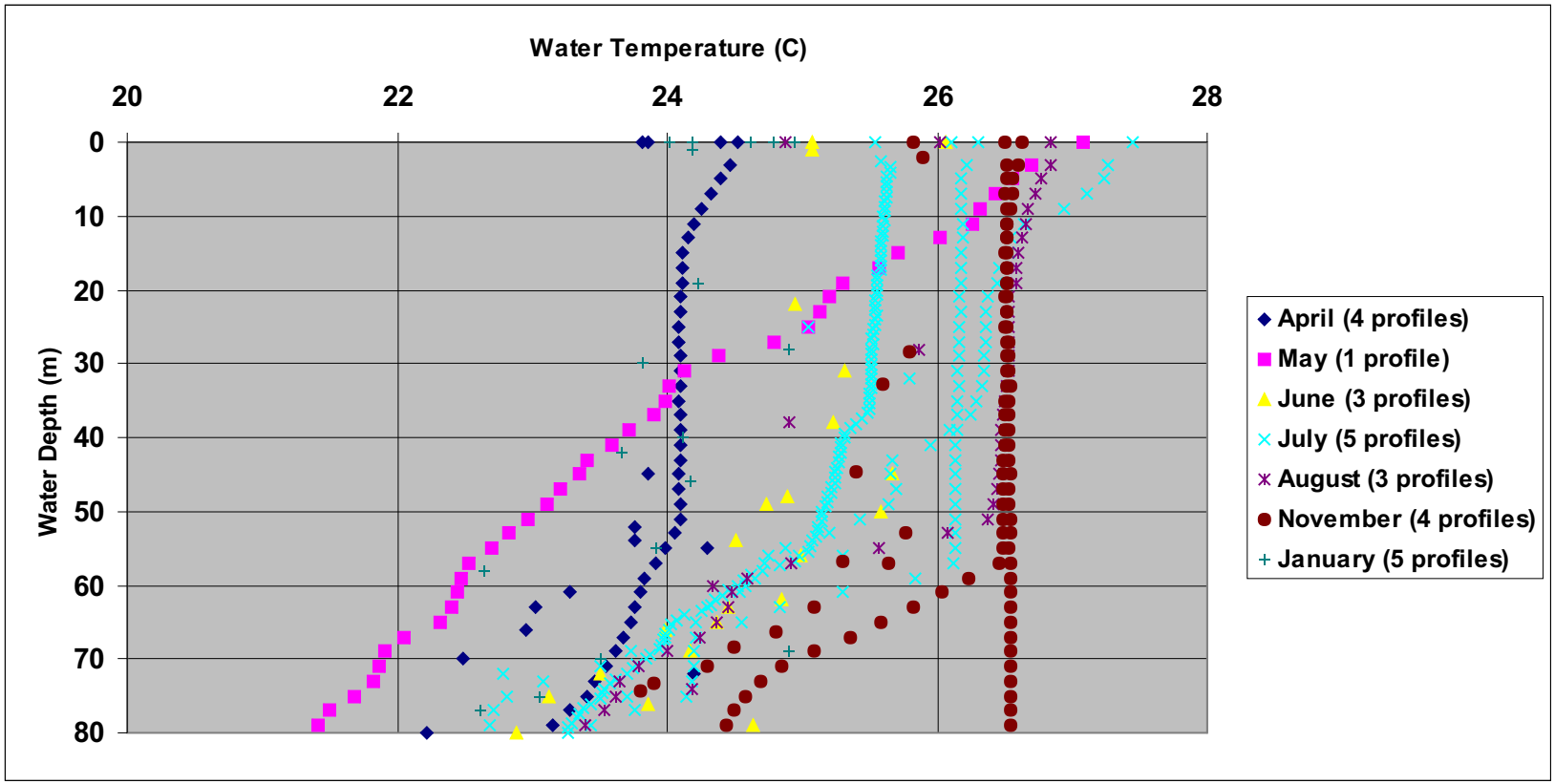
~~***Periods (T; sec.)***~~				
~~***Deep-Water Wave Length (L; m)****~~	~~4 - 10~~	~~16 - 45~~	~~10 - 16~~	~~31 - 75~~
~~***Approaching Direction (range, compass degrees)***~~	~~0° - 123°~~	~~282° - 45°~~	~~147° - 258°~~	~~147° - 236°~~
~~*Note: $L = gT^2/(2\pi)$, where g is the acceleration of gravity; L<<water depth (see e.g., Sverdrup, Johnson & Fleming 1961, p. 525)~~				
~~Source: Armstrong (1983), p. 54.~~				

3.3.5 WATER TEMPERATURE

The regional mixed-layer depth in this area varies on average between 30 meters (~100 feet) in May and 60 meters (~200 feet) in November (Monterey and Levitus 1997); consequently, the proposed site is always within this generally isothermal regional zone. However, as shown in Figure 3.6, shallow thermoclines to depths of about 15 meters (50 feet) can develop above this zone during relatively calm weather.

Table 3.2 NOAA Buoy 51027 Surface Wave Data Summary

	Trades (50˚-150˚)		~~150-230~~ Kona~~/~~ & S. Swell (150˚-230˚)		~~230-360~~ N~~.~~ ~~Pacific.~~orth Swell (230˚-360˚)	
	Period (sec.)	Significant Height (m)	Period (sec.)	Significant Height (m)	Period (sec.)	Significant Height (m)
% of Data	48		20		32	
Minimum	4.2	0.7	4.5	0.6	4.7	0.7
Maximum	8.3	3.3	8.7	2.8	11	3.3
Median	5.3	1.7	5.8	1.3	6.5	1.5
Mean	5.4	1.7	6.0	1.4	6.8	1.6
Std. Dev.	0.4	0.4	0.8	0.4	1.2	0.4
Source: NOAA (2007)						



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Dept. of Land & Natural Resources,
State of Hawai'i

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Source:
NODC (2001)

Note: Profiles from World Ocean Database 2001 archive of expendable bathythermograph (XBT) data; collection dates range from April 1969 to July 1998; profiles collected within 6 nm of the reef sites are included in the plot.

Figure 3-6:

Temperature Profiles Near the Site

Kalaeloa Artificial Reef Project

Figure 3-6 Temperature Profiles Collected Near the Sites 2006-05-01.cdr

3.4 WATER QUALITY

The State of Hawai'i Department of Health has classified the marine waters in the area offshore of Kalaeloa as "Class A Open Coastal Waters". Water quality data are available from seven nearshore stations located approximately 500 meters offshore[11] and at five offshore stations documented in the U.S. Dept. of Commerce World Ocean Data Center online archive (NODC 2001). Table 3.3 summarizes surface and near-bottom water quality data from each of the nearshore stations and the applicable water quality standards and Figure 3.7 shows the locations of these sampling stations.[12] Figure 3.8 shows the vertical profiles of the water quality data that NOAA has collected from farther offshore. With a few exceptions[13], these data suggest that the ocean water in the vicinity of the proposed reef site is within the State water quality standards. As shown on Figure 3.8, very little, if any, vertical stratification of the measured parameters is apparent in these profiles, particularly within the depth range of the site.

3.5 MICROCLIMATE AND AIR QUALITY

The Hawaiian Island chain is situated south of the large Eastern Pacific semi-permanent high-pressure cell, the dominant feature affecting air circulation in the region. This high-pressure cell produces very persistent winds called the northeast trade winds over O'ahu. During the winter months, cold fronts sweep across the north central Pacific Ocean, bringing rain and intermittently interrupting the trade wind regime. Thunderstorms, which are rare but most frequent in the mountains, also contribute to annual precipitation.

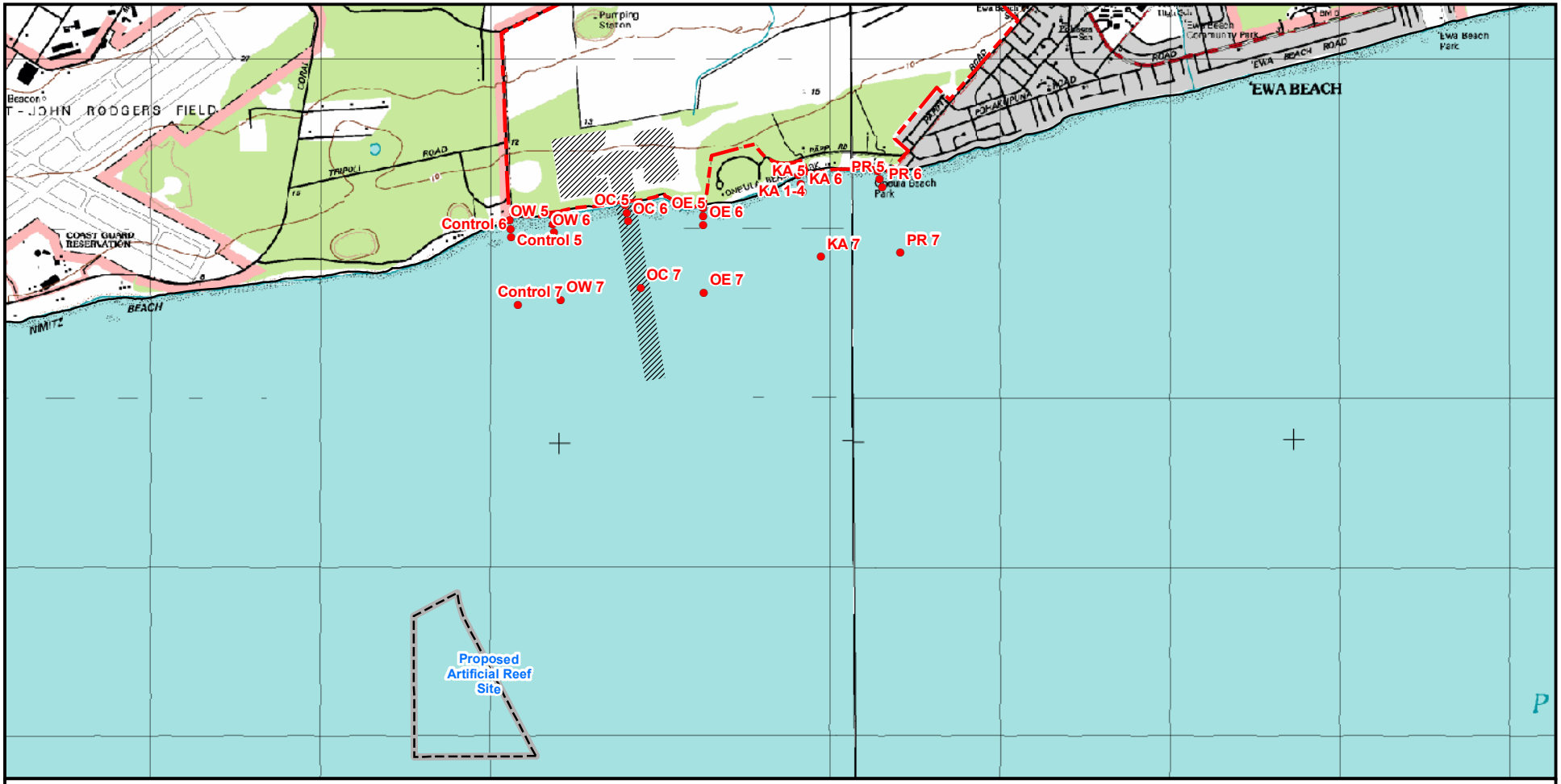
Due to the tempering influence of the Pacific Ocean and its low-latitude location, O'ahu experiences extremely small diurnal and seasonal variations in ambient temperature. Average temperatures in the coolest and warmest months at Honolulu International Airport are 72.9˚ (January) and 81.4˚ (July), respectively. These temperature variations are small compared to those that occur at inland continental locations. Table 3.4 provides average monthly data for temperature, rainfall, and humidity from Honolulu International Airport.

The terrain on O'ahu is influential in determining the amount of rainfall. While rainfall near the top of the Ko'olau Range on the windward side of O'ahu averages nearly 250 inches per year, annual rainfall along the 'Ewa shoreline averages only about 20 inches, an order-of-magnitude less. Most of this occurs between December and April; from May through September it averages 1 inch per month or less. The rainfall regime at the artificial reef site, which is about a mile offshore, is likely to be similar.

[11] The nearshore stations were established by HASEKO more than a decade ago to monitor marine water quality in the waters off Ocean Pointe and One'ula Beach Park under the terms of the Water Quality Certification that DOH issued for the Ewa Marina project.

[12] Because the proposed artificial reef site lies substantially farther offshore, these data can only hint at the existing water quality conditions there. In particular, nearshore water chemistry is heavily influenced by groundwater influx, which decreases further offshore. Similarly, TSS and turbidity are primarily related to re-suspension of sediments by wave energy, of which there is considerably less in the deeper offshore waters. However, constituents not related to groundwater efflux (NH4+, TN and TOP) could provide a more accurate indication of conditions at the reef site. Another consideration is the influence of a third water mass, this one flowing out of Pearl Harbor and continuing westward along the 'Ewa coast, which is likely more pronounced at the coast and may be less so at the site.

[13] Figure 3.8 includes two profiles (Phosphate in 1972 sample and Nitrate in 1985 sample) that exhibit nutrient levels above water quality standards.



Prepared For:

Division of Aquatic Resources
Dept. of Land & Natural Resources

Prepared By:

PLANNING SOLUTIONS

Sources:

--HASEKO (Ewa), Inc.
--USGS 7.5' Quad Maps

Legend:

- Water Quality Sampling Stations
- Proposed Ocean Pointe Marina & Entrance Channel

0 1,500 3,000 6,000
Feet

Figure 3-7:

Nearshore Water Quality Monitoring Stations

Kalaeloa Artificial Reef Project

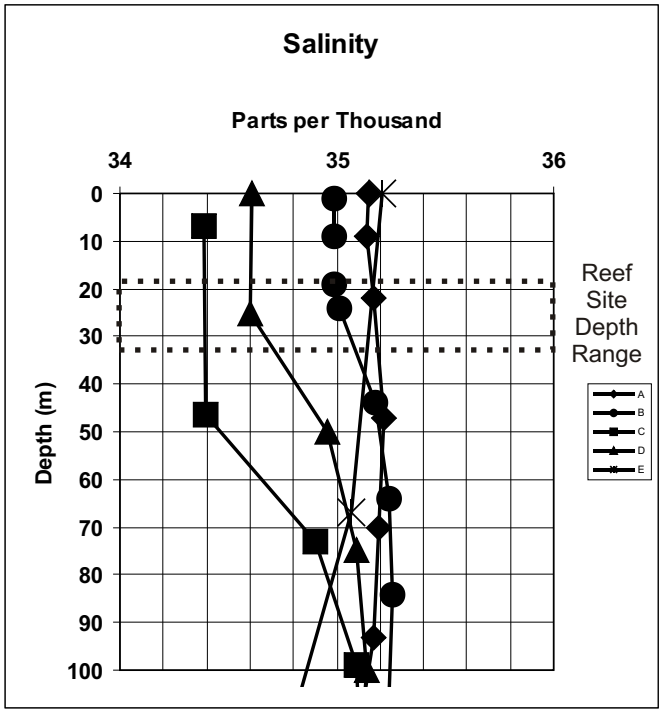
Figure 3-7 Marine Water Quality Monitoring Stations 2007-10-04.mxd

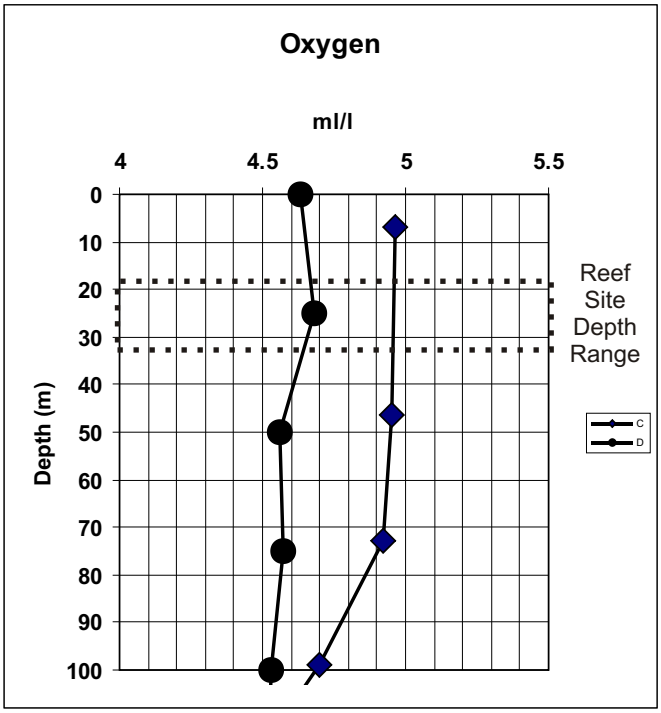
Table 3.3. Nearshore Water Quality Measurements and Ambient Water Quality Standards

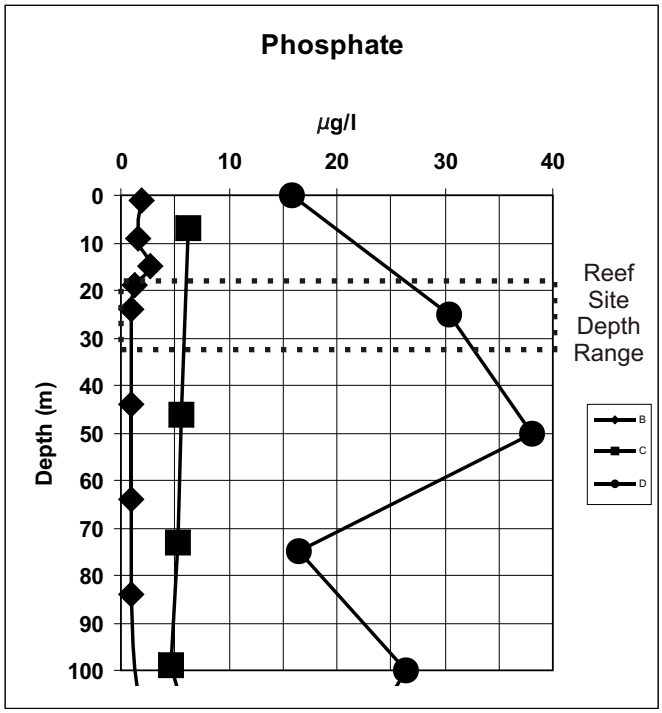
Site	Stn. #	PO_4 (µg/L)	NO_3 (µg/L)	NH_4 (µg/L)	Si (µg/L)	TOP (µg/L)	TON (µg/L)	TP (µg/L)	TN (µg/L)	TURB (NTU)	SAL (ppt)	CHLa (µg/L)	TEMP (deg C)	pH
Control	S	1.55	1.12	1.40	75.86	6.51	95.06	8.68	98.42	0.34	34.76	0.28	25.97	8.13
	D	1.55	0.84	0.84	68.53	6.82	92.40	8.99	95.34	0.32	34.77	0.28	25.92	8.14
O-W	S	1.86	0.98	1.26	77.83	6.82	88.20	9.30	91.70	0.27	34.78	0.26	26.00	8.14
	D	1.55	0.84	0.98	73.88	7.13	93.80	9.61	96.60	0.32	34.79	0.28	25.96	8.15
O-C	S	1.86	0.98	1.40	76.99	6.82	110.04	9.30	113.68	0.32	34.76	0.26	25.98	8.15
	D	2.48	0.98	1.82	69.65	7.13	99.96	9.92	104.72	0.30	34.80	0.31	25.97	8.15
O-E	S	1.86	1.26	1.54	66.55	6.82	98.00	9.30	103.46	0.21	34.76	0.24	25.99	8.15
	D	1.86	1.12	1.12	72.19	7.13	103.04	9.61	106.68	0.25	34.81	0.24	26.04	8.16
KA	S	1.84	0.86	1.13	71.68	6.17	96.23	8.38	99.20	0.29	34.68	0.30	26.19	8.18
	D	2.14	0.50	0.88	70.41	6.21	96.16	8.68	98.36	0.27	34.71	0.31	26.18	8.19
PR	S	1.59	0.91	1.14	72.66	6.80	101.12	8.93	103.77	0.36	34.79	0.21	26.68	8.18
	D	1.59	1.11	1.06	69.81	6.52	99.46	8.52	102.39	0.34	34.81	0.21	26.63	8.19
State Standard			5.00	3.50				20.00	150.0					

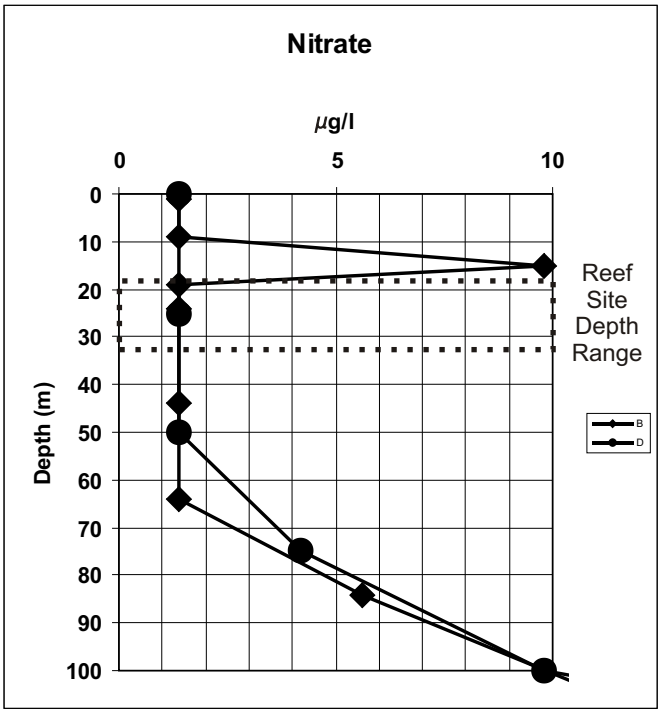
Notes: Geometric means of water chemistry measurements (in µg/L) collected from sites 500 m off Ocean Pointe during twelve surveys conducted since March 2003 for the West (OW), East (OE), Control and Central (OC) sites; since June 2004 for the KA site (N=9); and since September 2004 for the PR site (N=6). For calculation of geometric means, detection limits were used for sample data below the detectable limit. S: Surface water collection; D, Near-bottom water collection. State Standards: State of Hawaii, Department of Health (DOH) geometric mean water quality standards for open coastal waters under "wet" conditions.

Source: Marine Research Consultants









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Dept. of Land & Natural Resources

Prepared By:
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Source:
NODC (2001)

Key	WODC ID	Lat. N	Lon. W	Seafloor Depth (m)	Date
A	838767	21.237	158.033	348	12/3/1983
B	855607	21.317	158.133	-	8/16/1985
C	7095683	21.273	158.158	1492	2/27/1989
D	655302	21.370	158.200	820	4/13/1972
E	157017	21.230	158.270	2523	7/1/1947

Figure 3-8:

Offshore Marine Water Quality

Kalaeloa Artificial Reef Project

Figure 3-8 Offshore Marine Water Quality 2006-05-01.cdr

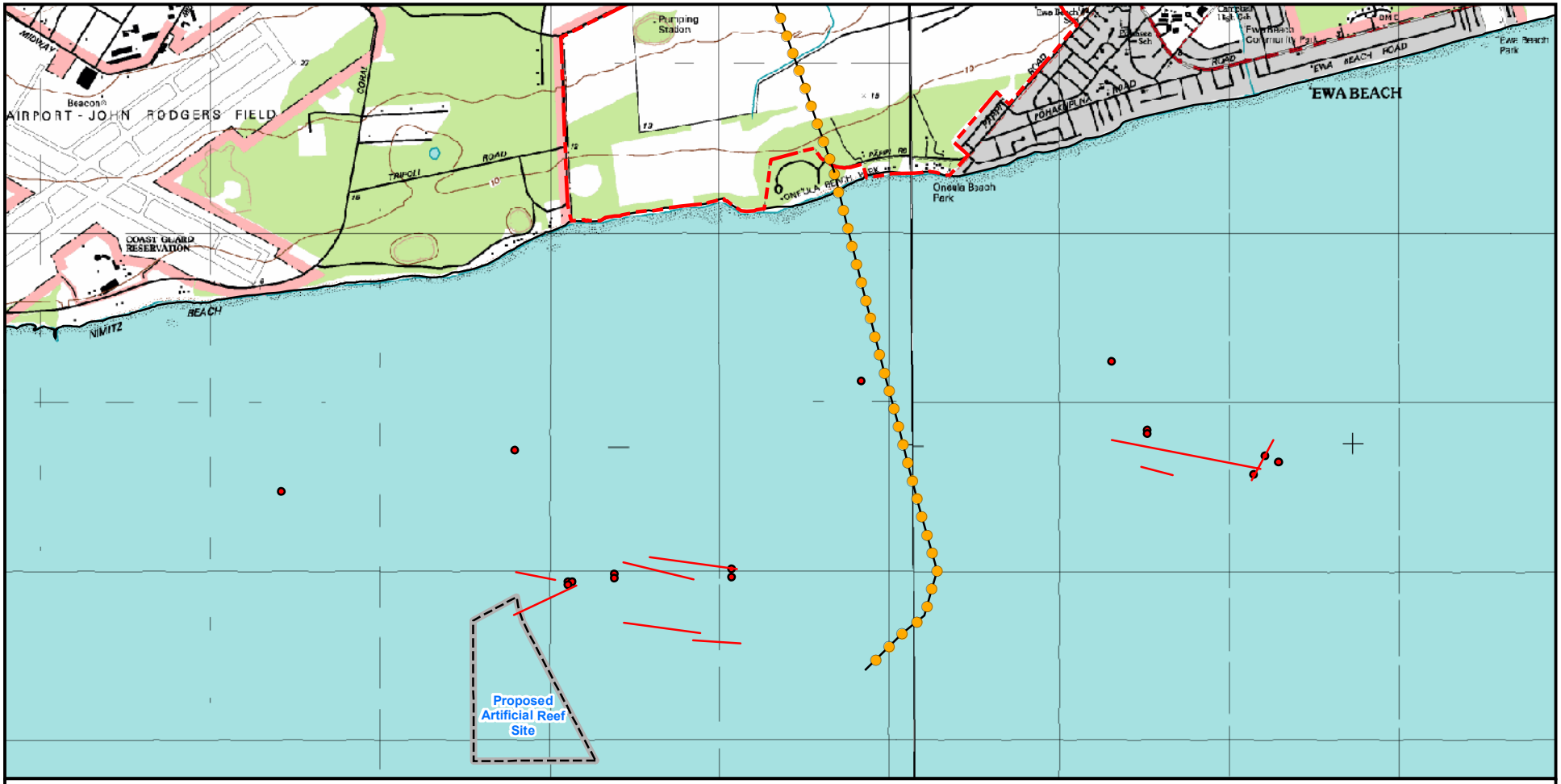
Table 3.4. Average Monthly Temperature, Rainfall, and Humidity

Month	*Normal Ambient Temperature, °Fahrenheit*		*Average Monthly Rainfall (inches)*		*Average Relative Humidity (%)*
	Daily Minimum	*Daily Maximum*	*Monthly Minimum*	*Monthly Maximum*	
January	65.7	80.4	0.18	14.74	71
February	65.4	80.7	0.06	13.68	69
March	66.9	81.7	0.01	20.79	65
April	68.2	83.1	0.01	8.92	62.5
May	69.6	84.9	0.03	7.23	60.5
June	72.1	86.9	T	2.46	59
July	73.8	87.8	0.03	2.33	60
August	74.7	88.9	T	3.08	60
September	74.2	88.9	0.05	2.74	61.5
October	73.2	87.2	0.07	11.15	63.5
November	71.1	84.3	0.03	18.79	67
December	67.8	81.7	0.04	17.29	74.75
Note: "T" signifies a trace amount of rainfall (i.e., less than 0.01 inch).					
Source: DBEDT 2003 (Data from Honolulu International Airport).					

The State of Hawai'i Department of Health monitors ambient air quality on O'ahu using a system of nine monitoring sites. The primary purpose of the monitoring network is to measure ambient air concentrations of the six criteria pollutants regulated by the National Ambient Air Quality Standards, which are particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2) sulfur dioxide (SO_2), carbon monoxide, and hydrogen sulfide. Data from the nearby Kapolei Air Quality Monitoring Station, which measures pollution constituents of carbon monoxide, sulfur oxides, nitrogen oxide and particulates, indicate that the air quality in the area is consistently within State and Federal regulatory limits. Given their increased distance from pollutants sources, air quality offshore at the proposed Kalaeloa Artificial Reef Site is almost certainly equal to or better than that measured at the Kapolei Air Quality Monitoring Station.

3.6 MARINE BIOTA

Brock (2006) conducted a survey offshore of Kalaeloa to identify the biological communities present (see Appendix C). The study identified several major biological zones or biotopes that characterize the area and conducted quantitative surveys of the organisms present in each biotope. The survey locations are depicted on Figure 3.9.



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Dept. of Land & Natural Resources

Prepared By:

PLANNING SOLUTIONS

Sources:

--R. Brock
--HASEKO (Ewa), Inc.
--USGS 7.5' Quad Maps

Legend:

- Dive Sites
- Towed Transects
- Honouliuli WWTP Sewer Line

0 1,500 3,000 6,000
Feet

Figure 3-9:

Biological Observation Stations

Kalaeloa Artificial Reef Project

Figure 3-9 Biological Transect Locations 2007-01-10.mxd

Biotopes present in water from about 50 to more than 80 feet deep included: 1) the biotope of scattered corals found on the limestone substratum, generally inshore of the first shelf break that occurs at -60 ft, 2) the biotope of deep featureless limestone found just seaward of the shelf break, and 3) the biotope of sand which is generally seaward of the biotope of deep featureless limestone. The biotopes all lie roughly parallel to shore with the biotope of scattered corals situated in the shallowest water (from ~23 to 56 ft depth) and the other two biotopes at increasing depths seaward of the first shelf break, although small patches of each type can be found outside of this general pattern. Because there are few macroinvertebrate and fish species found in the sand biotope (most coral reef species favor areas where shelter is present), the quantitative sampling focused primarily on the other two biotopes. The results of the survey are summarized below and included in Appendix C.

3.6.1 BIOTOPE OF SCATTERED CORALS

Corals are the visually dominant organisms in the Scattered Corals biotope; within it, the lobate coral *Porites lobata* typically provides the greatest amount of cover. Other important corals include rice corals (*Montipora verrucosa, Montipora patula*) and the cauliflower coral (*Pocillopora meandrina*). Towards the deeper (more offshore) boundary of this biotope, corals become less evident, colony sizes decrease, and coral coverage decreases such that exposed limestone substratum becomes more apparent between the patches of living coral.

Although it is estimated that the biotope of scattered corals covers no more than five percent of the substratum in the proposed artificial reef site, it covers much of the adjacent shoreward area. The locations of the survey stations (Stations B, 1-B, 3-B, and 4-B) in this biotope are depicted on Figure 3.9, and the data are included in Appendix C. The data show that coral coverage in this biotope ranges from 5 to 15% and fish communities are relatively diverse (see Table 3.5 below). The coral coverage and fish community estimates are relatively high because sampling was carried out in the areas with the greatest coral coverage. Fish census data are also given in Appendix C.

In addition, Brock (2006) noted a zone of transition (i.e., an ecotone) often occurs between the biotope of scattered corals and the deep featureless limestone biotope. Four sampling stations (A, C, G, and I) were established in the transitional ecotone. Table 3.5 shows that, as predicted, the mean values for biological parameters measured in the ecotone are less than those observed in the biotope of scattered corals but greater than the mean values measured in the biotope of deep featureless limestone. The area encompassed by this ecotone in the proposed artificial reef site is estimated to be less than 2 percent of the total area.

Table 3.5. Results of Biological Surveys in the Project Area.

Biotope	*% of Reef Site*	*Transects*	*% Coral (mean)*	*# Species (mean)*	*# Individual Fish (mean)*	*Mean Standing Crop (g/m^2)*
Scattered Corals	≤ 5%	B, 1-B, 3-B, 4-B	10%	38	272	242
Transitional Ecotone	< 2%	A, C, G, I	5%	30	124	58
Deep Featureless Limestone	> 93%	D, E, F, H, J, K	0.3%	10	13	4
Note: The "# Species" column includes observed species of coral, macroinvertebrates, and fish.						
Source: Brock 2006 (see Appendix C).						

3.6.2 BIOTOPE OF DEEP FEATURELESS LIMESTONE

As the name implies, the biotope of deep featureless limestone is a relatively bare rock substrate with little topographical relief. This biotope occurs all along the Kalaeloa region at depths from about 60 to over 100 feet. To the east of the Honouliuli WWTP outfall, much of the limestone in this biotope has a veneer of sand and coral rubble present which is typically no more than a few centimeters thick but occasionally occurs in layers thick enough to fill depressions in the limestone. In the areas west of the Honouliuli WWTP outfall, the biotope of deep featureless limestone is a relatively bare limestone substrate. This biotope is ideal for artificial reef deployment because of the stability of the substratum and relative lack of coral. It has been found to offer productive foraging grounds for fish species utilizing deployed reefs, thus contributing to higher abundance and standing crops at artificial reefs over time. The biotope of deep featureless limestone occupies at least 90 % percent of the substratum in the proposed artificial reef site.

Biological data from the biotope of deep featureless limestone are summarized in Table 3.5 and given in Appendix C. The relatively low diversity of macroinvertebrates and fish is related to the lack of topographical relief and shelter. Coral communities are not well-developed because the relatively flat substratum is periodically scoured by sand and coral rubble that abrades resident corals during high surf conditions.

3.6.3 MARINE SPECIES OF CONCERN[14]

Marine species of particular concern in the Hawaiian Islands include the endangered Hawaiian monk seal or ‘Ilio holo I ka uaua (*Monachus schauinslandi*), the threatened green sea turtle or honu (*Chelonia mydas*), the endangered hawksbill turtle or honu‘ea (*Eretmochelys imbricata*), and various species of whales including the humpback whale (*Megaptera novaeangliae*). Each of these species is described in further detail below.

Hawaiian Monk Seal. The Hawaiian monk seal (pictured below) subsists upon spiny lobsters, octopuses, eels, and various reef fishes, which they may dive up to several hundred feet to obtain (USFWS 2005). The Hawaiian monk seal is occasionally sighted hauled out on beaches in the ‘Ewa Beach area or in coastal waters near the proposed reef site.

Green Sea Turtles. Adult green sea turtles are primarily herbivorous, feeding on nearshore algae (limu) pastures around the main Hawaiian Islands. However, as juveniles, green sea turtles are omnivorous, feeding on plankton, jellyfish and fish eggs floating near the surface of the open ocean. This juvenile period is termed the “lost years” and lasts about 3-7 years. During this period turtles may venture farther offshore, although the scope of their foraging range during that time is unknown (Pacific Whale Foundation 2005). The green sea turtle is commonly present in nearshore coastal waters off ‘Ewa Beach, but its occurrence is less likely in deeper waters near the proposed reef site.

Hawksbill Sea Turtles. Coral reefs are widely recognized as the resident foraging habitat of hawksbill turtle juveniles, subadults, and adults (see photo below). This habitat association is undoubtedly related to their diet of sponges, which need solid substrate for attachment (NOAA 2005). Hawksbill turtles are very rare and none have been reported in the waters near the proposed or western reef site.

Humpback Whale. The humpback whale is not known to frequent waters in proximity to the proposed artificial reef site. According to prior research on whales in waters surrounding O‘ahu, the

[14]In carrying out its responsibilities under the Endangered Species Act (ESA), the National Marine Fisheries Service (NMFS), uses the term ‘‘species of concern’’ to identify species about which NMFS has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA. This may include species for which NMFS has determined, following a biological status review, that listing under the ESA is ‘‘not warranted,’’ pursuant to ESA section 4(b)(3)(B)(i), but for which significant concerns or uncertainties remain regarding their status and/or threats. Species can qualify as both species of concern and candidate species.

only area of significant utilization is the sub-region adjoining the northwest coast of the island, from Ka‘ena Point to Kahuku (Behavioral Research Consultants, 1992).

Hawaiian Monk Seal (‘Ilio holo I ka uaua)

Hawksbill Turtle (honu‘ea)

3.7 RECREATION AND TOURISM

Recreational uses in the area affected by the artificial reef project are currently limited to pleasure boats passing by and occasional recreational fishing, and the site is not particularly valued by either of these user groups. As discussed below, the proposed reef site is too far offshore (over a mile) to be important for surfing and other coastal water sports. The barges carrying the Z Blocks are to be deployed from Honolulu Harbor, a commercial port not used for recreation.

Recreational boat traffic in the area is expected to increase with the opening of Ocean Pointe Marina, which is tentatively slated for 2009. While the design for the marina has not yet been finalized, the first phase it is anticipated to have several hundred boat slips; it will also provide at least 7 boat launch ramps for public use. This will substantially increase the number of recreational boat users in the waters off Kalaeloa. Many of these users will have previously frequented marinas and boat launches elsewhere on the island and will shift to the ‘Ewa area out of convenience or preference. It is also likely that the availability of the new marina and the extensive new residential development that is occurring in ‘Ewa will increase the number of recreational users of the area.

3.8 NOISE

The proposed reef site lies more than a mile offshore, and consequently the main noise sources at the site (above the ocean surface) are wind, waves, aircraft, and occasional passing boats. Boat traffic at the site is currently sparse, as it is not along established navigational routes nor is it considered particularly attractive to recreational users. Noise from boats is expected to increase somewhat with the opening of the Ocean Pointe Marina in 2009.

3.9 ARCHAEOLOGICAL, HISTORIC, AND CULTURAL RESOURCES

The project area is offshore of the Honouliuli ahupua‘a, which is the largest and westernmost ahupua‘a in the ‘Ewa District. At over a mile offshore, the types of historic sites that could be encountered at the proposed artificial reef site are typically limited to shipwrecks. The marine biological survey of the proposed site presented in Appendix C noted no evidence of shipwrecks or other human evidence that might be considered historically significant. In addition, high resolution (100 kHz) side-scan sonar conducted at the proposed site for the project by University of Hawai‘i scientists[15] (see Figure 3.10) revealed only one feature (located ~~at a depth of about 100 feet and about 760 feet from the eastern boundary~~outside of the site) that exhibits some significant vertical extent.

[15] Principal Investigator, Dr. Christopher Kelley, Hawai‘i Undersea Research Laboratory

Archaeological and cultural surveys of the coastal area nearest the proposed site, which includes the One'ula Archaeological District (SHIP Site 50-OA-2873, Dunn and Haun 1991) indicate that nearshore fisheries and marine resources have long been important to native Hawaiians and other inhabitants of the area for subsistence and recreation. No fishponds are believed to have existed in the shoreline area, but the coast has been used extensively for fishing and gathering of limu, fish, lobster, and other shellfish. The surveys contained no indication that the offshore area where the proposed reef site exists is particularly valued for traditional cultural practices.

3.10 SOCIOECONOMIC ENVIRONMENT

The nearest community to the proposed reef site is 'Ewa Beach. There are a few military, commercial and industrial land uses offshore. These include military danger zones and underwater installations, the Cates aquaculture facility, the Honouliuli Wastewater Treatment Plant (WWTP) outfall, and the two Barbers Point tanker offloading facilities. The presence of recreational boaters in the vicinity is rare at present, although that is expected to change once the Ocean Pointe Marina is operational, as discussed above.

3.11 SCENIC AND AESTHETIC RESOURCES

The proposed artificial reef site is in the open ocean. From offshore of Kalaeloa, there are views of the O'ahu coastline to the north and east, and of open ocean on all other sides. As mentioned, the underwater seascape is relatively flat and devoid of marine life.

3.12 PUBLIC FACILITIES & NAVIGATION

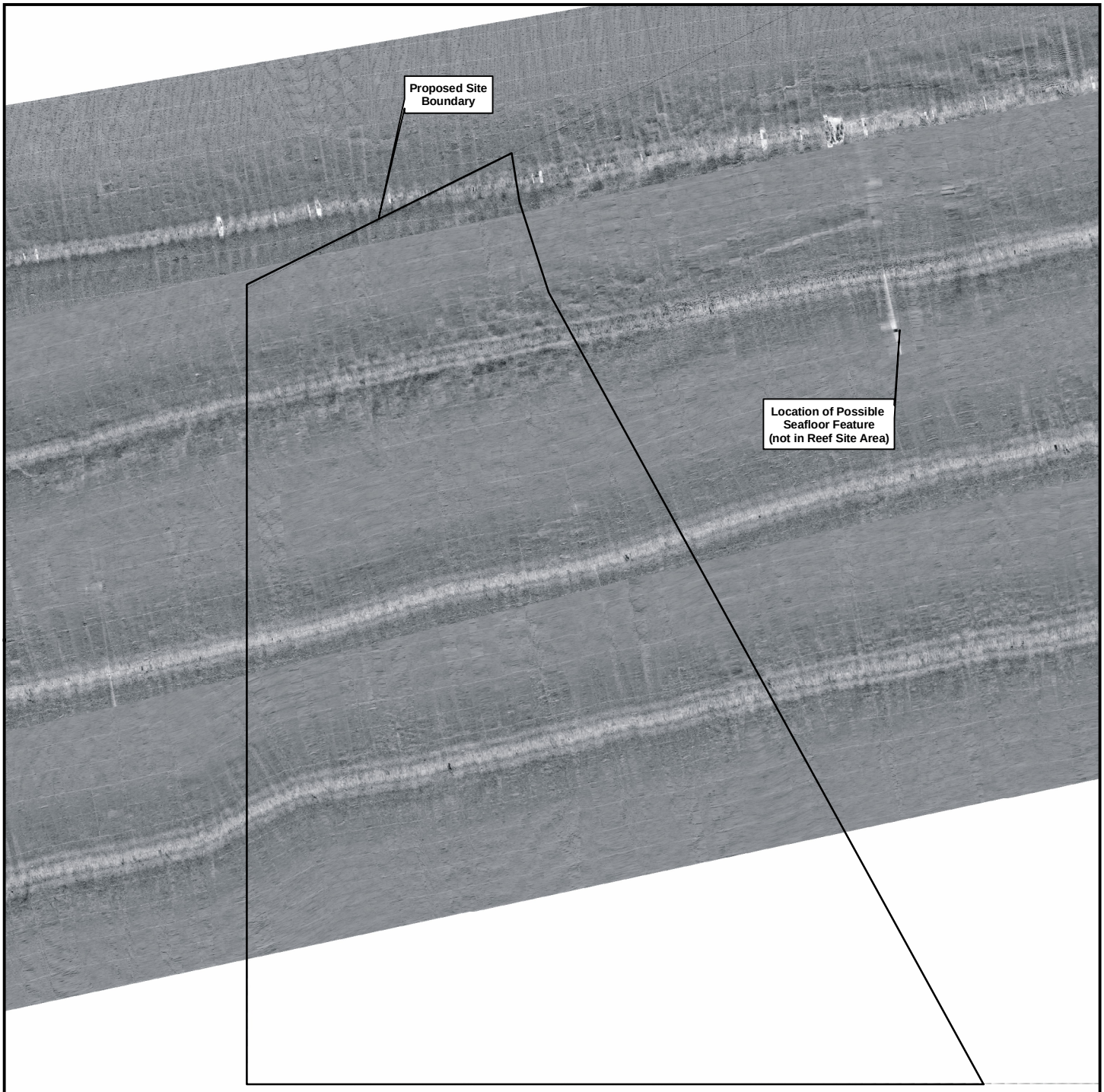
The only public facilities near the project area are the City's Honouliuli WWTP outfall mentioned above and DAR's existing deepwater artificial reef at 'Ewa.

Boat traffic offshore of 'Ewa presently consists of a limited number of recreational users, which are primarily fishermen visiting the coral-rich areas near the Honouliuli WWTP outfall and DAR's deepwater reef. Larger Navy and Coast Guard vessels, and oil tankers transiting to and from the offshore tanker unloading facilities, transit the area west of the proposed site. While fewer in number than the recreational boats, maintaining navigational safety for these larger vessels was an important consideration for siting the artificial reef.

Recreational vessels will increase once the Ocean Pointe Marina is completed. Some of these will stay in the offshore 'Ewa area to pleasure cruise or fish near the outfall. Others will circle around Barber's Point to dive or fish at the Wai'anae Artificial reef, and still others will proceed eastward toward Honolulu and the Waikīkī area. In the absence of an attraction for fishing and diving near the new Ocean Pointe Marina, more of these users are likely to choose one of the latter options.

3.13 LAND USE AND OWNERSHIP

The proposed reef site is outside the jurisdiction of the City and County and Honolulu. The seafloor out to a distance of three miles from the shoreline is State-owned, and its use is subject to the approval of the State Board of Land and Natural Resources. The proposed site is also within the State Conservation District, and DAR is applying for a Conservation District Use Permit (CDUP) for the project. While the proposed site is within a designated military restricted area, the Navy has indicated that they foresee no potential conflicts with placing the proposed artificial reef there so long as certain restrictions are placed on its use. Accordingly, DAR has agreed to prohibit bottom anchoring at the site, to provide mooring buoys, to avoid emplacing reef structures on any existing underwater Navy installations, and to situate the reef structures so that their potential movement is minimized. The Navy's official position on the project is documented in the letters included as Appendix E.



Prepared For:
Division of Aquatic Resources; Dept. of Land & Natural Resources

Prepared By:
PLANNING SOLUTIONS

Sources:
--Dr. Chris Kelley, U.H.-Manoa

Note: Images collected using 100 kHz sidescan sonar. Uphill image used for overlap areas.

Figure 3-10:

Sidescan Image of Proposed Site

Kalaeloa Artificial Reef Project

Figure 3-10 Sidescan Image 2007-10.04.mxd

4.0 POTENTIAL IMPACTS

This Chapter summarizes the probable adverse and beneficial effects that are likely to result from the proposed action as identified in Section 2.4. Where possible, the discussion will include potential impacts that could be associated with other potential marine habitat enhancement activities that DAR may elect to pursue if Alternative 2 is selected.

The discussion is organized by type of potential impact (e.g., air quality, water quality, visual, etc.). Where they exist, significant differences between the first reef increment and full build-out are described. Where applicable, the analysis also distinguishes between impacts resulting from construction of the artificial reef and those associated with it once it is in place.

Good project design and implementation integrates features and practices intended to avoid or mitigate potential environmental effects into the overall design of the project. Because of this, in most cases the discussion of "mitigation measures" is integrated into the overall discussion rather than limited to a separate section of the report.

The remainder of this Chapter is divided into the major subsections listed below, each corresponding to one aspect of the environment:

- Section 4.1 – Seafloor & Bathymetry;
- Section 4.2 – Physical Oceanography;
- Section 4.3 – Water Quality;
- Section 4.4 – Microclimate & Air Quality;
- Section 4.5 – Susceptibility to Natural Hazards;
- Section 4.6 – Marine Biota;
- Section 4.7 – Recreation & Tourism;
- Section 4.8 – Noise;
- Section 4.9 – Archaeological, Historic, & Cultural Resources;
- Section 4.10 – Socioeconomic Resources;
- Section 4.11 – Scenic & Aesthetic Resources;
- Section 4.12 – Public Facilities & Navigation; and
- Section 4.13 – Land Use and Ownership.

Geographically speaking, most of the environmental impacts of the proposed project are limited to offshore areas. Where applicable, the discussion broadens to include other areas and sectors expected to be influenced.

4.1 IMPACTS TO SEA FLOOR AND BATHYMETRY

4.1.1 ALTERNATIVE 1: PROPOSED ACTION

Construction of the first reef increment would have a substantial impact on a small percentage (about 0.~~08~~17%, or 8,000 square feet) of the proposed site's bathymetry. Within the area where the Z-blocks are deployed, the maximum relief would increase from a few inches to more than 10 feet. Full build-out of the proposed site would similarly modify a portion of the site. Using the assumptions for full build-out depicted in Figure 2.5, the full build-out of the proposed site would include ~~25~~ 14 groups of 5 sets each, or ~~125~~ 70 sets, which would cover a seafloor area of approximately ~~22~~ 12 acres, or ~~10~~11% of the site. This would substantially increase the roughness and maximum relief present at the

site and provide shelter and surface area for marine community development. In all likelihood, however, complete development would not be achieved for at least several decades.

4.1.2 ALTERNATIVE 2 (OTHER MARINE HABITAT ENHANCEMENT)

Most of the alternate marine habitat improvement activities that DAR might pursue have the same kind of potential to affect the seafloor and bathymetry as the proposed action. Adding additional reef structures to the existing Wai'anae Artificial reef, for example, would have impacts similar to those associated with the first increment of the Kalaeloa Artificial reef. Because the type, scope, and locations of these activities are as yet undefined, DAR will analyze their impacts separately if and when they are proposed.

4.2 IMPACTS TO PHYSICAL OCEANOGRAPHY

The seafloor structures contemplated for the Kalaeloa Artificial Reef would, even at full build-out, be too small (covering a total seafloor area of about ~~22~~ 14 acres) and deep (60- to 120-feet below the water surface) to exert any substantial effects over tidal and wind-driven currents. Potential effects on surface waves and water temperature are very small, but not absent. These are discussed in the following subsections.

4.2.1 IMPACTS TO SURFACE WAVES

Offshore submerged structures such as artificial reefs can attenuate surface waves if the wavelengths of the surface waves are on the order of the depth of the structures below the sea surface. These waves are highly valued by surfers and other users of the shoreline off Kalaeloa. Ocean engineers have used this fact to design and build submerged shoreline protection structures in areas where beach erosion is a problem (e.g. Harris, 1996; Pilarczyk and Zeidler, 1996; Friebel, 2000; Clauss, Habel and Pákodzi, 2001; and Schlurmann, Bleck, and Oumeraci, 2002).

This work, which includes theoretical studies, physical model experiments, and observations collected from actual offshore structures and the impacted shorelines, has resulted in some quantitative understanding of how artificial reefs impact surface waves. However, as documented by Friebel (2000), the ranges of modeling parameters used in these physical model experiments do not cover the ranges of interest here. This is because these studies are concerned with the design of submerged breakwaters, which are designed with the primary goal of attenuating the force of impinging waves~~Ahrens (1987; as cited in Harris, p. 30) developed the following empirical formula to determine the wave height transmission coefficient, K_t (i.e. the ratio of wave height before passing over the reef to its height after passing over the reef) as a function of the reef geometry and wave characteristics:~~

~~$$K_t = 1/(1+ (h/d)^{1.188}(A/dL)^{0.261}\exp(0.529((h-d)/H) + (A^{1.5}/D^2L)))$$~~

~~Where:~~

~~h = height of the reef above the seafloor~~

~~d = water depth~~

~~A = the vertical cross-sectional area opposing the wave~~

~~L = the wave length of the wave being considered~~

~~H = height of the incident wave~~

~~D = the nominal diameter of the reef's structural units (in this case, the Z-block)~~

~~Table 4.1 shows the results of this calculation for individual reef sets using appropriate values for these parameters (see Section 2.2.2 and) and using the most shallow reef location from the postulated full completion of the reef in Figure 2-5. The results suggest that, for the longest wavelengths and~~

~~highest waves (e.g. extreme Kona storms or South Swell), less than 2% of the wave height would be attenuated by a reef set. For smaller waves and deeper reef sites, the effect would be less.~~ . Specifically, the ratio of the reef height above the seafloor to the water depth is smaller than that considered in these studies, as is the ratio of the width of the top of the reef structure to the water depth and a number of other key factors. In short, the research performed to date cannot quantitatively predict the low-level of impacts on surface waves that would be expected from the Kalaeloa reef, and we must rely on qualitative factors to examine these impacts.

Table 4.1. Attenuation of Ocean Waves by Individual Reef Sets

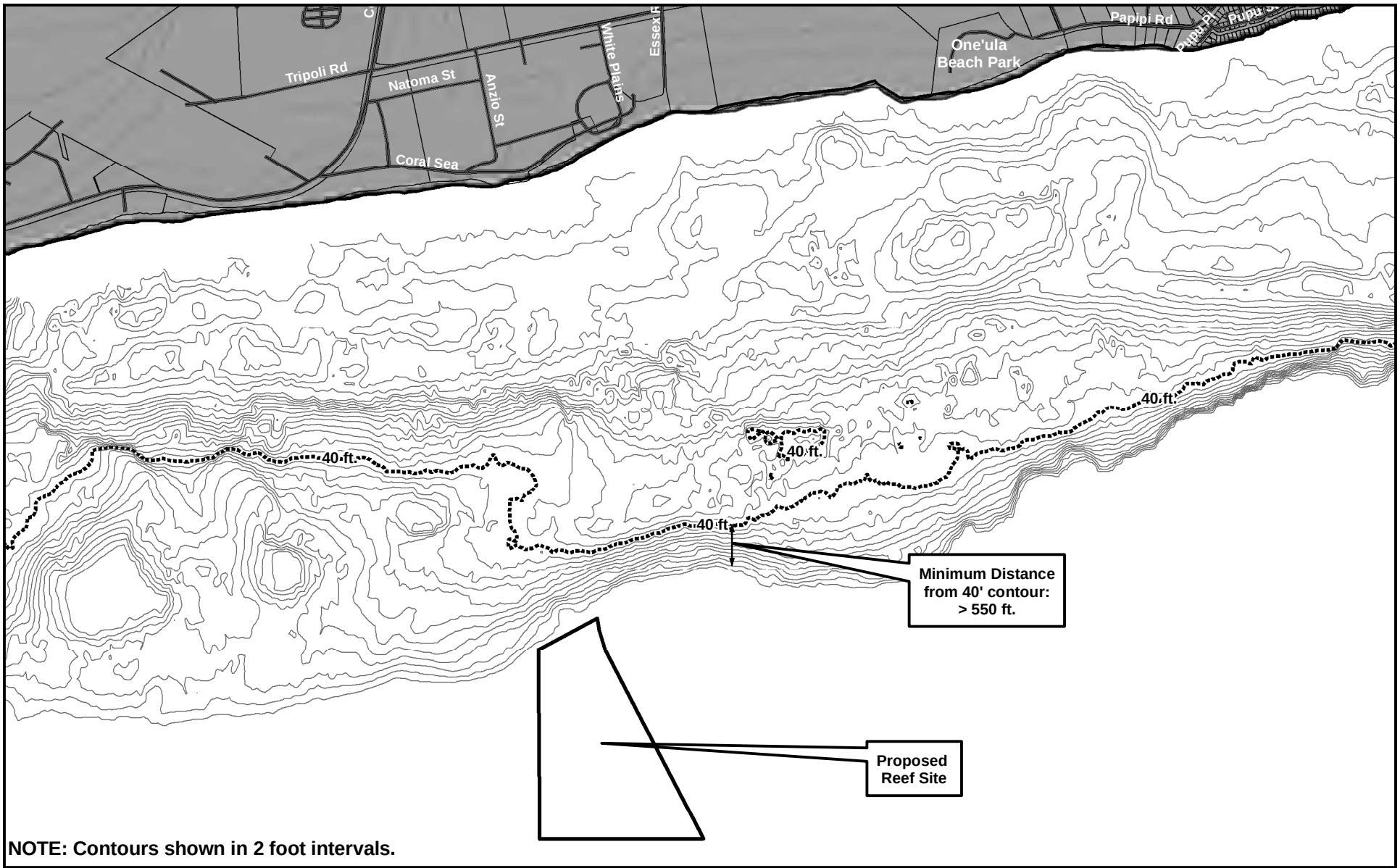
Wave Type	*Wavelength (m)*[a]	*Wave Ht. (m)*[a]	*Proposed Site*	
			K_t[b]	*Decreased Height (in inches)*
Trade Winds (min.)	4	1	1.000	0.00
Trade Winds (max.)	10	4	0.986	2.24
N. Pacific Swell (min.)	16	2	0.999	0.12
N. Pacific Swell (max.)	45	4	0.990	1.52
Kona Storms (min.)	10	3	0.993	0.82
Kona Storms (max.)	16	5	0.981	3.79
South Swell (min.)	31	1	1.000	0.00
South Swell (max.)	75	6	0.983	4.07

Notes:
[a]See
[b]One set's effect on waves; using the shallowest postulated group location in Proposed Site (see Figure 2-5)

Source: Planning Solutions, Inc.

The calculated attenuation of ocean waves presented in Table 4.1 is valid only immediately behind the reef sets. Wave energy is reflected by and diverted around submerged structures and disperses in all directions. As the distance from the reef sets increases toward the shore, their effect on waves would diminish. Extensive experience with offshore structures indicates that their effects on waves can be observed only at distances approximately equal to or less than the length of the structures parallel to the approaching wave fronts (e.g. Pilarczyk and Zeidler, 1996, p. 154). Thus, for example, a structure that is 100 feet long (parallel to the coastline) and more than 100 feet from the shore would not provide effective shoreline protection.

With full build-out at the proposed site, the submerged sets will interact in complex ways with approaching waves that will depend on the wavelengths and heights of the waves as well as the directions of the approaching wave fronts. However, because the groups of sets will be well separated from each other, their effects on waves will generally be individually exerted and thus effective only for a few hundred feet shoreward. Figure 4.1 shows the reef site with respect to the coastal bathymetry. The bolded 40-foot contour shows where waves that could be affected by the



NOTE: Contours shown in 2 foot intervals.

Prepared For:
HASEKO Hawaii, Inc.

Prepared By:
PLANNING SOLUTIONS

Sources:
-State of Hawaii GIS
-US Navy SHOALS Bathymetry

Legend:

0 0.25 0.5 1
Miles

Figure 4-1:

Coastal Bathymetry

Kalaeloa Artificial Reef Project

Figure 4-1 Coastal Bathymetry 2007-10-04.mxd

reef structures (which will be at least 40 feet deep at all locations) would begin interacting with the coastline.

As shown in this figure, the reef site at its closest point is more than ~~550~~ 950 feet from the 40-foot contour and generally further away. Because of this distance of the reef site from the 40-foot contour and because of the small magnitude of wave attenuation ~~(<2% from any one reef set)~~ to be expected, there would not be a measurable effect on surface waves off the Kalaeloa shoreline.

4.2.2 IMPACTS TO WATER TEMPERATURE

Artificial reefs have the potential to modify the character of the water column by presenting obstacles to seafloor water currents such as tidal currents and storm-induced bottom flows. Generally, this can result in the upwelling of bottom water on the upstream side of the reef structures and consequent modification of surface water temperature and chemistry. Based on the thermal structure indicated by the profiles in Figure 3.6, the water column in this area appears to be generally isothermal, and thus well mixed, to depths of at least 40 meters (130 feet), which is well below the seafloor depths at the proposed reef site. Consequently, any upwelling caused by the reef structures will not change the water temperature substantially.

4.2.3 ALTERNATIVE 2: OTHER MARINE HABITAT ENHANCEMENT

Most of the alternate marine habitat improvement activities that DAR might pursue have the same minimal potential to affect surface waves and water temperature as the proposed action. Because the type, scope, and locations of these activities are as yet undefined, DAR will analyze their impacts separately if and when they are proposed.

4.3 WATER QUALITY IMPACTS

4.3.1 REEF MODULE MANUFACTURE

The artificial reef modules that would be used for the first increment of reef-building at the site have already been manufactured. Consequently, there is no potential for their manufacture to affect water quality. Manufacturing of modules for subsequent increments would occur on paved surfaces, using new or reused clean concrete material that is free of dust. So long as normal best management practices are implemented during their manufacture, the production of these modules does not have the potential to impact water quality significantly.

4.3.2 REEF DEPLOYMENT

The modules are made of clean concrete and will be washed down on land if substantial amounts of dust have accumulated on them. The clean modules will be transported to the site via barge and deployed to the bottom by a front loader operating on the barge. As mentioned, the site is largely devoid of loose sand and bottom sediments. Deployment of the modules does have the potential to stir up what loose sediment is present, but it should settle out quickly once the modules are in place. No toxic substances or pollutants would be discharged as a result of the project.

4.3.3 REEF OPERATION

As discussed in Section 4.2.2 above, the proposed reef would not have noticeable effects on water temperature at either site through upwelling. Similarly, as shown in Figure 3.8, there are no persistent vertical gradients in inorganic nutrients within the depth range of the reef site, so any upwelling caused by the reef structures will not substantially change the water quality of the surface waters at the site nor lead to any significant local changes in primary productivity.

4.3.4 ALTERNATIVE 2: OTHER MARINE HABITAT ENHANCEMENT

Most of the alternate marine habitat improvement activities that DAR could conceivably pursue in the same depth range have the same minimal potential to affect water quality as the proposed action. The exact type, scope, and locations of such alternate activities (should they occur) are as yet undefined. DAR will analyze their impacts separately if and when they are proposed.

4.4 IMPACTS TO MICROCLIMATE & AIR QUALITY

The project does not involve activities that have the potential to alter the region's climate or weather patterns. All of the modules that would be used for the first increment of artificial reef construction have already been manufactured. Consequently, the only emissions that would result from its emplacement are those associated with the tug that would move the barge into position for the emplacement and the operation of the engine powering the small crane or other equipment that would be used to dump the modules into the ocean. The emissions from these internal combustion engines are far too small to have a significant effect on air quality.

Eventually, additional modules will be needed to complete full build-out of the artificial reef. Air emissions will result from the manufacture and emplacement of these modules. The magnitude of the emissions from their placement will be comparable to those associated with the first increment and would, therefore, have the same negligible effects. Manufacture of these additional modules (material production and assembly) will also produce air emissions. In the absence of a known design for these, it is impossible to quantify these, but the limited number that would be manufactured in any one time period and the likelihood that they will utilize a substantial percentage of recycled materials makes it certain that the emissions will not have a significant adverse effect on ambient air quality and will not contribute to a violation of ambient air quality standards.

Similarly, none of the marine habitat enhancement activities that DAR might reasonably be expected to fund under Alternative 2 would have the ability to significantly affect air quality or microclimate.

4.5 SUSCEPTIBILITY TO NATURAL HAZARDS

4.5.1 ALTERNATIVE 1: PROPOSED ACTION

4.5.1.1 Susceptibility to Extreme Oceanographic Conditions

Through years of experimentation, the DAR has developed the "Z Block" artificial reef module for deployment at Hawai'i's artificial reef sites. DAR staff has concluded that this choice represents the most appropriate material and configuration possible with existing technology. In general, deployed "Z" modules have shown little movement in response to storm waves. Modules were in place in the Maunalua Bay Artificial Reef and the Wai'anae Artificial Reef prior to Hurricane Iniki, which struck the Hawaiian Islands in September 1992. These modules, which are in water depths comparable to those of the proposed Kalaeloa Artificial Reef, remained in place despite considerable destruction to coral communities along the western and southern coasts of all the islands by this storm.

If waves were to occur that are larger and more forceful than previously experienced along this shoreline and produced a storm surge of sufficient force to move the blocks, the discrete, interlocking piles of "Z Blocks" might be leveled somewhat, but are unlikely to be transported far from their original position (Grace 1991). Isolated modules could end up in a variety of different orientations, and piled configurations of blocks could be rearranged to more stable configurations. Because the reef site lies at the base of a relatively steep submarine slope (see Figure 3.1) there is no possibility that the reef structural components would be transported a significant distance toward the shoreline.

4.5.1.2 Susceptibility to Change in Water Depth or Temperature

Water level changes over time. At present, higher global temperatures are depleting polar ice, and this is raising water levels, a process that marginally increases the depth of coralline communities, making less sunlight available for their normal development. The gradual subsidence of the Hawaiian Islands also contributes to this process. In the past, long periods of glaciation have lowered water levels, thereby reducing water depths. Whether rising or falling, changes in sea level occur so slowly that they are not a significant consideration in siting or designing structures at the depth of the proposed Kalaeloa Artificial Reef.

Rising ocean water temperatures can have a negative impact on coral communities such as those expected to colonize the Kalaeloa Artificial Reef. The artificial reef itself does not exhibit temperature sensitivities as a living coral would, however the species colonizing it may. Because of the water depth and the absence of a persistent thermocline at the proposed artificial reef site, sea level rise does not have the potential to create temperature changes that would substantially affect faunal successions at the artificial reef site.

4.5.1.3 Susceptibility to Seismic Damage

As with any artificial or natural structure, artificial reefs are potentially vulnerable to extreme seismic activity which could displace or bury the modules. The fact that the Kalaeloa Artificial Reef would be constructed in an area that is classified as Seismic Zone 1A together with the relatively gentle slope of the bottom means that the probability of collapse is small and the potential for a collapse (were one to occur) causing substantial damage to adjoining areas is small. In any case, the existence of the modules would not add to the danger to marine ecosystems, life, or property.

4.5.2 ALTERNATIVE 2: OTHER MARINE HABITAT ENHANCEMENT

If comparable additional artificial reef habitat were added to the Wai‘anae Artificial Reef, the susceptibility to natural hazards would be similar to those described for Alternative 1. While other activities that DAR might fund to enhance marine habitat could have varying degrees of sensitivity to natural hazards, it is unlikely that any would significantly add to the danger of natural hazards in the project area.

4.6 IMPACTS TO MARINE BIOTA

4.6.1 GENERAL IMPACTS OF ARTIFICIAL REEFS ON MARINE BIOTA

Artificial reefs are attempts to replicate naturally productive habitats in relatively unproductive locations. The use of artificial reefs is predicated on the premise that their deployment leads to an increase in the amount of available productive habitat and ultimately to an increase in fish stocks and benthic communities. Some debate has arisen around whether artificial reefs actually do enhance the production of fisheries, or whether they simply serve to aggregate existing fish stocks from surrounding areas.

The scientific literature suggests that aggregation does occur during the early stages of artificial reef development. For example, a number of studies have demonstrated or hypothesized that reefs are initially colonized by transient or opportunistic species that move in from elsewhere (Bohnsack 1989, Brock and Norris 1989, Brock 1995). In these early stages the reef primarily provides shelter; the newly resident fish must forage in surrounding areas until the reef is colonized by corals and other species. During this phase of succession the total biomass supported does not necessarily increase.

However, studies support the view that over time artificial reefs enhance productivity in addition to providing foraging ground for visiting species. For example, Barnett et al. (1991) examined feeding habits, prey abundance, and fish biomass both on an artificial reef deployed 14 years earlier in Southern California waters and surrounding habitat. He found that food availability was 100 times

greater on the artificial reef than elsewhere. Tagging studies showed that fishes resident to the reef showed high site fidelity. Production of fish on the artificial reef was estimated to be 6.5 times greater than the production of fish on the surrounding sand flats.

Finally, the fact that an artificial reef can take years to fully mature does not mean that prior to that time it only aggregates fish and does not contribute to the overall productivity of the area. The deployment of an artificial reef provides new shelter in an area of low cover, allowing immigrant adult fish to more fully exploit food resources in the area surrounding the reef. The immigration of these fishes from areas removed from the artificial reef allows other fish to take up residence in the previously vacated sites, thereby increasing the overall carrying capacity of the local environment. In other words, where a scarcity of appropriate shelter rather than a scarcity food resources is limiting (as it may be for many Hawaiian reef fish communities), the addition of shelter in the form of reefs will increase the productivity of an area.

In summary, there is good circumstantial evidence to suggest that, if properly sited, artificial reefs do enhance local fishery stocks. This enhancement initially occurs because these systems are probably shelter limited rather than food limited. With time and the further development of benthic communities, the deployed reef surfaces will contribute a greater proportion of the forage for resident fishes, thus truly enhancing fishery resources. The following section describes the anticipated impacts of the proposed Kalaeloa artificial reef.

4.6.2 POTENTIAL EFFECTS OF THE PROPOSED ACTION ON MARINE BIOTA

4.6.2.1 Fish and Macroinvertebrate Populations

If allowed to occur, a program developing and deploying designed artificial reefs offshore of Kalaeloa will lead to substantial local increases in the abundance and diversity of fishes. Once established, this locus of high fish concentration will serve as a point source for the production and recruitment of larvae and/or immigration of adults to other locales, thus increasing the biological diversity and abundance over an area considerably larger than just the reef itself.

The proposed reef would attract a number of benthic dwelling fish species. These will likely include squirrel fishes or ala‘ihis (Family Holocentridae), bigeyes or aweoweos (Family Priacanthidae), goatfishes (Family Mullidae), surgeonfishes (Family Acanthuridae), parrotfishes or uhus (Family Scaridae), scorpionfishes or nohus (Family Scorpaenidae), snappers (Family Lutjanidae), moray eels or puhis (Family Muraenidae), cardinalfishes or ‘upapalus (Family Apogonidae), butterfly fishes or kikakapus (Family Chaetodonidae), damselfishes (Family Pomacentridae), wrasses or hinaleas (Family Labridae) and triggerfishes or humuhumus (Family Balistidae). The reef would also provide appropriate stable substratum for the recruitment and growth of corals and other benthos (see Section 4.6.2.2). As these benthic communities develop and proceed through succession, they may serve as forage or forage sites for fish resident to the reef, thereby enhancing the diversity of food webs utilized by some fish species.

Because the proposed Kalaeloa Artificial Reef is intended for public use, control over the level of fishing effort will be limited. To reduce the effectiveness of nets in a reef set (which would apportion more of the resources to a greater number of non-net fishermen), reef sets will be deployed within visual contact of one another, but at least 50-100 feet apart. By allowing fish to move easily among the sets of a group, the design prevents the entire reef from being netted at once.

4.6.2.2 Corals

As discussed in Section 3.6.1, less than five percent of the proposed artificial reef site contains scattered corals. These areas (as well as the transitional ecotone between the two biotopes) will be avoided during deployment of the artificial reef. The remaining 90-95% of the site, where the artificial reef units will be deployed, is within the biotope of deep featureless limestone. Assuming an

average of 0.3% coral coverage in that area, approximately 1428,000 square feet (0.63 acre) of live coral is present on the portion of the artificial reef site on which the reef modules would be deployed.

The deployment of reef modules will impact the isolated coral organisms found on the featureless limestone on which they will be placed. The first increment of deployment will only occupy about 8,000 square feet of seafloor. Even at the preliminary full build-out scenario described in Section 2.2.3, the reef would have a footprint of only about 22 14 acres (roughly 1011% of the total site area). If coral were evenly distributed across the site, full build-out would incur a loss of about 2,8001,500 square feet of coral (Brock 2006). The loss will actually be less because coral patches are not evenly distributed and will be avoided whenever possible during reef deployment.

Ultimately, creation of the Kalaeloa artificial reef is expected to result in a significant increase of coral coverage at the site. The reef sets are designed to rise approximately 10-20 feet above the ocean bottom, thus providing a substrate for corals that will not be affected by occasional scouring of bottom sediments due to wave action. Based on observations of coral growth on the Honouliuli WWTP sewage discharge pipe since it was deployed around 1980, Brock (2006) estimates that corals will be able to colonize all but the bottom meter of artificial reef substrate, which would remain subject to scouring.

Assuming that the individual artificial reef sets form a cone shape 20 feet in height and 100 feet in diameter and that the bottom meter would be devoid of coral due to wave scour, each reef set would provide about 8,000 feet^2 of surface area for new corals to colonize. All together, the 125 70 sets anticipated at full build-out would provide 1,002,397560,000 square feet (about 213 acres) of colonizable substrate.[16] If the mean coral coverage on the WWTP discharge pipe (29%) is representative of the coral community that would form on the "Z" blocks elevated more than a meter off the substratum, there would be about 290,700163,000 square feet of live coral present on the site after twenty or so years, a 993% increase in coral coverage over the present condition. This estimated increase is low because it does not take into account the increased surface area caused by the individual "Z" blocks but just assumes a simple conical surface (Brock 2006, see Appendix C).

4.6.2.3 Marine Species of Concern

The proposed artificial reef will either be inconsequential or beneficial to the marine species of concern discussed in Section 3.6.3. It is unlikely that green sea turtles would frequent the new reef site since they primarily forage in nearshore limu communities. Hawksbill turtles, though very rare and not likely to be present, could benefit from the new foraging habitat once sponges have become established on the artificial reef substrate. The hawksbill's highly specific diet and its dependence on filter-feeding, hard-bottom communities make it vulnerable to deteriorating conditions on coral reefs and so the addition of new habitat is generally advantageous to the species.

Humpback whales are rarely seen in the waters near the site and the reef does not have the potential to affect the whales' feeding patterns or movement. Hawaiian Monk Seals do prey upon several of the species expected to colonize the reef. Hence, any that do pass through the area may benefit from the increase in forage.

4.6.3 POTENTIAL IMPACTS OF ALTERNATIVE 2 ON MARINE BIOTA

Adding artificial reef habitat to an existing artificial reef would have tangible benefits to marine habitat, although the magnitude of those benefits is uncertain. At present, the size of the additional habitat remains unknown. In all likelihood, the benefits to marine habitat would be somewhat less than those associated with the proposed action, because this option would simply add incrementally to existing habitat rather than creating habitat where none presently exists. While the effects of other activities DAR might choose to fund cannot be ascertained at this time, they would be geared toward enhancing marine habitat in a way that would benefit both marine life and recreational fishing.

[16] The total surface area of the sets is slightly greater than the bottom area that they cover because of their sloping sides.

4.7 IMPACTS TO RECREATION AND TOURISM

4.7.1 OPPORTUNITIES FOR RECREATION AND TOURISM

Recreational use of the proposed artificial reef site is expected to diversify and intensify once the reef is deployed. It will likely become a known point of interest among divers and fishermen, as well as a potential site for research and educational activities. The following sections introduce the types of recreational uses DAR anticipates will occur at the proposed reef and discuss their potential impacts on the reef and on recreational opportunities in Hawai‘i. William Aila, the Harbor Master of the DLNR Division of Boating and Outdoor Recreation’s (DOBOR’s) Wai‘anae Boat Harbor, provided information on the existing range of recreational activities at the Wai‘anae artificial reef, which helped to inform this discussion. Economic impacts of these various uses are discussed in Section 4.10, and impacts on public facilities and navigation are discussed in Section 4.12.

4.7.1.1 Recreational Fishing

As mentioned in Section 1.2, recreational fishing accounts for a significant portion of Hawai‘i’s inshore fishery harvest. Recreational fishermen employ a variety of techniques, including line fishing, spear fishing, and netting. All of these techniques are expected to be used by fishermen at the proposed reef site. Approximately half of the users of the Wai‘anae artificial reef are recreational fishermen. It is estimated that, on a weekly basis, the reef is visited by one to two spearfishing boats, two to three daytime line-fishing boats, and six to eight nighttime line-fishing boats (William Aila, pers. comm.). Each boat averages about four passengers. The reef is also utilized for commercial fishing. DOBOR estimates that one commercial fishing vessel visits the reef every two weeks.

The Kalaeloa Artificial Reef will likely experience similar or somewhat higher levels and types of use, although fishermen may represent a higher percentage of users at the proposed reef (William Aila, pers. comm.).

The proposed artificial reef is intended to help ameliorate the pressure on fish stocks while maintaining opportunities for recreational fishing. As discussed in detail in Section 4.6, the reef is expected to boost fish, macroinvertebrate, and coral populations over time, and it is designed to minimize the vulnerability of the resident fish to unsustainable harvest. The data presented in that Section suggest that the deployment of the proposed artificial reef would improve fishing opportunities in an area where few such opportunities exist today while also contributing to the maintenance of viable populations of reef-dependent species. Carl Jellings, a knowledgeable fisherman and resident of ‘Ewa Beach consulted as part of this impact analysis, confirmed that the area containing the proposed reef site is well away from valued fishing locales and would not be perceived by local fishermen as negatively impacting existing fishing activities.

4.7.1.2 Recreational Diving

In addition to recreational fishing, the proposed artificial reef is also expected to attract SCUBA divers. William Aila estimates that five commercial diving boats (each with about 18 passengers) currently visit the Wai‘anae artificial reef daily during the week. That number increases to 7 or 8 boats per day on weekends. However, the Wai‘anae artificial reef is of particular interest to commercial tours because it consists of a sunken ship. The proposed Kalaeloa Artificial Reef, which will be made of Z-Blocks, is unlikely to experience as high a volume of commercial diver traffic, although it will certainly be an attraction for local divers and possibly some tours. SCUBA divers (excluding spear fishermen, which are considered under recreational fishing) typically do not significantly impact the marine communities present. The new reef will present divers with an additional location for viewing and studying fish and thus will significantly benefit this user group.

4.7.1.3 Competition Between Recreational User Groups

In summary, the proposed reef will attract some fishermen and some divers, although probably more of the former. It may lessen some of the existing traffic at the Waiʻanae artificial reef, but overall it is not expected to be as much of a tour attraction as the Waiʻanae due to the Z-block construction and the presence of stronger winds and rougher waters. It will, however, provide a convenient destination for users of the future Ocean Pointe Marina, which may add to the site's popularity. Recreational users may occasionally compete for space while only the first reef increment is in place. However at full build-out the reef will be spread out over an area with more than adequate space for all user groups.

4.7.2 PUBLIC SHORELINE ACCESS

The proposed artificial reef project will in no way hinder public access to the shoreline. Recreational and touring vessels visiting the site would originate from various ports and boat launch ramps around the island, although it will be most convenient to users of the Ocean Pointe Marina and associated public boat launches. It is unlikely that the reef will create such an attraction as to place noticeable pressure on public access to particular boat launches or shoreline areas.

4.7.3 SAFETY OF RECREATIONAL USERS

Some concern has surfaced over the possibility that artificial reefs could attract major reef predators, sharks in particular, that could prove a threat to recreational users. There are few data to support this hypothesis (DLNR 1994). As discussed above, it is known that artificial reefs attract fish. Aggregations of fish will, in turn, frequently attract predators, including sharks. This behavioral trait is well known and capitalized on by trap fishermen, for example, who frequently use half a coconut or an aluminum pie-plate hung in a trap to attract the first few fish, which, in turn, attract others. This does not appear to have led to problems for recreational users, however.

According to records kept in the International Shark Attack File maintained by the Florida Museum of Natural History (http://www.flmnh.ufl.edu/fish/sharks/statistics/GAttack/mapHawaii.htm), there were a total of 104 shark confirmed unprovoked shark attacks in Hawaiʻi between 1882 and 2005. Of the 29 that occurred off Oʻahu, six were fatal, the most recent in 1992. This is consistent with data compiled by George Balazs of the National Marine Fisheries Service (NMFS), who also maintains a database of reported shark encounters and their general locations. None of the shark attacks in these databases occurred on or immediately around any of the Hawaiian artificial reefs.

Brock (2006) reviewed the fish transect data he had collected for the last 40 years and determined that there had been a number of shark sightings over natural substratum but never around an artificial reef. Brock also spent more than 300 man-hours underwater deploying, constructing and monitoring the Maunalua Bay artificial reef from 1985-1989 without a single shark sighting (see Appendix C). Similarly, more than 60 hours spent inspecting fish populations on the Waikīkī artificial reef did not result in any shark sightings. Two oceanic black-tip sharks (*Carcharhinus limbatus*) were once reported around Atlantis' Waikīkī artificial reef by submarine operators; however this shark species is not typically a threat to humans.

None of these data suggest that artificial reefs attract a disproportionate number of sharks. Nonetheless, the presence of sharks around an artificial reef site, as with almost any recreational ocean site, remains a possibility.

4.7.4 ALTERNATIVE 2: OTHER MARINE HABITAT ENHANCEMENT

Adding to an existing artificial reef would not create new opportunities or locales for recreation and tourism. However, an addition to the Waiʻanae Artificial Reef might relieve some of the competition between recreational users at that location by providing a larger area where users can spread out. It should not affect shoreline access, although it may slightly increase the number of users at existing

boat ramps, particularly on the Wai‘anae Coast. Any other activity that DAR undertakes will be intended to benefit recreational users and will be defined with their cooperation. The precise form that benefit would take is yet undetermined.

4.8 NOISE IMPACTS

The proposed reef site is well offshore and away from noise-sensitive areas. Moreover, the project does not involve activities with the potential to create a significant noise source. The vessels transporting the reef modules will have motors, as will the equipment used to place the Z Blocks on the ocean bottom, but these will be no noisier than the motors of other oceangoing vessels using the area.

Once the blocks are installed the artificial reef itself will not be a noise source. Boat traffic in the area is likely to increase as the artificial reef becomes an attraction for divers and researchers, but the site is too far away from shore for the noise from recreational vessels to be disruptive or exceed noise limitations. There is no evidence that underwater noise resulting from the type and intensity of vessel traffic likely to result from installation of the proposed Kalaeloa Artificial Reef would adversely affect marine biota.

The alternative of adding habitat to the Wai‘anae Artificial Reef or investing in other marine habitat enhancement off leeward O‘ahu is unlikely to involve significant noise other than that associated with recreational vessels. This will be confirmed at the time the activity is permitted.

4.9 IMPACTS TO ARCHAEOLOGICAL, HISTORIC, AND CULTURAL RESOURCES

4.9.1 ALTERNATIVE 1: PROPOSED ACTION

There are no known shipwrecks or other archaeological remains at the proposed reef site, and none are likely to be found. As noted above, a high resolution side-scan sonar survey of the area including more than ~~three-quarters~~70% (~~175~~ 87 of ~~224~~108 acres) of the proposed artificial reef site indicates that, consistent with the SHOALS bathymetric data, ~~almost~~ all of the site ~~i~~appears~~s~~ smooth and featureless. Only~~, with only~~ one possible feature that may have some significant vertical relief was detected, and it is outside the area planned for artificial reef development (see Figure 3.10). Site-specific diving surveys of all areas selected for deployment of reef-building structures will be conducted before the structures are installed, ensuring that if any significant archaeological features were missed by the previous surveys, they will be identified before any work is undertaken. This will allow them to be excluded from future artificial reef deployment. Should any archaeological or historical evidence be encountered at the site, SHPD will be notified immediately.

Dunn and Haun (1991) and Franklin et al.’s (1995) extensive historical and cultural background research found no practices or beliefs associated with the area that would be affected by fishing and other activities directly related to the proposed project. At the same time, they, and other studies, do confirm that ocean resources were important to the prehistoric and modern Hawaiians who use them.

In view of the foregoing, the only manner in which the proposed reef could adversely affect traditional cultural uses and resources would by affecting the nearshore environment in such a way as to reduce its value or suitability for harvesting coastal resources. As outlined in Section 4.6 above, it is possible that the reef may initially attract some fish from nearshore areas utilized by fisherman and gathering of marine resources, as well as from nearby offshore reefs. However, because this incremental addition will be balanced by the fish migration brought about by the equivalent reduction in reef habitat resulting from construction of the entrance channel to the Ocean Pointe Marina, there is likely to be little net change in this regard. The small size of the proposed first reef increment will also keep this type of change from becoming significant. Over time, of course, the reef is expected to enhance fishery stocks. Based on this and the lack of indication that the site is valued for traditional

cultural uses, establishment of an artificial reef there is not expected to impact cultural resources or practices negatively.

4.9.2 ALTERNATIVE 2: OTHER MARINE HABITAT ENHANCEMENT

If this Alternative is selected, DAR would conduct surveys as needed to determine that no cultural or archaeological resources would be impacted by emplacing additional habitat at the Waiʻanae Artificial Reef or by conducting any other activities offshore of leeward Oʻahu.

4.10 SOCIOECONOMIC IMPACTS

4.10.1 ALTERNATIVE 1: PROPOSED ACTION

The economic sector that will be most affected by the project is recreational fisheries. As discussed in Section 4.6, the newly deployed reef will initially be colonized by transient fish from elsewhere in the region. However, the proposed artificial reef is not expected to have a negative impact on existing fishing sites for the following reasons:

- The first reef increment is small and cannot support a large resident community initially. Hence, its ability to draw fish away from existing sites will be limited. By the time subsequent increments are installed, the fish populations in and around earlier increments are likely to have grown to the point where they are the major source of recruitment.
- Shelter is thought to be the main factor limiting the populations that can be supported by existing habitats. Hence, once fish migrate to a new area of shelter any vacancies at the original habitat site should fill quickly as a result of natural reproduction. This will maintain their productivity and usefulness.
- Many of the fish that will colonize the reef are likely to be transient individuals to begin with and will likely not have been regularly present at any one fishing site (see Appendix C).
- The site is well away from existing valued fishing locales. Hence, its ability to attract fish that are important to existing fishing grounds is limited.

Overall, the economic effect on recreational fisheries is expected to be beneficial. Small gains may also result for the tourism industry. While the site is less likely to be utilized by commercial diving tours and charters than, say, a sunken ship, it may benefit those industries by reducing user pressure on the most popular dive sites.

4.10.2 ALTERNATIVE 2: OTHER MARINE HABITAT ENHANCEMENT

The socioeconomic effects of the proposed action are minor, and any impacts associated with Alternative 2 would be as well. The benefits of adding to an existing reef would be incremental; this alternative would not create an entirely new venue for fishermen or marine life to utilize. Other activities may also have socioeconomic benefits, but their nature and scale is unknown.

4.11 IMPACTS ON SCENIC & AESTHETIC RESOURCES

For the most part, the proposed artificial reef will not be visible from the surface. It is possible that the sets that are placed in the shallowest part of the designated area may be visible from boats passing over them during periods of high sun angle (i.e., near noon), calm seas, and particularly low turbidity. Even then, however, the effect is more likely to be one of shading than it is to be a clear view of the sets.

As discussed above in Section 4.1, the reef will change the bathymetry and thus will affect underwater views. It is expected to enhance scenic and aesthetic qualities of the seascape by hosting corals, colorful reef-dwelling fish and other organisms.

4.12 IMPACTS TO PUBLIC FACILITIES & NAVIGATION

4.12.1 ALTERNATIVE 1: PROPOSED ACTION

The proposed artificial reef will provide a recreational venue near the Ocean Pointe Marina. To the extent that it keeps boats operating out of the marina from traveling farther afield, siting an artificial reef at the proposed site will tend to slightly reduce the number of interactions between recreational boaters and large vessels using the offshore tanker unloading facilities and Kalaeloa Harbor. Chevron has confirmed that, because the artificial reef area is entirely outside of the designated tanker unloading area (33 CFR 165.1407), the proposed reef will not conflict with its offshore operations. In general, while the reef may draw more users to the public boat launches at Ocean Pointe Marina, it may simultaneously reduce the traffic at other boat launches on the island, and therefore the cumulative effect is expected to be minimal. No public facilities exist offshore near the artificial reef site.

4.12.2 ALTERNATIVE 2: OTHER MARINE HABITAT ENHANCEMENT

Adding habitat to the Wai‘anae Artificial Reef would not generate boat traffic in currently unused areas, however it may slightly increase use of the reef site and of the boat launches near it. Barring a nearby venue for fishing and diving, users of the Ocean Pointe Marina may also be more apt to travel to the reef. Doing so would require them to cross the route of the oil tankers to and from the offshore unloading facility. Any impacts to public facilities and navigation from other types of activities would have to be evaluated once they are better defined.

4.13 IMPACTS TO LAND USE AND OWNERSHIP

The offshore area containing the proposed reef site is under the jurisdiction and ownership of the State of Hawai‘i, and will remain so regardless of whether or not the proposed Kalaeloa Artificial Reef project is implemented. The use of the designated area would evolve, with both biological and human activity becoming more intense. As shown in Figure 2.1, there are many offshore uses in the area off Kalaeloa, and DAR consulted representatives of these user groups during preparation of the EIS to identify any concerns and ensure that the proposed reef would be compatible with them. A summary of the concerns presented by each offshore stakeholder consulted is included as Appendix D. As discussed below, to the best of DAR’s knowledge, these have been addressed satisfactorily in the boundaries and design that are now proposed.

At the proposed site itself, the main consideration is the existence of a military underwater installation (33 CFR 334.1400) which encompasses the entire area that is proposed for the artificial reef. Anchoring and other activities which could damage underwater installations are restricted within the area. The Navy has confirmed that an artificial reef at the proposed site would be compatible with Navy operations and facilities, insofar as certain measures are taken to protect underwater installations (i.e., requiring boats to moor to buoys rather than drop anchor on the seafloor, siting reef modules away from installations in a way that minimizes the risk of damage).

In general, most of the concerns presented by offshore stakeholder related to placing an artificial reef east of the Honouliuli WWTP outfall, as discussed in Section 2.5.2.2. The general area containing the proposed site was favored by all offshore stakeholders with the exception of Chevron, which was initially concerned about potential conflicts between recreational vessels utilizing the reef and oil tanker navigational routes. After looking into the matter, Chevron adopted the official position that, so long as the site is outside of the designated tanker unloading area, use of the reef should not interfere with Chevron’s operations. With the input obtained from these stakeholders, DAR delineated the proposed site in the area to the west of the WWTP outfall.

5.0 NO ACTION ALTERNATIVE

"No Action" consists of: 1) failure to obtain the necessary permits for the establishment of a reef site off Kalaeloa or a decision on the part of DAR not to establish the proposed artificial reef, and 2) DAR electing not to apply the funds dedicated by HASEKO to an activity that would benefit marine life off O'ahu's leeward coast. Because "No Action" would not meet the objectives of the proposed project, DAR does not consider it a feasible alternative for the purpose of Chapter 343. It is analyzed in this EIS solely to fulfill the procedural requirements of HRS Chapter 343.

5.1 POTENTIAL IMPACTS OF THE NO ACTION ALTERNATIVE

5.1.1 MEMORANDUM OF AGREEMENT

If DAR did not establish the proposed artificial reef and also failed to apply the $150,000 that HASEKO has dedicated toward the first reef increment toward an activity to benefit marine life off leeward O'ahu, DAR would not fulfill the obligations it assumed in 2004 when it signed the agreement with HASEKO and the Department of the Army. This would be inconsistent with DAR's interest in mitigating the habitat that will be lost as a result of the marina channel excavation.

5.1.2 WASTED EFFORT

The No Action alternative would reverse the progress that has been made toward building a consensus about artificial reef development along the 'Ewa shoreline. While some of the scientific information concerning the marine resources along this stretch of shoreline that has been collected and analyzed would remain valuable, DAR would be forced to return to near the beginning with respect the approvals it needs to create additional aquatic habitat in this area.

5.1.3 LOSS OF MARINE HABITAT OFF O'AHU'S LEEWARD COAST

No Action would preclude any benefits to marine communities off O'ahu's leeward coast. In fact, there would be a net loss in marine habitat there due to the construction of the Ocean Pointe Marina channel. No Action precludes the mitigation of that loss for any marine life or recreational users that currently use the area, and it fails to improve on the habitat and recreational value of the Kalaeloa area.

6.0 RELATIONSHIP TO RELEVANT PLANS, POLICIES, & CONTROLS

This chapter discusses the compliance and compatibility of the proposed artificial reef with pertinent plans, policies, and regulations at county, state, and federal levels.

6.1 CITY AND COUNTY OF HONOLULU

The proposed artificial reef site is seaward of the certified shoreline and is therefore outside of the jurisdiction of the City and County of Honolulu. The only land-based activity involved in the project is the transportation of the pre-fabricated modules from the manufacturer to Honolulu Harbor, where they will be loaded onto barges. Thus, the project does not require any City-administered permits or approvals. The project does, however, relate to several of the goals and objectives set forth in the City and County's regional and islandwide planning documents. The project is discussed in the context of each of the relevant documents in the following sections.

6.1.1 O'AHU GENERAL PLAN

The proposed artificial reef is relevant to two key objectives outlined in the O'ahu General Plan. Each of these objectives and the relevant policies are listed below, followed by a discussion of the project's relationship to them.

> *II. Economic Activity, Objective D: To make full use of the economic resources of the sea.*
>
> *Policy 1: Assist the fishing industry to maintain its viability.*
>
> *Policy 2: Encourage the development of aquaculture, ocean research, and other ocean- related industries.*

Discussion: The proposed artificial reef will support the fishing industry by providing a new fishing locale and enhancing fish stocks to improve the sustainability of the resource. The artificial reef may also be used for research and educational purposes.

> *X. Culture and Recreation, Objective D: To provide a wide range of recreational facilities and services that are readily available to all residents of Oahu.*
>
> *Policy 8: Encourage ocean and water-oriented recreation activities that do not adversely impact on the natural environment.*
>
> *Policy 13: Encourage the safe use of Oahu's ocean environments.*

Discussion: The reef will be accessible to the public for recreational uses such as fishing and diving. The reef is configured to increase fish habitat and productivity while also preventing over-harvest, as described in Section 4.6. Overall, the reef will contribute to the sustainability of recreational fishing in Hawai'i.

6.2 STATE OF HAWAI'I LAWS AND REGULATIONS

6.2.1 HAWAI'I STATE PLANNING ACT

The Hawai'i State Planning Act (Chapter 226, Hawai'i Revised Statutes, as amended) outlines themes, goals, guidelines, and policies for statewide planning. The proposed artificial reef relates to the following objectives stated in §226-11: "*Objectives and policies for the physical environment--land-based, shoreline, and marine resources*":

(1) Exercise an overall conservation ethic in the use of Hawaii's natural resources.

(3) Take into account the physical attributes of areas when planning and designing activities and facilities.

(4) Manage natural resources and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage.

(8) Pursue compatible relationships among activities, facilities, and natural resources.

(9) Promote increased accessibility and prudent use of inland and shoreline areas for public recreational, educational, and scientific purposes. [L 1978, c 100, pt of §2; am L 1986, c 276, §10]

The proposed artificial reef is intended to conserve and enhance existing fish stocks and coral reef habitat for biological, recreational, and educational purposes. The reef is designed to increase the habitat and recreational value of an area relatively lacking in those qualities and to support multiple recreational uses without significant risk of fishery or reef depletion. Thus, it is consistent with the above objectives.

6.2.2 STATE LAND USE LAWS

The Board of Land and Natural Resources (BLNR) regulates uses of the State Conservation District by issuing Conservation District Use Permits for approved activities. DAR will submit a Conservation District Use Application (CDUA) to the DLNR Office of Conservation and Coastal Lands (OCCL) for approval. The criteria that the OCCL will use in evaluating the project are outlined in Hawai‘i Administrative Rules §13-5-30. Each criterion is listed below, followed by a discussion of how the proposed artificial reef project complies with it.

(1) The proposed land use is consistent with the purpose of the conservation district;

Discussion: The purpose of the Conservation District is to conserve, protect, and preserve the important natural resources of the State through appropriate management and use to promote their long-term sustainability and the public’s health, safety, and welfare (HAR §13-5-1). As discussed throughout this EIS, the artificial reef project is expected to improve public recreation and educational opportunities, enhance fish stocks, and create habitat for corals and many other reef-dependent organisms. Thus, it is in keeping with the purpose of the Conservation District.

(2) The proposed land use is consistent with the objectives of the subzone of the land on which the use will occur;

Discussion: The proposed reef site is in the Resource (R) subzone of the Conservation District. The objective of this subzone is to develop, with proper management, areas to ensure sustained use of the natural resources of those areas (HAR §13-5-13(a)). The proposed artificial reef is identified as a permitted land use in the Resource subzone, provided that a Board permit is obtained. DAR is seeking a Board permit pursuant to this requirement.

(3) The proposed land use complies with provisions and guidelines contained in chapter 205A, HRS, entitled "Coastal Zone Management," where applicable;

Discussion: The discussion in Section 6.3.4 below confirms the consistency of the project with the Coastal Zone Management Act and the objectives outlined in Chapter 205A, HRS.

(4) The proposed land use will not cause substantial adverse impact to existing natural resources within the surrounding area, community or region;

Discussion: The proposed artificial reef will initially recruit transient fish from existing habitats, some of which may be utilized by local fishermen. As discussed in Section 4.6, any migration to the

newly deployed reef, if noticeable, would quickly be countered by the increased production of fish stocks that is anticipated to occur at the vacated sites and at the new reef site. Moreover, fish migrating away from the disturbed entrance channel would also replenish stocks in areas affected by out-migration.

(5) The proposed land use, including buildings, structures and facilities, shall be compatible with the locality and surrounding areas, appropriate to the physical conditions and capabilities of the specific parcel or parcels;

Discussion: The proposed reef project does not involve any aboveground structures. As discussed in the siting study included as Appendix C, the substratum and topography of the proposed reef site has been shown to be ideal for the intended use.

(6) The existing physical and environmental aspects of the land, such as natural beauty and open space characteristics, will be preserved or improved upon, whichever is applicable;

Discussion: The existing underwater landscape at the proposed reef site is relatively flat and devoid of marine life. The proposed reef will add structural relief and will attract a diversity of fish and marine organisms. It is expected to increase the aesthetic value of the reef site.

(7) Subdivision of land will not be utilized to increase the intensity of land uses in the conservation district;

Discussion: No property subdivision is needed for the proposed project.

(8) The proposed land use will not be materially detrimental to the public health, safety and welfare.

Discussion: The proposed reef does not produce emissions or waste that could prove detrimental to public health. All offshore uses have inherent safety risks to users (e.g., inclement weather, rough seas, potentially dangerous marine life). However, as discussed in Section 4.7.3, there is no indication that the artificial reef would disproportionately attract predators such as sharks. Thus, the reef will not create a significant hazard to public safety and welfare.

6.3 FEDERAL ACTS AND LEGISLATION

6.3.1 ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACTS

As documented in Section 3.9, DAR has complied fully with the provisions of the Archaeological and Historic Preservation Act (16 U.S.C. § 469a-1) and the National Historic Preservation Act (16 U.S.C. § 470(f)).

6.3.2 CLEAN AIR ACT (42 U.S.C. § 7506(C))

As discussed in Section 3.5, the artificial reef modules are pre-fabricated, and once installed, the reef will produce no emissions. The only emissions associated with the project would be during the operation of the barges and equipment that transports the modules to the site and deploys them to the ocean bottom.

6.3.3 CLEAN WATER ACT SECTION 401 (33 U.S.C. §1341)

This Act states:

Any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into

the navigable waters, shall provide the licensing or permitting agency a certification from the State…

The deployment of the artificial reef constitutes a discharge into navigable waters, and thus falls under Section 401 jurisdiction. DAR has a blanket Section 401 Water Quality Certification in place for its artificial reef program and plans to seek coverage under that permit for this project.

6.3.4 COASTAL ZONE MANAGEMENT ACT (16 U.S.C. § 1456(C) (1))

Enacted as Chapter 205A, HRS, the Hawai'i Coastal Zone Management (CZM) Program was promulgated in 1977 in response to the Federal Coastal Zone Management Act of 1972. The CZM area encompasses the entire state, including all marine waters seaward to the extent of the state's police power and management authority, as well as the 12-mile U.S. territorial sea and all archipelagic waters.

6.3.4.1 Recreational Resources

Objective: *Provide coastal recreational opportunities accessible to the public.*

Policies:

1. *Improve coordination and funding of coastal recreational planning and management; and*
2. *Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:*
    a. *Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;*
    b. *Requiring replacement of coastal resources having significant recreational value including, but not limited to, surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;*
    c. *Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;*
    d. *Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;*
    e. *Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;*
    f. *Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;*
    g. *Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and*
    h. *Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and county authorities; and crediting such dedication against the requirements of section 46-6.*

Discussion: One of the proposed artificial reef's intended purposes is as a coastal recreational resource. It will be open to the public and is expected to draw several types of recreational users, as well as potentially providing a site for education and research.

6.3.4.2 Historic Resources

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

Policies:

1. *Identify and analyze significant archaeological resources;*
2. *Maximize information retention through preservation of remains and artifacts or salvage operations; and*
3. *Support state goals for protection, restoration, interpretation, and display of historic resources.*

Discussion: No shipwrecks or other historic or archaeological resources are known or likely to exist at the site. Surveyors will revisit the site to determine an appropriate location for deployment of the first increment, and if they encounter any features they will notify the SHPD and will not damage any such resources as a consequence of artificial reef installation.

6.3.4.3 Scenic and Open Space Resources

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

Policies:

1. *Identify valued scenic resources in the coastal zone management area;*
2. *Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;*
3. *Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and*
4. *Encourage those developments that are not coastal dependent to locate in inland areas.*

Discussion: The project site is underwater more than a mile from the coastline and will not affect views, access, or natural landforms there.

6.3.4.4 Coastal Ecosystems

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

Policies:

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

5. *Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.*

Discussion: The initial marine surveys noted very little existing coral at the site. As discussed in Section 4.6, any small coral patches will be identified and avoided to the greatest extent possible during deployment of the reef. It is estimated that if any coral is lost, it will be mitigated many times over by the new growth that is expected to occur on the artificial reef substrate.

6.3.4.5 Economic Uses

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

Policies:

1. *Concentrate coastal dependent development in appropriate areas;*
2. *Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and*
3. *Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:*
    a. *Use of presently designated locations is not feasible;*
    b. *Adverse environmental effects are minimized; and*
    c. *The development is important to the State's economy.*

Discussion: The proposed artificial reef site was chosen because it meets DAR's and other agencies' suitability criteria, which take into consideration environmental, social, and visual impacts. The reef site will not damage valuable existing marine communities, interfere with navigation, or detract from economic and social well-being.

6.3.4.6 Coastal Hazards

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

Policies:

1. *Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards;*
2. *Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards;*
3. *Ensure that developments comply with requirements of the Federal Flood Insurance Program; and*
4. *Prevent coastal flooding from inland projects.*

Discussion: The proposed reef site is more than a mile offshore and has no potential to affect life or property on land. Its presence will not increase the danger inherent in storm waves or tsunami; at most, the Z blocks may shift slightly with a wave of sufficient force. They are not expected to travel long distances, even during very heavy storms (see Section 4.5.1).

6.3.4.7 Managing Development

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

Policies:

1. *Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;*
2. *Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and*
3. *Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.*

Discussion: The DAR and their consultants are working closely with the DLNR Office of Conservation and Coastal Lands on the Chapter 343 and CDUP processes. This will help ensure that the permits are prepared correctly and processed in a timely manner.

6.3.4.8 Public Participation

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

Policies:

1. *Promote public involvement in coastal zone management processes;*
2. *Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and*
3. *Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.*

Discussion: The public will have an opportunity to review and comment on this EIS as part of the Chapter 343 review process. They will also be able to participate in a public hearing during the processing of the CDUP application.

6.3.4.9 Beach Protection

Objective: *Protect beaches for public use and recreation.*

Policies:

1. *Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;*
2. *Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and*
3. *Minimize the construction of public erosion-protection structures seaward of the shoreline.*

Discussion: The proposed artificial reef site is over a mile seaward of the shoreline, and does not involve the construction of erosion protection structures.

6.3.4.10 Marine Resources

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

Policies:

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

Discussion: The proposed reef is intended to enhance marine habitat, to support marine communities and to contribute to the sustainability of Hawai‘i’s recreational fishery resources. The proposed reef site will be open to researchers and educators as well as to recreational users.

A copy of this EIS is being sent to the Office of Coastal Zone Management at the State of Hawai‘i Department of Business, Economic Development, and Tourism. The Department’s response is expected to confirm the consistency of the project with the CZM policies.

6.3.5 ENDANGERED SPECIES ACT (16 U.S.C. 1536(A)(2) AND (4))

The Endangered Species Act (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the U.S. or elsewhere. The Act mandates that federal agencies seek to conserve endangered and threatened species and use their authorities in furtherance of the Act's purposes. It provides for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions.

Existing biota on and near the project site are discussed in Section 3.6 of this report. The discussion documents the fact that there are no known rare or endangered species on or immediately adjacent to the project site that would be adversely affected by the project. The project will not result in the loss of habitat necessary to the survival of endangered species; if anything, it will increase available foraging habitat for some individuals passing through the area. Copies of the Draft EIS are being provided to the U.S. Fish and Wildlife Service and to the National Marine Fisheries Service, and their responses, if any, will be included in the Final EIS.

7.0 OTHER CHAPTER 343 TOPICS

Hawai‘i Administrative Rules §11-200-17 establishes the content requirements for draft environmental impact statements. Most of these topics have been dealt with in the preceding sections of this report. This chapter addresses the few that do not fit neatly into any of the previously defined categories.

7.1 SECONDARY AND CUMULATIVE IMPACTS

The proposed artificial reef is not directly related to other possible actions by DAR and would not lead to substantial growth or changes in the character of economic activity (e.g., the opening of new industries not previously practical) that might have secondary impacts. It would, however, enhance recreational opportunities for fishing & diving off O‘ahu’s coastline and could thereby have some indirect economic benefits to the users of the site. None of these benefits are expected to be large enough to impact the island’s economy to a noticeable extent.

7.2 SHORT-TERM USES VS. LONG-TERM PRODUCTIVITY

The proposed reef site is currently mostly flat and devoid of coral, with a low abundance and diversity of marine life. As such, its value for recreational use and for marine habitat are currently limited. The installation of an artificial reef there would greatly increase the site’s long-term productivity by creating important habitat for corals, fishes, and benthic organisms and creating a productive fishing and diving locale where none currently exist.

7.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS

DAR is seeking to permanently designate the proposed site to be used for artificial reef development. This precludes many other uses of the site.

7.4 UNRESOLVED ISSUES

There are no known unresolved issues associated with the project.

7.5 RATIONALE FOR PROCEEDING

Chapter 4 describes the environmental effects that could result from the proposed artificial reef, none of which are significantly adverse. Because of this and because of the substantial benefits associated with the project, DAR believes the project is worthwhile. Further, DAR does not believe that there are alternatives, including those considered in this report, which would achieve the same goals with fewer environmental effects.

8.0 CONSULTATION & DISTRIBUTION

8.1 PARTIES CONSULTED

The Office of Conservation and Coastal Lands of the Department of Land and Natural Resources was consulted during preparation of this EIS. Planning Solutions, Inc., also contacted Carl Jellings, a knowledgeable fisherman from ʻEwa, and William Aila, the Waiʻanae Harbor Master.

DAR held a preliminary scoping meeting on April 13, 2006 to allow offshore stakeholder groups to ask questions and identify their concerns about the siting of the proposed reef and its compatibility with other user groups in the area offshore of Kalaeloa. A summary of the meeting and a list of the attendees is included as Appendix D. DAR also presented the project to the ʻEwa Neighborhood Board on June 8, 2006.

8.2 EISPN DISTRIBUTION

DAR distributed the EISPN to the individuals and organizations listed in Table 8.1.

Table 8.1. EISPN Distribution List

Federal Agencies	
National Oceanic & Atmospheric Administration	Department of the Army, Regulatory Branch
Environmental Protection Agency, Pacific Islands Contact Office	U.S. Fish & Wildlife Service, Pacific Island Eco-Region
U.S. Coast Guard	U.S. Naval Base, Pearl Harbor
State Agencies	
Office of Environmental Quality Control	Department of Business and Economic Development & Tourism, Office of Planning (5 copies)
State Department of Defense	Department of Health, Environmental Planning Office
Department of Hawaiian Home Lands	Department of Health, Clean Water Branch
Office of Hawaiian Affairs	Department of Land and Natural Resources (5 copies)
Harbors Division, Dept. of Transportation	DLNR Historic Preservation Division
State Department of Accounting and General Services	
City and County of Honolulu	
Department of Planning and Permitting	Department of Environmental Services
Elected Officials	
U.S. Senator Daniel Akaka	Mayor Mufi Hanneman
U.S. Senator Daniel Inouye	Congressman Mazie Hirono
Senator Will Espero	Congressman Neil Abercrombie
Representative Kymberly Pine	Chair, Neighborhood Board #23
Other Organizations	
Water Resources Center, University of Hawaiʻi	Environmental Center, University of Hawaiʻi
Tesoro Hawaiʻi Corporation	Chevron Hawaiʻi
Clean Islands Council	
Libraries and Depositories	
Hawaiʻi State Library Hawaiʻi Documents Center	Waianae Public Library
DBEDT Library	Pearl City Regional Library
UH Hamilton Library	Ewa Beach Public & School Library
News Media	
Honolulu Advertiser	Honolulu Star Bulletin

8.2.1 WRITTEN COMMENTS RECEIVED ON THE EISPN

DAR received written comments on the EISPN from the individuals and organizations listed in Table 8.2 below. The comment letters and DAR's responses to them are reproduced ~~at the end of this Section~~in Appendix F.

Table 8.2. Written Comments Received on the EISPN

Number	*Name & Title of Commenter*	*Organizational Affiliation*
1	Ernest Y.W. Lau, Public Works Administrator	State Dept of Accounting & General Services
2	Laura H. Thielen, Director	Office of Planning, State Dept. of Business, Economic Development, & Tourism
3	Linda Chinn, Administrator	Land Management Division, Dept of Hawaiian Homelands
4	Denis R. Lau, P.E., Chief	Clean Water Branch, State Dept of Health
5	Senator Daniel K. Akaka	United States Senate
6	John R. Cates, President	Cates International, Inc.
7	Henry Eng, FAICP, Director	Department of Planning & Permitting, City & County of Honolulu
8	Norman H. Messinger, Program Director	Operating Forces Support, Dept of the Navy
9	Melanie Chinen, Administrator	State Historic Preservation Division
10	Clyde Nāmu'o, Administrator	Office of Hawaiian Affairs

8.3 EIS PREPARATION & DISTRIBUTION

8.3.1 LIST OF EIS PREPARERS

The Kalaeloa Artificial Reef EIS was prepared by Planning Solutions, Inc. The respective contributions of the individuals and organizations are as follows:

Planning Solutions, Inc.

Perry J. White	Principal-in-Charge
Charles Morgan	Contributing Author
Melissa M. White	Contributing Author
Makena B. White	Maps and Graphic Design

Technical Consultants

Dr. Richard Brock	Reef Design Considerations Report

8.3.2 DEIS DISTRIBUTION

DAR distributed the Draft EIS to the individuals and organizations listed in Table 10.3 and requested their comments on the project. It provided a limited number of loan copies to the libraries listed.

8.3.3 DEIS WRITTEN COMMENTS AND RESPONSES

DAR received written comments on the DEIS from the individuals and organizations listed in below. The comment letters and DAR's responses to them are reproduced in Appendix G.

Table 8.3. Draft EIS Distribution List

State Agencies	**Libraries and Depositories**
Commission on Water Resource Management	DBEDT Library
Department of Defense	ʻEwa Beach Public & School Library
Hawaiʻi State Civil Defense	Hawaiʻi State Library Documents Center (2 copies)
Office of Environmental Quality Control (5 copies)	Library, Honolulu Department of Customer Services
Office of Hawaiian Affairs	Legislative Reference Bureau
Department of Accounting and General Services	Pearl City Regional Library
Department of Business, Economic Development, and Tourism (DBEDT)	UH Hamilton Library
DBEDT Planning Office	Waiʻanae Public Library
DBEDT Energy, Resources, & Technology Division	Kapolei Library
Department of Health, Env. Planning Office (3 copies)	
Department of Land and Natural Resources (5 copies)	**Elected Officials**
DLNR Office of Conservation & Coastal Lands	U.S. Senator Daniel Akaka
Department of Transportation, Harbors Division	U.S. Senator Daniel Inouye
DLNR Historic Preservation Division	Senator Will Espero
Department of Hawaiian Homelands	Representative Kymberly Pine
Department of Accounting & General Services	Mayor Mufi Hanneman
Clean Water Branch, Department of Health	Congressman Ed Case
Department of Agriculture	Congressman Neil Abercrombie
	Neighborhood Board #23 Chair, Kurt Fevella
Federal Agencies	Neighborhood Board #24 Chair, Patty Teruya
Environmental Protection Agency (PICO)	Neighborhood Board #34 Chair Maeda Timson
National Marine Fisheries Service (2 copies)	County Councilmember Todd K. Apo
US Army Engineer Division	
US Fish and Wildlife Service	**Other Parties**
US Coast Guard	Cates International
Department of the Navy, Navy Region Hawaiʻi	Water Resources Center, University of Hawaiʻi
	Tesoro Hawaiʻi Corporation
City and County of Honolulu	Clean Islands Council
Department of Planning & Permitting (5 copies)	Environmental Center, University of Hawaii (4 copies)
Department of Environmental Services	HASEKO (Ewa), Inc.
Oʻahu Civil Defense Agency	Chevron Texaco
Honolulu Police Department	
Honolulu Fire Department	**News & Media**
Department of Facility Maintenance	Honolulu Advertiser
Department of Transportation Services	Honolulu Star-Bulletin
Department of Parks & Recreation	
Department of Facility Maintenance	
Department of Design & Construction	
Board of Water Supply	
Source: Compiled by Planning Solutions, Inc. (2007)	

Table 8.4. Written Comments Received on the DEIS

Number	***Name & Title of Commenter***	***Organizational Affiliation***
1	Ernest Y.W. Lau, Public Works Administrator	State Dept of Accounting & General Services
2	Keith S. Shida, Principal Exec.	Customer Care Div., Honolulu Board of Water Supply
3	Lester K.C. Chang, Director	Dept of Parks and Recreation, C&C of Honolulu
4	Laverne Higa, P.E., Director & Chief Engineer	Dept of Facility Maintenance, C&C of Honolulu
5	Glenn Okimoto, Harbors Administrator	Dept of Transportation Harbors Division, State of Hawai‘i
6	Peter J.S. Hirai, Acting Director	Dept of Emergency Management, C&C of Honolulu
7	Boisse P. Correa, Chief of Police	Honolulu Police Department, C&C of Honolulu
8	Eugene C. Lee, P.E., Dep. Dir.	Dept of Design & Construction, C&C of Honolulu
9	Russell Y. Tsuji, Administrator	Land Division, Dept of Land & Natural Resources, State of Hawai‘i
10	Edward Underwood, Administrator	DLNR Division of Boating & Ocean Recreation
11	Eric T. Hirano, Chief	DLNR Engineering Division
12	Dan Quinn, Administrator	DLNR State Parks Division
13	Edwin Sakoda, Administrator	DLNR Commission on Water Resource Mgmt
14	Sam Lemmo, Administrator	DLNR Office of Conservation & Coastal Lands
15	Cecil Santos	DLNR Land Division, O‘ahu District Office
16	Kenneth G. Silva, Chief	Honolulu Fire Department
17	Genevieve Salmonson, Director	Office of Environmental Quality Control, State Department of Health
18	Peter Rappa, Env Review Coordinator	UH Environmental Center
19	Kelvin H. Sunada, Manager	Environmental Planning Office, DOH
20	Melvin N. Kaku, Director	Dept of Transportation Services, C&C of Honolulu
21	Melanie Chinen, Administrator	DLNR Historic Preservation Division
22	Patrick Leonard, Field Supervisor	Pacific Island Office, US Fish & Wildlife Service

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APPENDIX A. HAWAI'I'S ARTIFICIAL REEF PROGRAM

By Brian Kanenaka, State of Hawai'i Division of Aquatic Resources,
Department of Land and Natural Resources

DRAFT

HAWAII'S ARTIFICIAL REEF PROGRAM: PAST, PRESENT AND FUTURE

Brian K. Kanenaka

ABSTRACT

Hawaii initiated artificial reef development in the late 1950s to increase and enhance fishing opportunities for its fishermen. During the 1960s through the mid-1970s, four artificial reefs were created by deploying nearly 3,000 derelict car bodies and 6,000 metric tons of damaged concrete pipes. These reefs succeeded in attracting and sustaining large numbers of fish and other marine life to bottom areas that were barren and without substantial vertical relief. In the late 1970s and early 1980s, the advent of stringent environmental requirements and prioritization of other fisheries projects reduced emphasis on artificial reef activities. The artificial reef program regained resurgence in the mid-1980's. Fish shelters were constructed with discarded automobile tires, donations of reef building materials were encouraged, and the existing reefs were closely monitored to evaluated impacts on the resident reef fish population. New reef sites in shallow and deepwater areas were also searched for and established.

Today, Hawaii's growing population places an ever increasing fishing pressure on our limited nearshore fishery resources. To partially accommodate the increased demand on existing resources, the State's artificial reef program continues to be very active with ongoing reef construction and research projects.

Future plans include exploring innovative reef designs and concepts to change the direction of our artificial reef program from increasing fish habitat to creating fish havens.

Hawaii's volcanic origin caused steep submarine slopes to form around the islands resulting in a narrow band of shallow water encircling each island. Within this band, the majority of the nearshore areas between 15 and 25 m depths are composed mainly of flat limestone and sand patches with limited fishery resources.

In 1957, the Territory of Hawaii initiated an investigation on the effects of installing artificial shelters in areas of sparse natural habitat. Increases in the fish population around these structures were observed almost immediately. The State of Hawaii established the first artificial reef at Maunalua Bay, Oahu, in 1961 (Fig. 1). Artificial reefs off Keawakapu, Maui and Waianae, Oahu followed in 1963 (Figs. 2 and 3). A fourth reef was built in 1972, off Kualoa, Oahu (Fig. 4). Encompassing a total of 800 ha, these reefs were primarily comprised of 3,000 derelict cars and 6,000 mt of damaged concrete pipes. The artificial reef materials appeared to increase the fish resources in areas of poor habitat and provided alternatives to using traditional fishing grounds that were being heavily fished. Kanayama and Onizuka (1974) reported details on the project's early years between 1957 and 1973.

During the 1970s, stricter environmental laws precluded the use of automobile bodies as reef material because of the high cost involved in cleaning and preparing these materials. It became difficult to sustain reef construction at previous activity levels as budgetary restraints and personnel shifts to other priority projects were experienced (Onizuka, 1984). Between 1974 and 1984, the State's artificial program relied mostly on periodic donations of derelict vessels. Except for a minesweeper, a barge, and six steel rafts, the only significant reef addition involved the deployment of 31 experimental mid-water fish aggregating devices (FADs).

In the mid-1980s, the State revitalized the artificial reef program by constructing and deploying fish shelters, encouraging donations of suitable reef building materials, monitoring and studying existing reefs, and searching for and establishing new reefs. Annual job progress reports (1985-1991) prepared in compliance with the Dingell-Johnson/Wallop-Breaux Federal Aid in Sport Fish Restoration Program requirements have provided most of the information used in

this report.

MATERIALS AND METHODS

Construction and Deployment of Artificial Reef Habitats.- Onizuka (1984) reported that 15 experimental mid-water FADs were added to the Waianae Artificial Reef to attract semi-pelagic fish species. These FADs were deployed linearly (25-50 m apart) at a depth of about 23 m in December 1983. Each FAD consisted of a 70 cm diameter spherical float attached by 7.6 m of 1.3 cm galvanized chain (Fig. 5) to a 363 kg steel railroad car wheel anchor. Plastic streamers were tied along the chain links to attract marine life. To improve the effectiveness of the FADs, divers also secured 1 m by 9 m sections of nylon cargo netting to the mooring chain. In June 1984, 16 additional FADs were placed in a cluster next to the existing FADs. A 590 kg concrete block anchored each FAD. Discarded car tires were attached along the mooring chain in two configurations as noted in Figure 6.

The first step in enhancing the existing artificial reefs was to design an experimental reef module that needed to be both durable and stable in Hawaii's high energy nearshore waters. After considering many designs (Vik, 1982), a simple, cost-effective form consisting of discarded automobile tires embedded in concrete was constructed in November 1984 (Fig. 7).

Weighing over 1,000 kg, the prototype module measured 1.83 m in length, 0.71 m in width, and 0.61 m in height. Each module consisted of eight to ten tires embedded in 0.38 m^3 of concrete supported by 10 m of 6 mm diameter steel reinforcement bar (re-bar) and 1.8 m^2 of wire mesh. In 1985, 50 modules were

constructed at a cost of $50 each, including labor and materials. The modules were deposited within a 46 m diameter circular area, adjacent to deteriorating remains of car bodies previously added at the Maunalua Bay Artificial Reef. The design was later modified from a block to a trapezoidal-sided form reducing the volume of concrete by one-third to 0.25 m^3 per module (Fig. 8). The new design reduced construction time and allowed 66 additional modules to be produced per 100 m^3 of concrete. Improved production and design change decreased the cost per module to $40 per unit. Between 1986 and 1990, nearly 6,000 tire modules were built using 50,000 old tire casings and 1,500 m^3 of concrete. Maunalua Bay received the first major deployment of 500 modules in May 1987, followed by an additional 500 modules in November 1987. In April 1991, a tug and barge company deposited an additional 1,200 modules at 18-20 m depths between the piles of modules added to the reef in 1987. The Maunalua Bay tire reef today encompasses an area of over 4,000 m^2.

In July 1988, tug and barge contractors deployed 750 modules at the Waianae reef in 18 m depth scattered over an 8,000 m^2 of bare limestone. Another 750 modules were added to the existing tire reef at Waianae in August 1989.

At the Keawakapu Artificial Reef a contractor barged 2,200 modules to Maui in two increments and deposited the initial increment of 1,000 modules in 17-20 m depths over 6,000 m^2 of sand bottom in January 1989. In February 1990, the second increment of 1,200 modules was added over the existing modules.

Costs to transport and deploy modules has not increased dramatically over the five year period between 1986-1990. Awarded by competitive bids, the average cost for these services was $15 per module. However, the labor and material cost

has increased from $40 to $65 per module over the same time period which has reduced the cost-effectiveness of using the tire modules.

In 1989, a new concrete casting company was contracted to utilize waste (leftover) concrete to fabricate 65 fish shelters in two "table" designs (Fig. 9). Each table shelter was 2.4 m long by 1.2 m wide and 0.15 m thick. Reinforced with wire mesh and 12 mm diameter re-bar, each shelter weighed over 1,000 kg and cost $120 apiece to build. Thirty shelters were deposited at the Waianae reef in July 1989. The remaining 35 shelters were added to the Keawakapu reef in February 1990.

In June 1990, another private company was contracted to build 310 shelters with an "inverted double L" design using waste concrete (Fig. 10). The contractor completed construction of the shelters in January 1991, at a cost of $128 per unit. The cost per shelter was double the amount of a tire module, but each shelter provided nearly twice the surface area of a module. The 310 shelters were placed at the Maunalua Bay reef in April 1991.

Other habitat designs include six rectangular structures built from surplus concrete. Each structure is 1.8 m long by 1.4 m wide by 0.20 m high. One end of the trapezoidal-shaped habitat is left open, while the other end is closed except for three 7.5 cm diameter holes. In July 1988, these habitats were added to the Waianae reef to serve as possible shelters for spiny lobsters (Fig. 11).

In July 1988, a contractor was hired to build 100, pre-cast concrete "dolos armor", weighing 5.5 mt apiece (Fig. 12). The three arms of the dolos armor were reinforced with 1.6 cm re-bar. Generally used to fortify breakwaters and jetties, the "dolos armor" was deployed at a deepwater artificial reef off Ewa Beach,

Oahu.

Forty truck tires (six-foot in diameter) were weighted with concrete and added to the Maunalua Bay reef in November 1987. Between 0.3-0.5 m^3 of surplus concrete was secured by 6 mm re-bar to ballast each tire (Fig. 13).

Finally, the National Marine Fisheries Service constructed and donated four "pipe houses" to the State's Artificial Reef program. The habitats were built of three, 45.7 cm diameter concrete pipes of 2.4 m in length, strapped together by 2.5 cm wide stainless steel bands. A concrete plug blocked the middle of each pipe and prevented the flow of water through the pipe. These habitats were added to the Waianae reef in August 1989 (Fig. 14).

Donations of Vessels and Other Materials.-Several vessels have been donated to the State and placed in appropriate artificial reef sites. In 1985, private construction companies donated a number of barges to the State. Two barges, a damaged 49 m construction barge and a derelict 32 m mud scow were scuttled by one of the companies in coordination with the State at the Maunalua Bay reef. Another barge sank off Maili Point, Oahu, while being towed to the Waianae reef. This 800 mt barge measured 43 m long, 26 m wide, and 15 m high.

In 1987, the U.S. Navy donated and scuttled a 40 m barge and two dry dock caissons (39 m and 30 m "doors" used to close dry docks), thereby initiating the development of the deepwater reef off Ewa Beach, Oahu. The barge was badly corroded and the caissons were pre-World War II models no longer needed by the Navy. Also offered to the State in 1988 was a 53 m "moth-balled" World War II water barge. Navy divers placed and detonated a 45 kg explosive charge below the

vessel's keel to sink it in 165 m at the Ewa site.

Other donations of reef material to the State included razed sections of a 28-year old hospital in July 1986. Although the State agreed to accept large concrete sections of the building, higher than anticipated cost for tug and barge services prevented consummation of an agreement effected with a private contractor.

In July 1989, under a similar situation, a construction company donated about 450 mt of concrete culverts to the State and offered to deploy the culverts at the Maunalua Bay reef. However, the cost to barge the culverts to the reef was higher than trucking the material to a landfill. Therefore, the construction company who made this offer opted for the latter method of disposition.

However, on a more successful note, the State was able to receive donation and disposition services of suitable reef building material from a private construction company in April 1991. Between 150-200 sections of a concrete pier (1,300 mt estimated weight) were deposited at the Maunalua Bay reef over flat, barren limestone at a depth of 40 m. The pier sections were inspected and found to be free of harmful contaminants. In addition, conditions on the deployment operation and ownership of the material were mutually agreeable to and accepted by the State and the private company prior to the deployment.

The provisional use of a storage area for stockpiling of donated reef material was obtained in December 1986 from the State Department of Transportation (DOT). The 2,000 m^2 parcel located in close proximity to a pier at the Barbers Point Harbor on Oahu, was posted with signs to identify the area for stockpiling of artificial reef material.

Artificial Reef Surveys.-SCUBA divers conduct underwater surveys to determine abundance, standing crop density, and species diversity of fish populations residing at artificial reefs. Divers count and estimate the size of fish observed over a 228 m transect using a modified strip census technique (Brock, 1954). Annual surveys are conducted at the three active shallow water artificial reefs at Maunalua Bay and Waianae on Oahu, and at Keawakapu, Maui. Additional surveys are usually conducted following periods of reef construction. Since 1983, surveys have been suspended at the Kualoa Artificial Reef, Oahu, because no car remains could be found.

Concerned about heavy fishing pressure on bottomfish stocks, the State began to search for an appropriate site to create a pilot deepwater artificial reef in November 1985. A potentially suitable ground was located approximately 3 km off Ewa Beach, Oahu. Surveys of the area indicated a gentle sloping bottom of firm substrate with a barren topography along a 90-130 m contour. After sufficient reef material are deployed, sampling will be initiated over the new habitat using conventional bottomfish handline gear and traps of various sizes. Use of submersibles for monitoring are planned, but high cost may limit the use of these devices.

Renewed efforts to locate new shallow water artificial reef sites began in May 1986. Divers surveyed three potential areas off West Maui in the vicinity of Puamana, Launiupoko, and Wahikule.

In February 1989, divers surveyed the inshore (7-10 m) and offshore (15-18 m) areas off Makapuu, Oahu, to locate a site for an artificial reef for research purposes.

Permits, Exemptions, and Notifications.-Artificial reef construction activities are authorized under permits obtained from the U.S. Army Corps of Engineers, State Department of Transportation, and State Department of Land and Natural Resources. Permit exemptions are also required from the State Department of Health, State Office of Environmental Quality Control, and the U.S. Environmental Protection Agency. Other agencies notified of artificial reef construction activities include the U.S. Coast Guard, State and County Civil Defense, County Fire Department, County Police Department, and the National Marine Fisheries Service.

RESULTS AND DISCUSSION

Monitoring of Artificial Reef Habitats.-Divers periodically monitored the 31 mid-water FADs at the Waianae reef. Reef fishes including the orange-spot surgeonfish (Acanthurus olivaceus), cornet fish (Fistularia commersoni), fan-tail file fish (Pervagor spilosoma), and giant porcupine fish (Diodon hystrix) were observed hovering around the FADs. The white-spotted damsel fish (Dascyllus albisella) seemed to prefer FADs with tires strung on the mooring chain. The structures did not appear to attract semi-pelagic fish species, except for a small school of mackerel scad (Decapterus macarellus). However, placement of the FADs in shallow water (20 to 25 m) provided an opportunity to study their mooring system and design. In September 1985, divers found extensive corrosion on the mooring chain of 15 FADs with steel anchors. Because of concerns for

navigational safety, divers cut the mooring chains and removed the FADs. Zinc anodes were attached to the mooring chain of the remaining 16 FADs with concrete anchors. Two years later (1987) corrosion again set in along the mooring chain on one of the FADs. However, noting that healthy colonies (15-30 cm diameter) of stony corals (Pocillopora meandrina) were found growing on the metal float, tire casings, and mooring chains of all the FADs, the divers punctured the floats and stabilized the structures instead of removing them. The coral colonies appeared to be in poor condition during a subsequent inspection on the sunken FADs in 1988. About half of the colonies appeared to have died.

Monitoring of the 50 experimental tire modules deposited in a cluster at the Maunalua Bay reef revealed that fish were attracted to the habitats. To improve the effectiveness of the habitats, divers successfully regrouped a few modules using a lift bag. Safety concerns and manpower shortfalls precluded further attempts to cluster isolated modules. Notwithstanding, the state embarked on a project to build and deploy thousands of modules to restore fish populations at existing shallow water artificial reefs (Fig. 15). Tug and barge services were contracted to deposit the modules in specific sites at the reefs (Fig. 16). Requiring a barge to be anchored over a deployment site resulted in modules being deposited in concentrated piles (Fig. 17). Positioning a barge over a pre-determined area caused the modules to be spread over a larger area. There appeared to be more cryptic fish species when modules occurred in piles (Fig. 18). Whether deposited in piles or loose clusters, the fish numbers and standing crop densities at the artificial reefs have increased to levels equal to or greater than those reported by Kanayama and Onizuka (1974).

Initial monitoring of 65 prototype "table" shelters added to the Waianae and Keawakapu reefs indicated that fish are attracted to the habitats. Preliminary results on the recent deployment of 310 shelters at the Maunalua Bay reef in April 1991, were encouraging. Divers observed schools of green damsel fish (Abudefduf abdominalis) laying eggs on the shelters. As a result, construction of 900-1000 additional shelters have been scheduled for completion by June 1992. Plans are to deploy the shelters at a site void of existing material to test their effectiveness in attracting and sustaining reef fish populations. Since the shelters are fabricated from waste concrete, production cost may be held at a stable level.

Various habitats (lobster shelters, "dolos armor", weighted truck tires, and "pipe houses") were placed at reef sites on an experimental basis. The lobster shelter's trapezoidal-sided design caused construction difficulties. Also, during deployment the design caused the shelters to land up-side-down and divers had to turn them over. Months later, reef fish were observed in and around the shelters, but lobster have not used this specially designed habitat. The concrete "dolos armor" appears to have provided excellent vertical relief at the new deepwater reef off Ewa, Oahu. But the cost to construct these structures was nearly $1,000 per unit. Weighted truck tires, many with diameters in excess of 2 m, added vertical relief to the Maunalua Bay reef. However, the large tires did not provide crevicular habitat, apparently important to shallow water artificial reefs. At the "pipe houses", various reef fish species are using the narrow space between the pipes for shelter. Plugging the middle of the pipes and blocking the flow of water appear to deter fish from utilizing the inside of the pipes.

Donations of Vessels and Other Materials.-Since 1985, four of seven donated vessels were added to the new deepwater artificial reef off Ewa Beach, Oahu. The U.S. Navy deployed a barge, two dry dock caissons, and a water barge at depths between 110 to 165 m within a 2 ha section of the reef (Fig. 19). The addition of derelict vessels provided the much needed vertical relief at the reef site.

A private construction company scuttled two vessels at the Maunalua Bay reef. A large 49 m construction barge sank upright in 25 m of water over sand and limestone bottom at coordinates 21-15-01 N and 157-46-18 W. The second barge, a 32 m mud scow lies in an up-side-down position at a depth of 21 m over flat limestone, approximately 150 m inshore of the larger barge.

Another vessel was unintentionally deployed off the leeward coast of Oahu, enroute to the Waianae reef. Searches of the sea floor between 50 and 350 m depths with side-scan sonar systems located only a small section of the barge at 64 m. The tug operator who towed the barge claimed that the vessel sank beyond 350 m depths.

In November 1990, the Navy canceled the scuttling of another 53 m water barge. Trace levels of polychlorobiphenyls were found in the vessel. Initially, vessels are inspected by U.S. Coast Guard and State personnel (Fig. 20). The vessels must be free of contaminants and debris before an ownership agreement can be reached between the donor and the State. Depending on the situation, the cost of cleaning a vessel to pass the inspection could be cost-prohibitive.

Vessels scuttled in shallow water (20-25 m) become "instant" artificial reefs and are especially attractive to SCUBA divers. Accordingly, the problems of user conflicts, liability concerns, and preparation costs may be reduced if vessel are

placed in deepwater (100-150 m).

Local construction companies stockpiled approximately 8,000 mt of surplus and damaged concrete construction material at a storage yard adjacent to the Barbers Point Harbor, Oahu, between January 1987 and December 1990 (Fig. 21). The companies donated and transported surplus rock boulders, cut-off pilings, damaged conduit pipes, and concrete slabs to the storage yard. The material at the storage yard was earmarked for deposition at the new deepwater artificial reef off Ewa Beach, Oahu. It has been estimated that approximately 5,000 to 10,000 mt of materials is needed to construct the deepwater reef. By January 1991, tug and barge companies deposited 5,000 mt of material in five increments at the Ewa reef (Fig. 22). The companies were contracted to transfer materials from the storage yard to an adjacent pier, load the material on to a barge, transport the material to the Ewa reef, and deploy the material at a specifically marked site. The material was deposited over approximately 2 ha of ocean bottom between depths of 100 m to 110 m. Deployment operations were contracted through competitive bids and averaged $25,000 per trip for 1,000 mt of material. Approximately 3,000 mt of stockpiled material that remained had to be removed by January 1992, because of scheduled harbor improvements. Although another stockpiling area has been offered, its location and distance from a pier would make transfer of materials cost prohibitive. Alternatives being considered include assessing construction companies a fee to deposit material at this newly offered site to defer cost of transporting material, or coordinating the transport of material from the construction sites directly to a pier onto an awaiting barge. Construction companies are currently paying fees of $50 per mt to dispose of materials at

landfills, and may be receptive to these alternatives.

A private company offered concrete pier sections and the cost-free deployment of the material at the Maunalua Bay reef in January 1991. It resulted from the state's efforts to encourage donations of suitable reef building materials. A survey of the deployment site in May 1991, revealed a random pile of pier sections covering 0.5 ha of flat limestone bottom. Divers observed a few reef fish species such as the white-spotted damsel fish, red and white banded goatfish (Parupeneus multifasciatus) and millet seed butterfly fish (Chaetodon miliaris). As the new reef matures, a more diverse the fish community is expected to develop.

Artificial Reef Surveys and Research Activities-Annual surveys over established transect stations at the three active shallow water artificial reefs reflect long-term trends in the fish population (Fig. 23). Surveys prior to the addition of tire modules indicated a decline in the population to near pre-reef levels. Over the years, car bodies that were initially deployed have deteriorated and storm surges have scattered the concentrations of concrete pipes such that available shelter for resident marine life has been reduced (Brock, 1986). The addition of over 6,000 tire modules to existing artificial reefs at Maunalua Bay, Waianae, and Keawakapu has helped to restore fish stocks at these sites (Figs. 24, 25, and 26). Dominant fish species at the three reefs have included the Samoan goat fish (Mulloides flavolineatus), the golden-banded goatfish (M. vanicolensis), and the blue-lined snapper (Lutjanus kasmira). Within five years after the addition of the modules, the number of fish per hectare at the Maunalua Bay reef was observed to have

increased by an average of four and a half times the number recorded for a five year average before the modules were deployed (Table 1). During the same period, there was a corresponding increase in the standing crop of nearly eight fold and species diversity improved by an average of 29%. Less dramatic increases occurred in the fish population at the Waianae and Keawakapu reef (Tables 2 and 3). Modules were added to these reefs one to two years after the Maunalua Bay reef and may need time to mature. The effectiveness of the tire reefs are being monitored through annual surveys.

Eight surveys at two barges scuttled in the Maunalua Bay reef were conducted between 1985 and 1989. The fish communities associated with the barges appear to be increasing gradually (Table 4). The trend should continue as the barges age and create a more attractive habitat.

In October 1987, divers located vast, lush coral beds within the boundaries of the Keawakapu Artificial Reef. A follow-up survey in June 1988, confirmed an earlier suspicion that the coordinates of the boundaries for the Keawakapu reef actually included an area about 1.5 km north from the barren sandy grounds that characterizes the present reef site. Boundaries of the reef will be amended and shifted approximately 1 km south to avoid the coral beds during future reef building activities.

Divers surveyed potential shallow water artificial reef sites at Puamana, Launiupoko, and Wahikule, off West Maui in May 1986 and Makapuu, Oahu, in February 1989. The three Maui sites were very similar, described by flat, sand bottom between 18 to 20 m in depth and with limited fishery resources. A second survey was conducted at Wahikule in June 1988. In addition to a fish transect,

boundaries and landmarks were recorded to delineate the area. At Makapuu, survey results indicated that the shallow inshore areas were highly exposed to strong wave forces, and there were sufficient natural habitat in the offshore areas.

Juvenile (10-15 cm total length) blue-lined snappers were trapped at the Waianae reef in June 1990, for experimental tagging with visible implant (V.I.) tags. Only six of 28 fish retained their V.I. tags over a seven day period. Limited adipose tissue around the eyes caused problems with tag retention. Additional tagging experiments are planned using different types of tags to document fish production at shallow water reefs.

As a result of favorable surveys conducted along the southwestern coast of Oahu, a 12.5 ha pilot deepwater artificial reef was established about 2.5 km off Ewa Beach, Oahu (Fig. 27). Prior to development of the reef, handline sampling for bottomfish during day and night collections were conducted between January and August 1986. Biologists did not catch any fish at the project site on three sampling trips that totaled three hours of effort. After the addition of the first materials (a barge and two caissons) in the summer of 1987, the Catch-Per-Unit-Effort (CPUE) increased gradually. Nearly eight fish per line-hour were caught for 11 sampling hours over seven trips through June 1988. For the period from August 1987 to June 1991, a total of 1,419 fish has been captured in 106 sampling hours for a CPUE of 13.4 fish per line-hour on 67 trips to the Ewa reef. During this period, 27 fish species were caught with handline gear at the Ewa reef. The blue-lined snapper dominated the catch comprising 53% (758 specimens) of the total samples. Juvenile small-scaled snappers (Pristipomoides filamentosus) followed

with 35% (499 specimens) of the catch. In addition, 12 days/nights of trap sampling were conducted at the Ewa reef in September and November 1988. Fifty blue-lined snappers, four amberjacks (Seriola dumerilii), four portunid crabs (Portunus sangiolentus), a red spiny lobster (Panulirus marginatus), a slipper lobster (Scyllarides squammosus), and a Jordan's squirrelfish (Flammeo scythrops) were caught in the traps. Sampling at the reef will continue with emphasis on trap fishing.

In February 1989, a submersible was used to observe the fish community at the Ewa reef. Observers in the submersible recorded 22 fish species over the derelict vessel and construction material components of the reef. The majority of the fish were juveniles, dominated by the black damselfish (Chromis verator) and an unidentified cardinalfish (Family Apogonidae). Depending on available funding, submersibles or remote operated vehicles may be used to monitor the Ewa reef.

In October 1989, an experimental tagging study on juvenile (20-30 cm) small-scale snappers began at the Ewa reef. Biologists monitored tag retention, movement patterns, growth rates and population size for the fish species. Between October 1989 and October 1991, 294 snappers were caught, tagged and released at the reef. Fish surviving capture by handline gear and removal of excess gas from their air bladders, were measured and marked with internal anchor tags inserted into their body cavity. In the two years that the study has been active, 78 fish were recaptured all at the Ewa Reef. The Ewa reef is a "testing area" for a project that intends to tag, release, and recapture bottomfish at the Penguin Banks off Molokai, an important commercial fishing ground.

CONCLUSION

Restoration of Hawaii's shallow-water artificial reef is well underway. Thousands of stable and durable tire modules lie clustered over corroded remains of car bodies and scattered concrete pipes. Specially designed experimental shelters fabricated from waste concrete are being tested and deployed in increasing numbers. If available, surplus and derelict vessels, cleaned of their contaminants make "instant" habitats for shallow and deepwater reef sites. Higher fees to dispose of materials at land fills are convincing construction companies to donate suitable material and deployment services. Surveys to track long-term trends at existing reefs are to be continued with emphasis on the effectiveness of specially designed habitats. Tagging projects to monitor fish production and movement could provide the necessary information to base important management decisions. Expansion of boundaries at certain reefs, searching for potential reef sites, and establishment of new reefs are planned. In addition, data acquisition on users of artificial reefs through systematic vessel and creel census is long overdue.

The State's active artificial reef program continues to provide additional fishing and diving opportunities. As increasing environmental and fishing pressures are exerted on limited resources, innovative, cost-effective concepts to artificial reef construction will be required. These include developing of fish havens by creating new reefs designed and structured to challenge the user. Formations of massive reef complexes with a myriad of interstitial spaces will

hopefully provide fish a better shelter from net and spear fishermen. A complex deepwater reef will hopefully deter anchoring and require drift fishing over the reef, a less efficient method of bottomfishing. Increasing the productivity of our nearshore waters and allocating these resources equitably by creating fish havens are goals that the State of Hawaii plans to accomplish in the future.

ACKNOWLEDGMENTS

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25. Fish biomass at Maunalua Bay, Waianae, and Keawakapu Artificial Reefs in kilograms per hectare.

26. Number of fish species observed at the Maunalua Bay, Waianae, and Keawakapu Artificial Reefs.

27. Location and boundaries of the Ewa Deepwater Artificial Reef, Oahu.

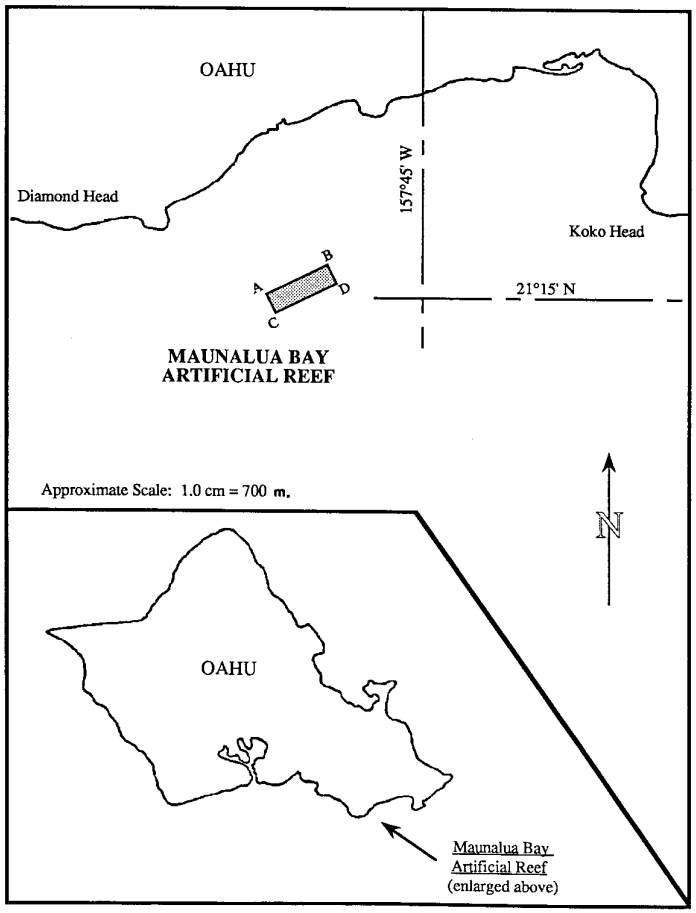

Figure 1. Location and boundaries of the Maunalua Bay Artificial Reef.

Boundary coordinates in latitude and longitude.

A. 21°14' 58" N, 157°46' 34" W
B. 21°15' 14" N, 157°46' 03" W
C. 21°15' 06" N, 157°45' 58" W
D. 21°14' 50" N, 157°46' 29" W

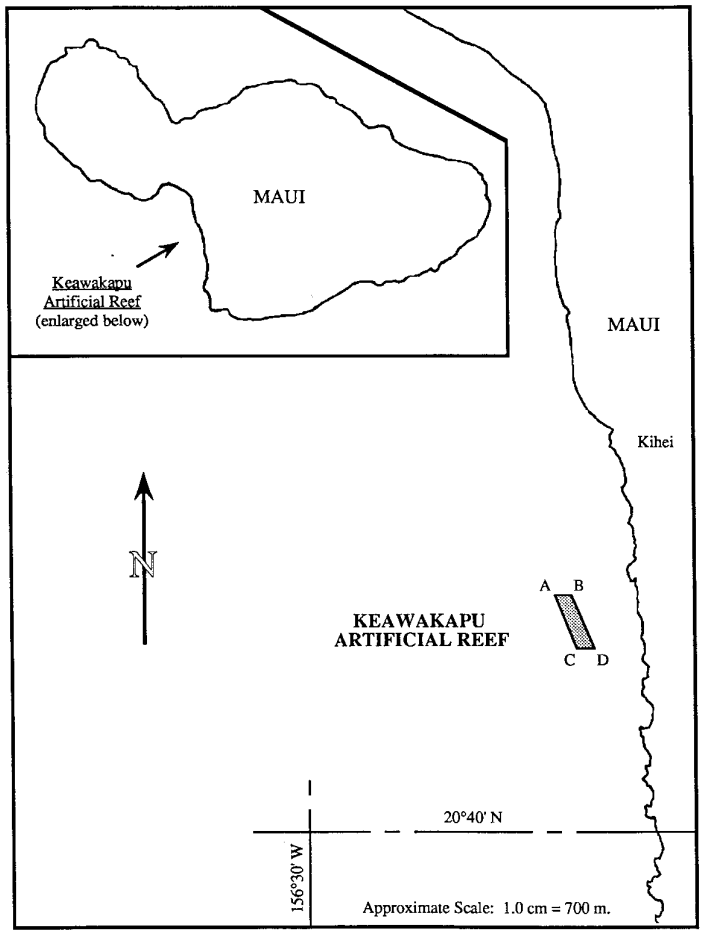

Figure 2. Location and boundaries of the Keawakapu Artificial Reef, Maui.

Boundary coordinates in latitude and longitude.

A. 20°41' 18" N, 156°27' 36" W
B. 20°42' 18" N, 156°27' 30" W
C. 20°14' 48" N, 156°27' 18" W
D. 20°41' 48" N, 156°27' 12" W

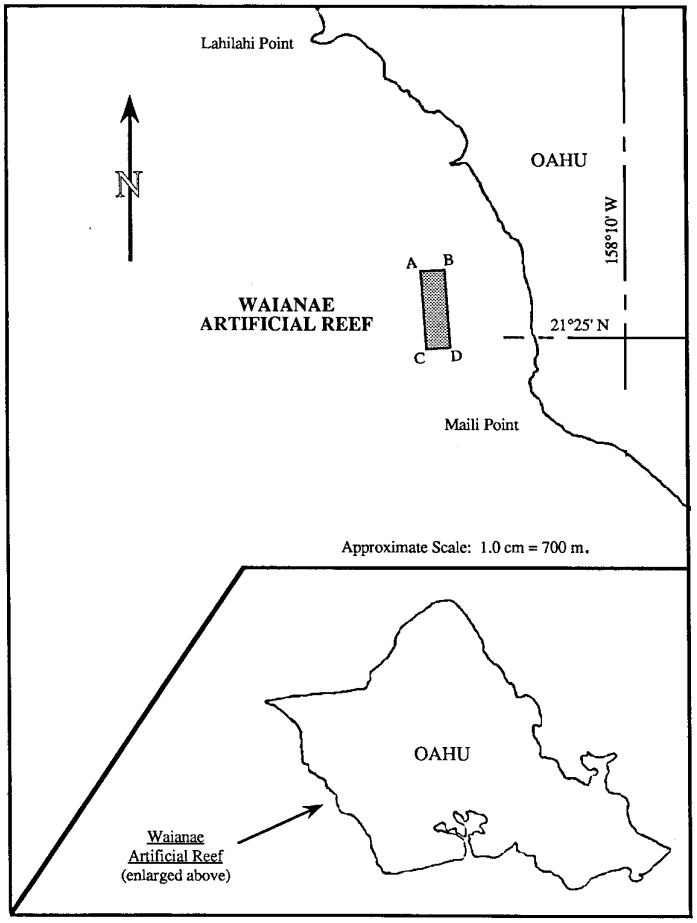

Figure 3. Location and boundaries of the Waianae Artificial Reef, Oahu.

Boundary coordinates in latitude and longitude.

A. 21°25' 35" N, 158°11' 58" W
B. 21°25' 36" N, 158°11' 45" W
C. 21°24' 48" N, 158°11' 54" W
D. 21°24' 48" N, 158°11' 40" W

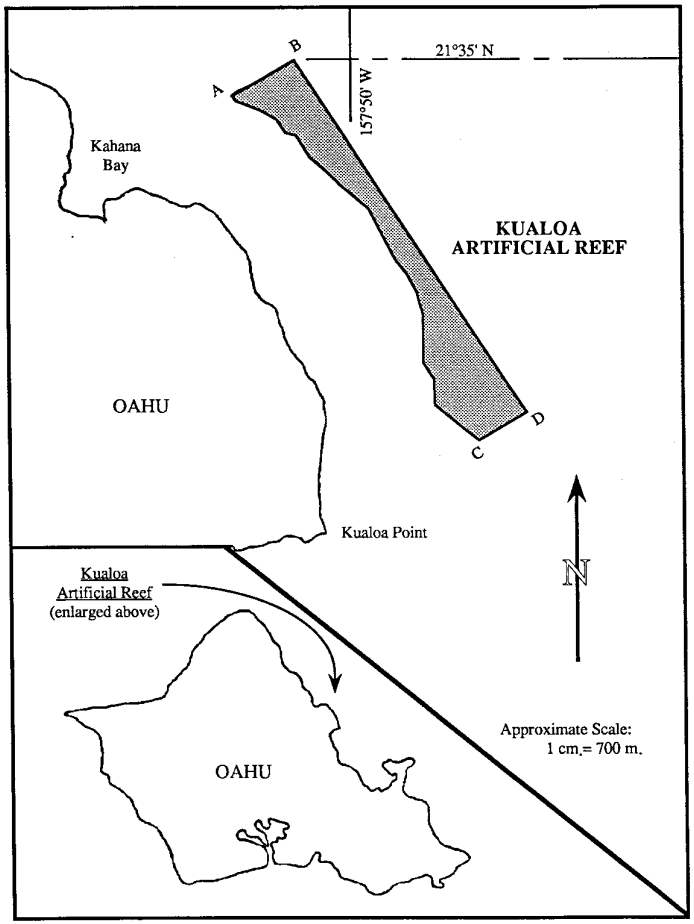

Figure 4. Location and boundaries of the Kualoa Artificial Reef, Oahu.

Boundary coordinates in latitude and longitude.

A. 21°34' 42" N, 157°51' 09" W
B. 21°35' 04" N, 157°50' 26" W
C. 21°31' 42" N, 157°48' 56" W
D. 21°31' 54" N, 157°48' 24" W

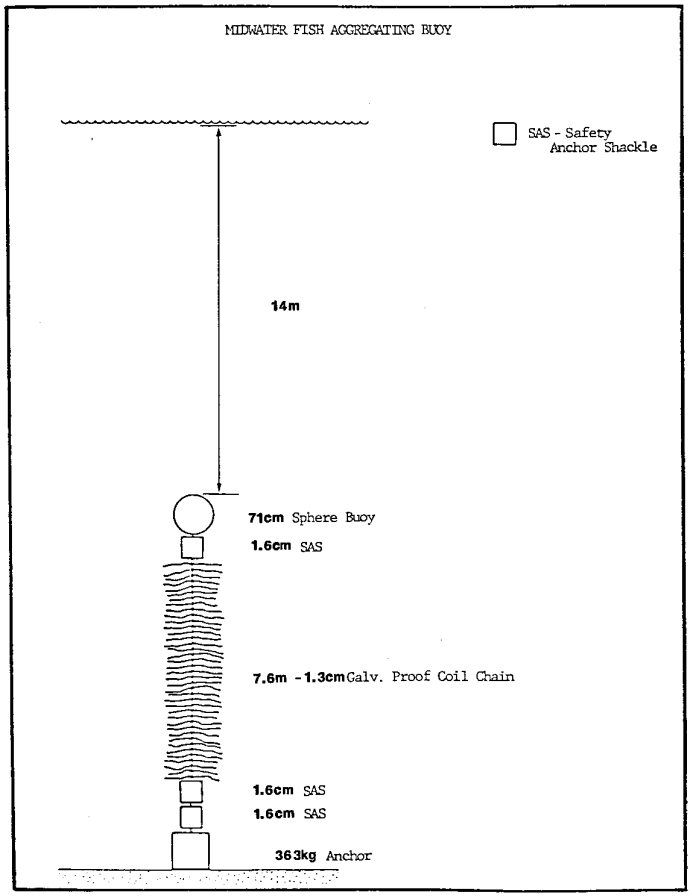

Figure 5. Midwater FAD with plastic streamer attractants.

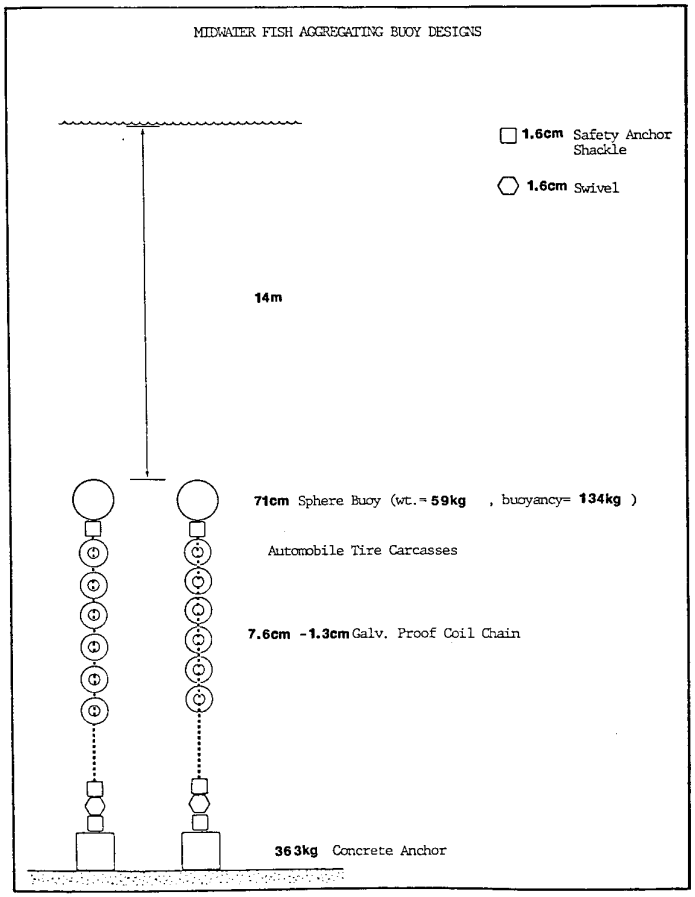

Figure 6. Midwater FAD with tire attractants in different configurations.

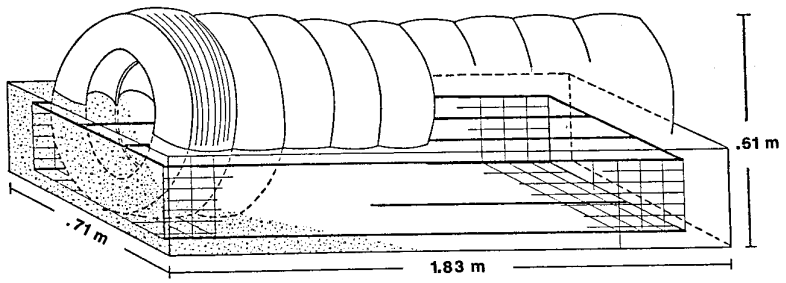

Figure 7. Artificial reef tire module.

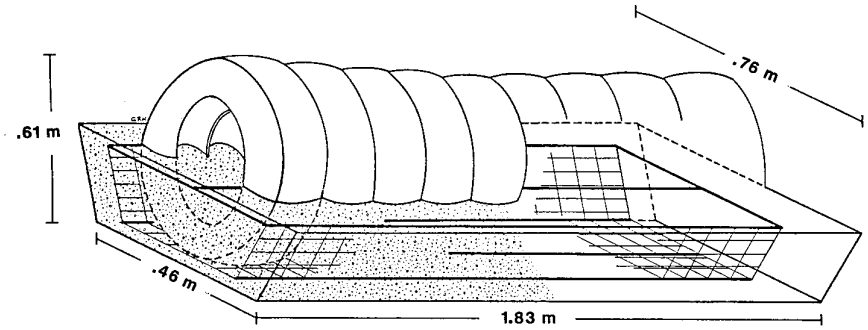

FIGURE 8.

TRAPEZOIDAL-SIDED TIRE MODULE

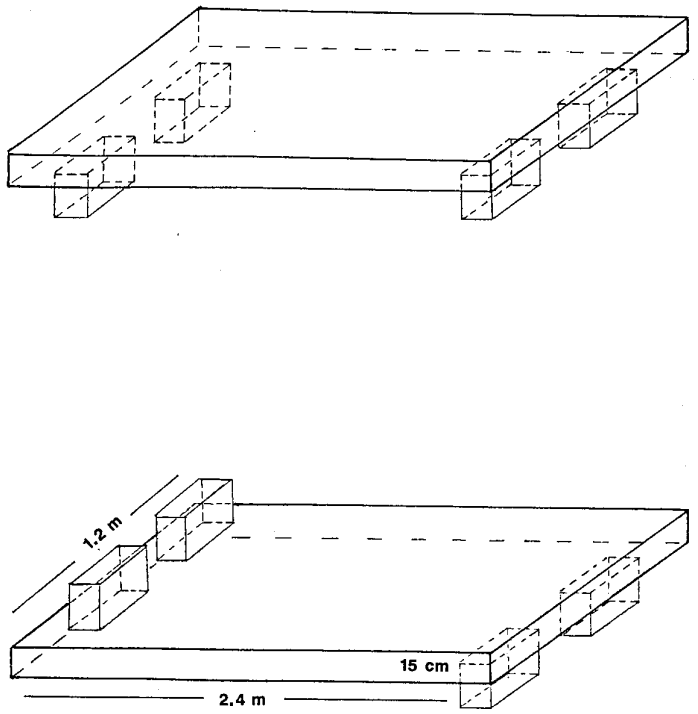

FIGURE 9

EXPERIMENTAL "TABLE" SHELTERS (TWO DESIGNS)

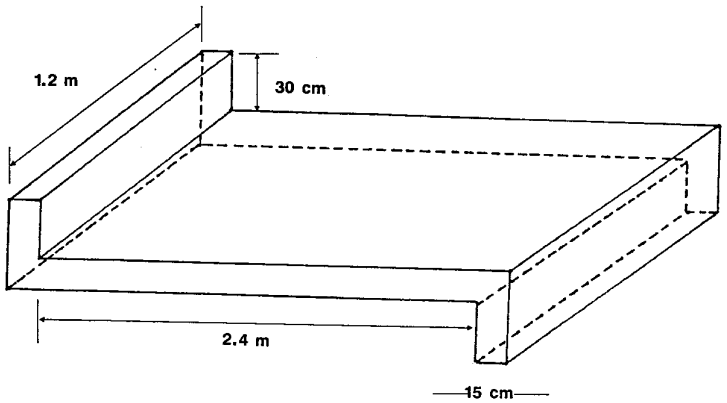

FIGURE 10

"INVERTED DOUBLE-L SHELTER"

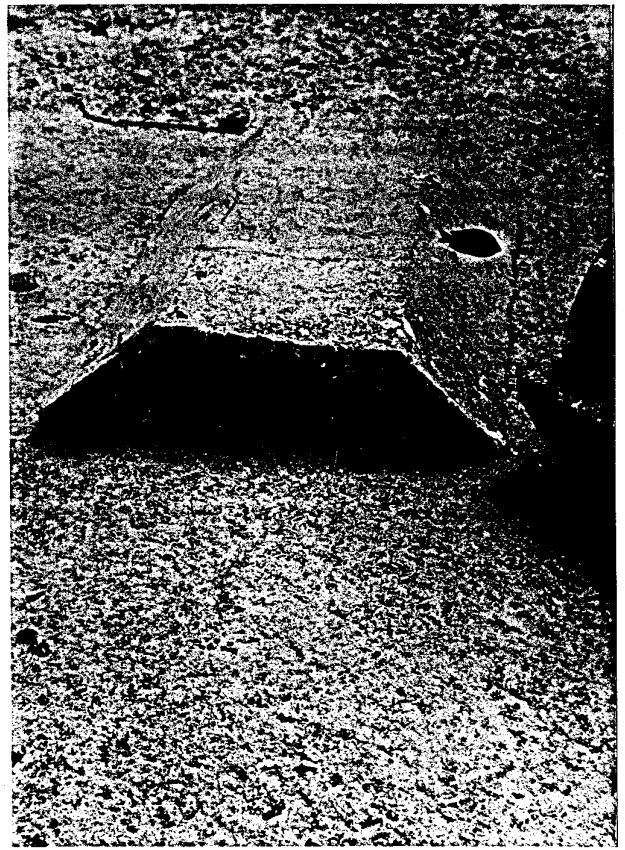

Figure 11. Experimental "lobster house".

Figure 13. Adding concrete ballast to large truck tires.

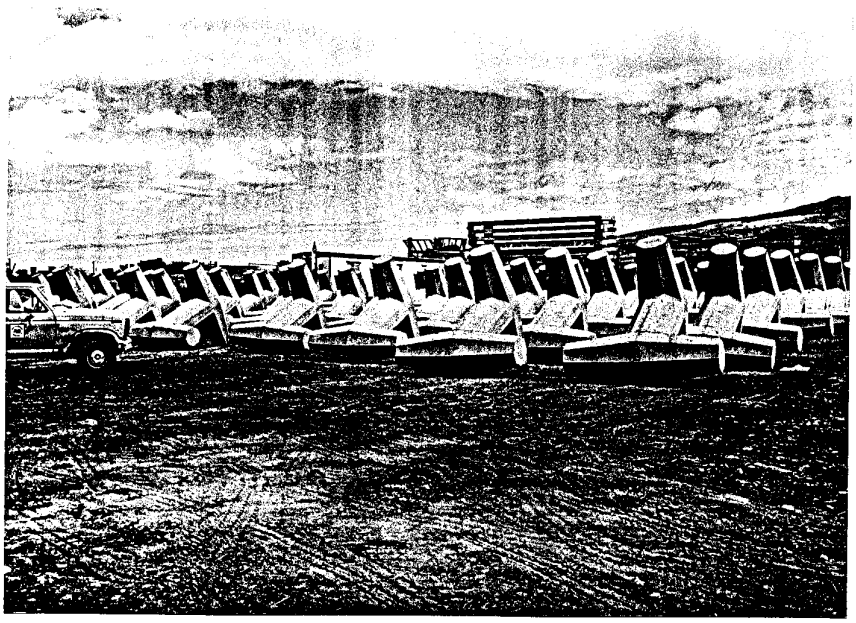

Figure 12. Pre-cast concrete "dolos armor".

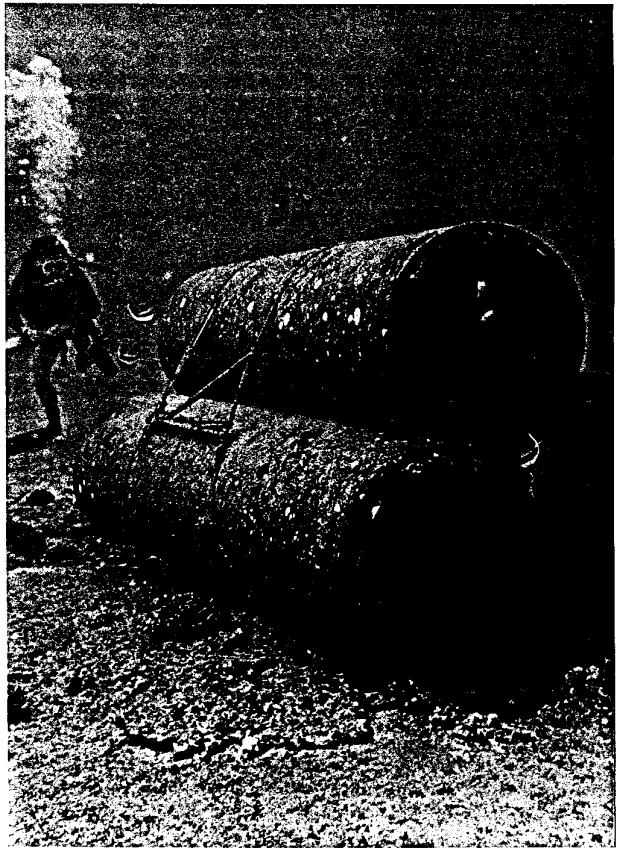

Figure 14. Diver monitoring "pipe house".

Figure 15. Mass production of tire modules.

Figure 17. Reef fish attracted to clusters of tire modules.

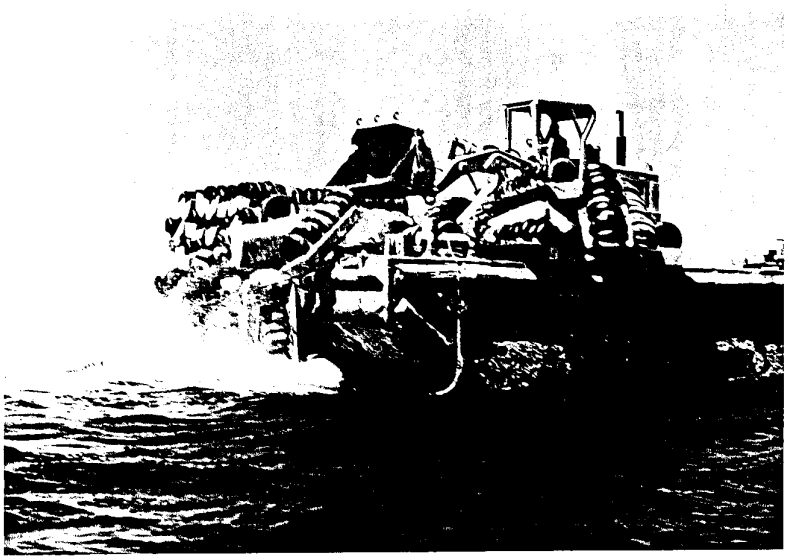

Figure 16. Deploying tire modules off a barge.

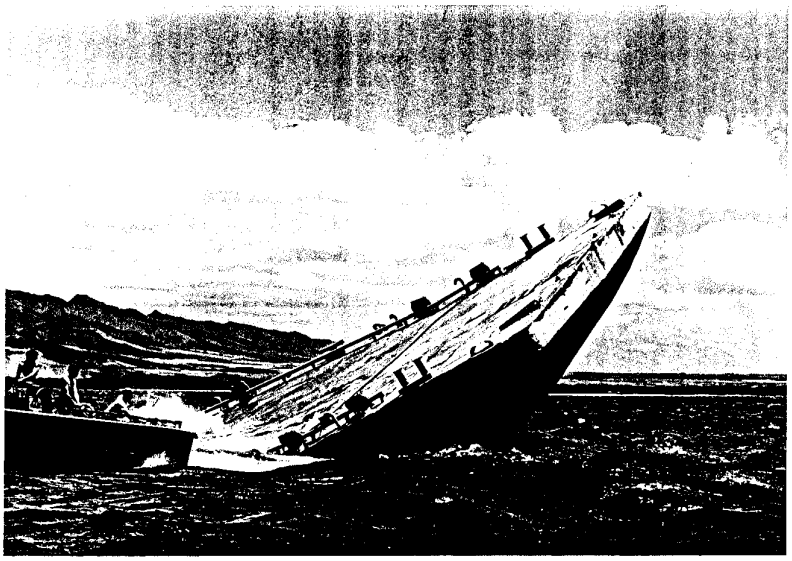

Figure 19. Scuttling of a Navy barge.

Figure 18. Reef fish hiding in a tire module.

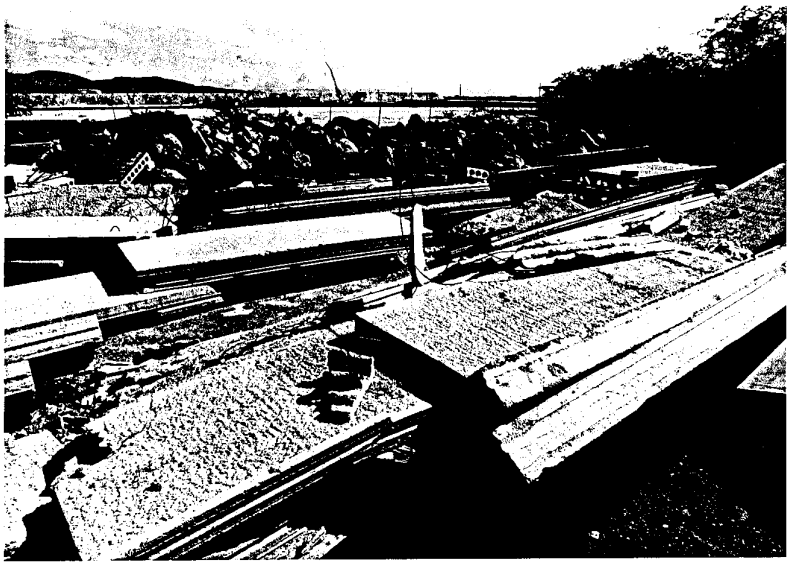

Figure 21. Construction material at a storage yard.

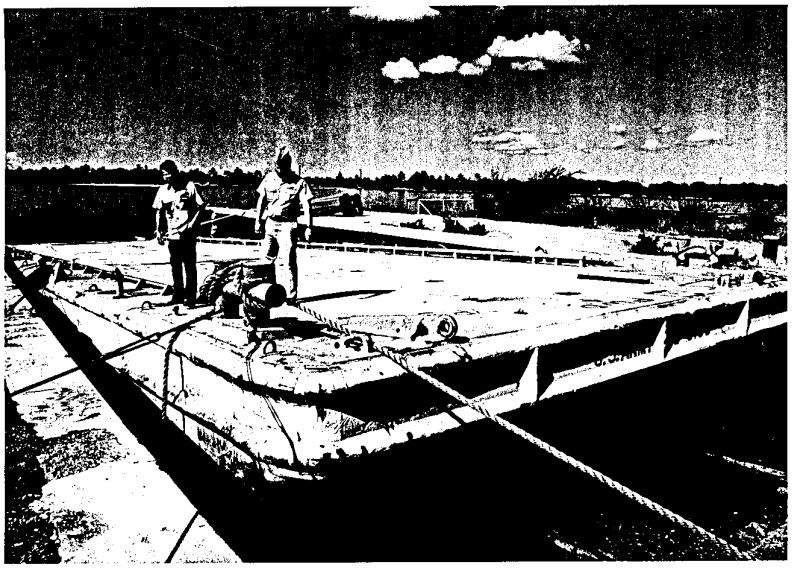

Figure 20. Inspection of an old Navy barge.

Figure 23. Conducting SCUBA surveys at a tire reef.

Figure 22. Depositing construction material at a deepwater reef.

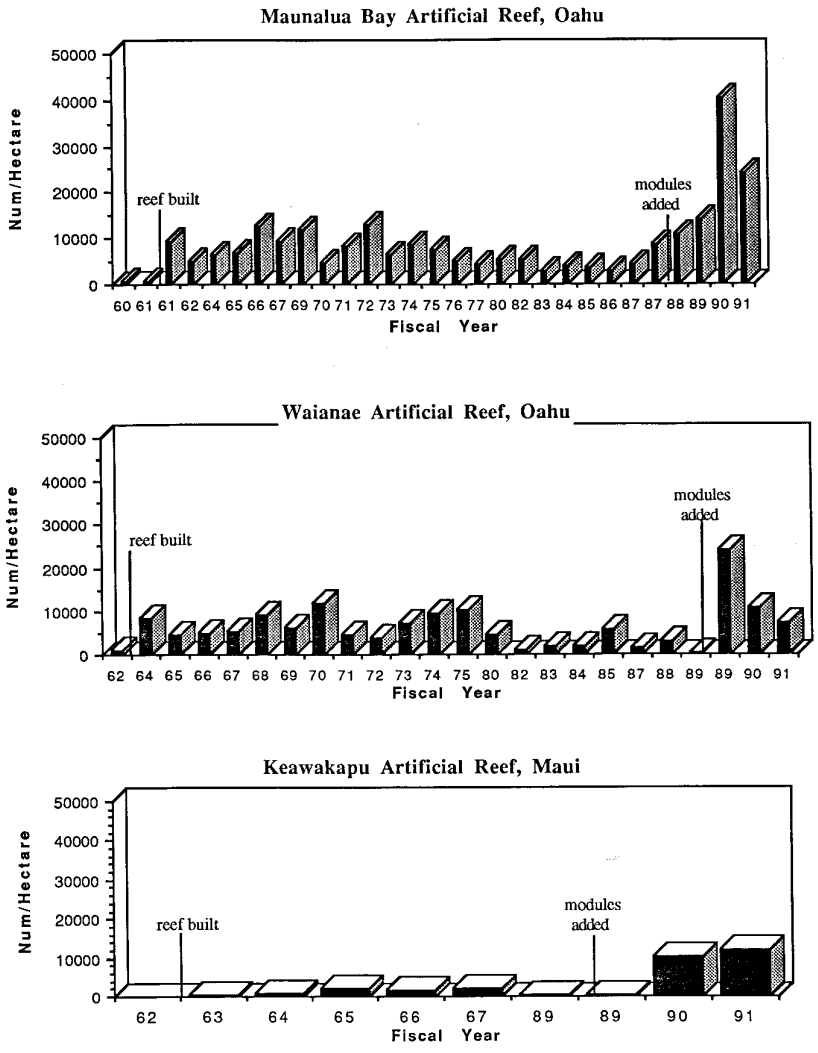

Figure 24. Fish abundance per hectare at Maunalua Bay, Waianae, and Keawakapu Artificial Reefs.

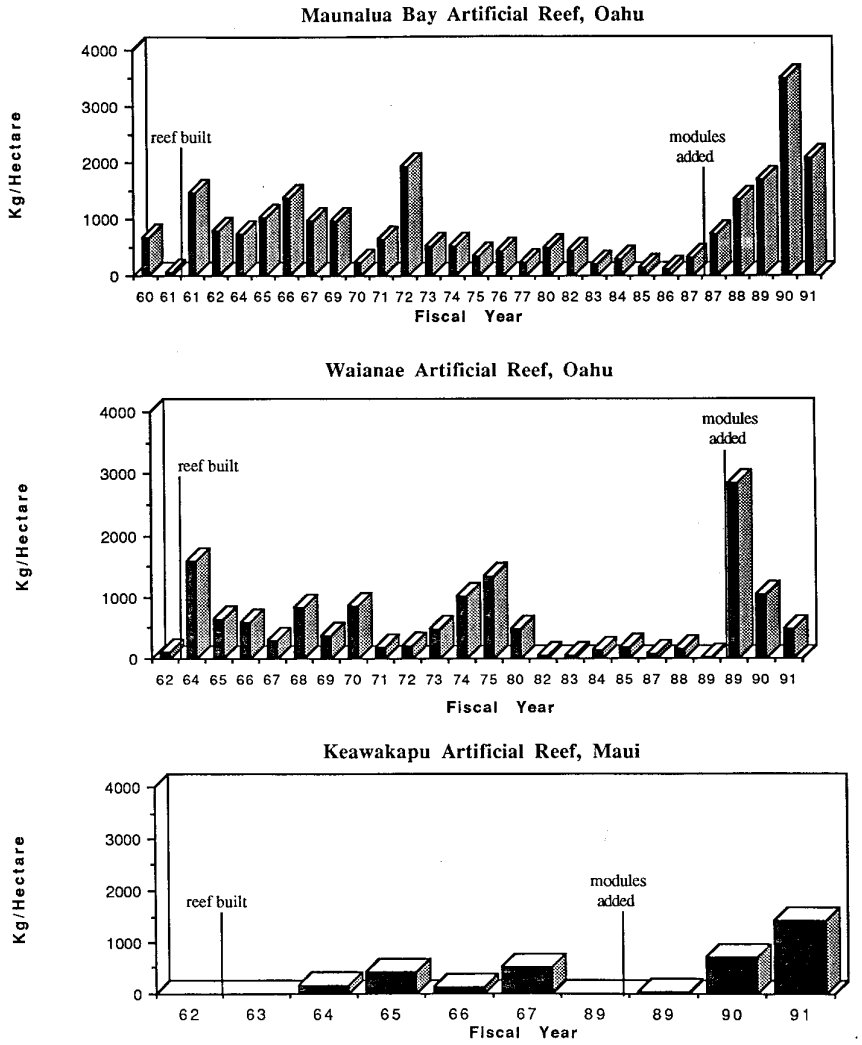

Figure 25. Fish biomass at Maunalua Bay, Waianae, and Keawakapu Artificial Reefs in Kilograms/Hectare.

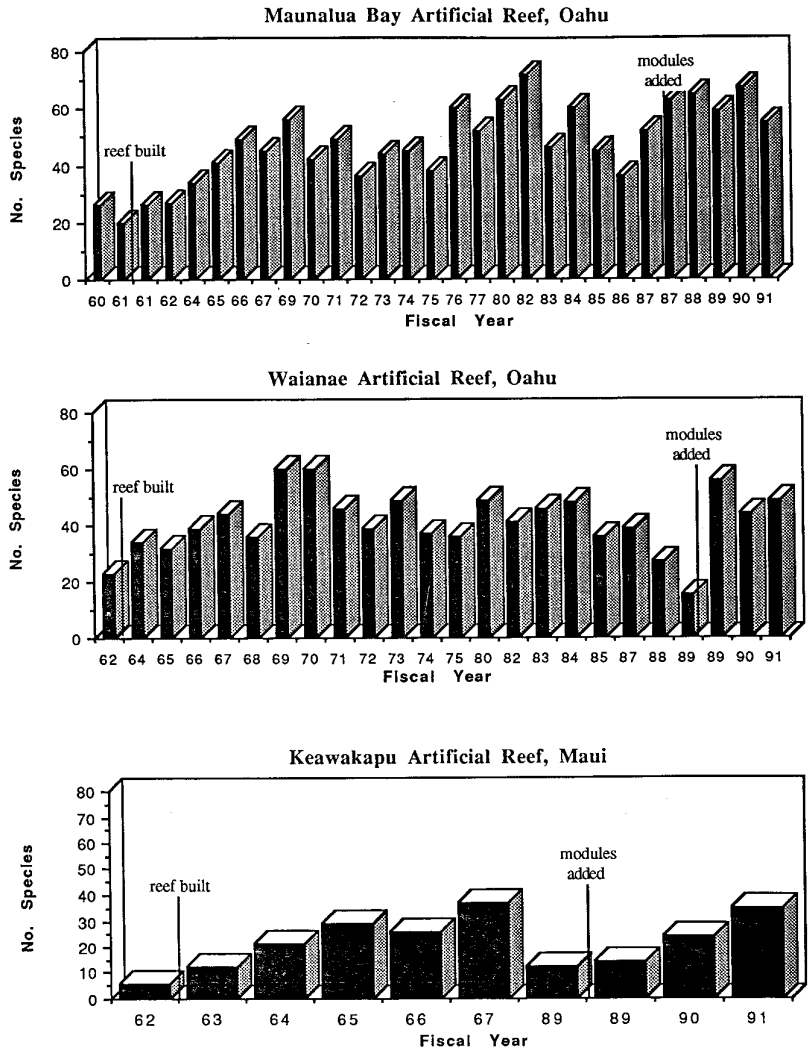

Figure 26. Number of fish species observed at the Maunalua Bay, Waianae, and Keawakapu Artificial Reefs.

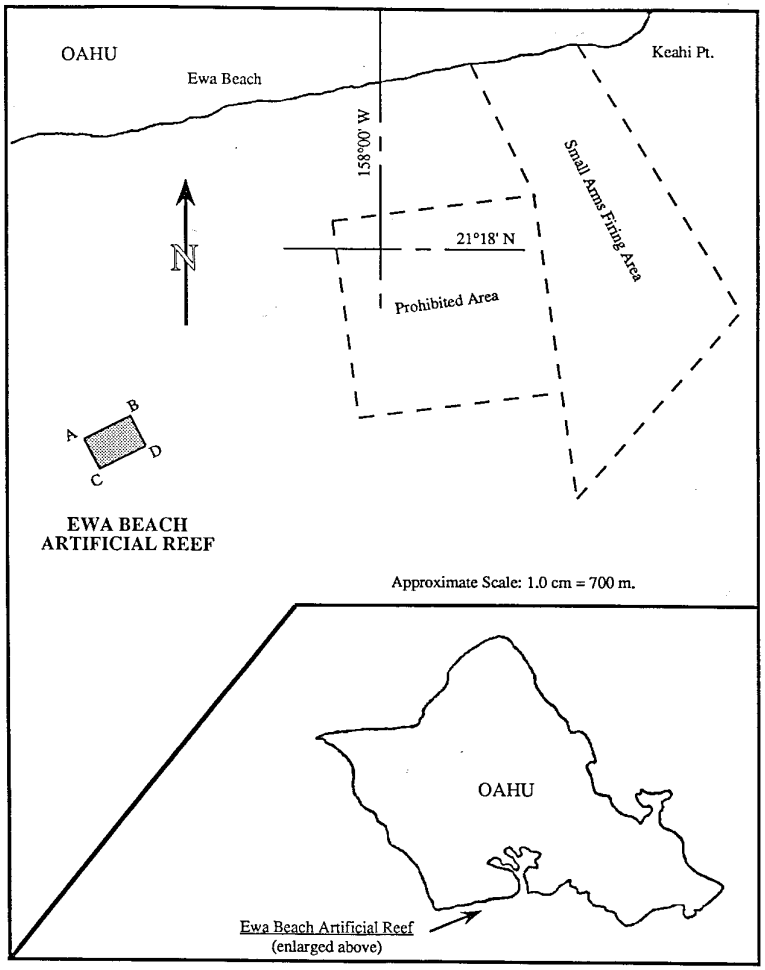

Figure 27. Location and boundaries of the Ewa Deepwater Artificial Reef, Oahu.

Boundary coordinates in latitude and longitude.

A. 21°~~17 00~~ 16-49 N, 158°~~10 31~~ 01-22 W
B. 21°~~17 07~~ 16-56 N, 158°01' ~~18~~ 08 W
C. 21°16' ~~53~~ 42 N, 158°01' ~~27~~ 17 W
D. 21°16' ~~59~~ 49 N, 158°01' ~~13~~ 03 W

Table 1. Results of surveys conducted at Maunalua Bay Artificial Reef, Oahu

Fiscal Year	Counts	Abundance (no. fish/ha)	Biomass (kg/ha)	No. Species
60	4	712	673	26
61	1	786	45	20
61	3	9,424	1,484	26
62	6	4,952	808	27
64	2	6,301	730	34
65	2	6,850	1,039	41
66	1	12,681	1,390	49
67	1	9,323	983	45
69	1	11,942	980	56
70	1	4,683	229	42
71	2	8,340	640	49
72	1	12,847	1,947	36
73	3	6,437	516	44
74	1	8,515	535	45
75	1	7,571	364	38
76	1	5,026	436	60
77	1	4,359	239	52
80	1	5,404	499	63
82	1	5,327	427	72
83	1	2,849	220	46
84	1	3,983	288	60
85	1	3,650	137	45
86	3	2,955	115	36
87	3	4,379	310	52
87	1	8,804	729	63
88	4	10,877	1,358	65
89	2	13,857	1,696	59
90	1	40,250	3,512	67
91	1	24,280	2,102	55

Table 2. Results of surveys conducted at the Waianae Artificial Reef, Oahu

Fiscal Year	Counts	Abundance (no. fish/ha)	Biomass (kg/ha)	No. Species
62	1	1,322	112	23
64	4	8,315	1,592	34
65	5	4,537	651	32
66	8	5,080	579	39
67	1	5,310	307	44
68	1	9,281	835	36
69	1	6,029	374	60
70	1	11,762	856	60
71	1	4,645	198	46
72	2	3,694	217	39
73	1	7,240	481	49
74	2	9,486	1,009	37
75	2	10,272	1,330	36
80	1	4,700	471	49
82	1	996	50	41
83	1	2,004	66	46
84	2	1,885	136	48
85	1	5,673	184	36
87	1	1,357	73	39
88	1	3,160	170	27
89	1	331	19	15
89	1	24,114	2,851	56
90	2	10,776	1,045	44
91	1	7,154	474	49

Table 3. Results of surveys conducted at the Keawakapu Artificial Reef, Oahu

Fiscal Year	Counts	Abundance (no. fish/ha)	Biomass (kg/ha)	No. Species
62	1	143	3	6
63	1	348	13	12
64	3	687	146	21
65	2	2,103	419	29
66	3	1,530	132	26
67	1	2,199	529	37
89	1	250	10	12
89	3	353	30	14
90	2	10,418	725	24
91	1	12,167	1,407	35

Table 4. Results of eight surveys conducted at two barges in the Maunalua Bay Artificial Reef, Oahu

Mud Scow (32m)			
Survey Date	No. Fish Observed	Est. Weight (Kg)	No. Species
5/85	568	27	20
8/85	364	20	28
12/85	330	27	26
5/86	255	30	35
9/86	630	36	50
7/87	623	38	38
3/88	1,330	148	44
1/89	2,612	149	49

Construction Barge (49m)			
5/85	741	69	27
8/85	463	31	16
12/85	572	33	33
5/86	754	53	46
9/86	984	196	39
7/87	638	323	34
3/88	417	504	35
1/89	669	272	39

APPENDIX B. MEMORANDUM OF AGREEMENT (MOA) BETWEEN US ARMY CORPS OF ENGINEERS, DAR, & HASEKO

MEMORANDUM OF AGREEMENT

Parties: HASEKO (Ewa), Inc.
U.S. Army Corps of Engineers, Pacific Ocean Division
Department of Land and Natural Resources, Division of Aquatic Resources

1. Purpose

The purpose of this Memorandum of Agreement (MOA) is to establish certain commitments binding upon HASEKO (Ewa), Inc. ("HASEKO"), the U.S. Army Corps of Engineers, Pacific Ocean Division ("COE"), and the State of Hawai'i Department of Land and Natural Resources Division of Aquatic Resources ("DLNR/DAR"), related to Special Condition #13 of HASEKO's Department of the Army Permit (PODCO 2117, issued on June 28, 1993). Special Condition #13 requires HASEKO to construct an artificial reef in the vicinity of its Ocean Pointe Marina (previously known as the "Ewa Marina") development to offset impacts to coral-reef habitat associated with construction of the entrance channel to the Marina.

This MOA establishes a plan to satisfy Special Condition #13 (i.e. enhancement of coral-reef habitat in the area) while taking into account recent improvement in scientific understanding concerning the optimum size of artificial reef habitat. Under the terms of the MOA, discussed in more detail below, HASEKO will support the DLNR/DAR application for a Conservation District Use Permit (CDUP) for a much larger artificial reef (on the order of 100 acres of surface area) than required by Special Condition #13 and specifies the financial support that HASEKO will provide for the emplacement of the first increment of the reef construction. DLNR/DAR will be responsible for the design, construction, and long-term maintenance of the artificial reef. Should HASEKO be unable, despite a good faith effort, to obtain the CDUP or other approvals needed to construct the artificial reef, HASEKO will provide DLNR/DAR with the funds committed to the First Increment of Reef Construction to support the DLNR/DAR artificial reef program at another location.

2. Definitions

For the purposes of this MOA, the following terms have the meanings indicated below:

"Board" means the Board of Land and Natural Resources, State of Hawai'i.

"CDUP" means State of Hawai'i Conservation District Use Permit for the proposed artificial reef.

"COE" means the U.S. Army Corps of Engineers, Pacific Ocean Division.

"DLNR/DAR" means the State of Hawai'i Department of Land and Natural Resources Division of Aquatic Resources.

"First Increment of Reef Construction" means the placement of materials in the Permitted Area under the direction of DLNR/DAR and funded by HASEKO to a maximum level of $150,000 and within a time of less than 12 months after the acquisition of all required approvals.

"HASEKO" means HASEKO (Ewa), Inc., its employees, agents, representatives, designees, and its successors and assigns.

"Permitted Area" means the location of the proposed artificial reef identified in the CDUP application.

"Parties" means HASEKO, COE, and DLNR/DAR.

"U.S. Department of the Army Permit" means a Clean Water Act Section 404 permit for the proposed artificial reef.

3. Background

Special Condition #13 to HASEKO's Department of the Army Permit (PODCO 2117) is reproduced in italics below:

13. Artificial Reef:

a. The permittee shall construct an artificial reef in the vicinity of an existing sunken barge, identified as Site No. 4 in the Ewa Marina Sea Turtle Population Surveys and shown on sheet 10 of 10 of this permit, or at a suitable site along the Leeward Coast between Ewa Beach and Barbers Point Naval Air Station, which meets the following site selection and design criteria:

(1) relatively flat hard bottom;

(2) water depths from 60-90 feet;

(3) location outside lanes of shipping and pleasure craft traffic;

(4) location devoid of live coral;

(5) location in a benthic community with appropriate forage for the fishes expected to be resident to the reef;

(6) materials and design which would provide a 40-year life expectancy and high stability as ascertained by a qualified engineer; and

(7) a navigation safety clearance of a minimum of 40 feet of water above the highest point of the artificial reef.

b. Final site selection and/or detailed design will be made in consultation with the National Marine Fisheries Service, subject to the approval of the State Department of Land and Natural Resources and the State Department of Health. A plan for construction shall be submitted within 6 months of issuance of this permit. Construction of the reef shall be completed prior to initiation of the entrance channel excavation.

c. The permittee shall notify National Ocean Service, Source Data Unit (N/CG2211), Mapping and Charting Branch, 130 East-West Highway, Station 7317, Silver Spring, MD 20910-3233, and the Corps of Engineers in writing, at least six months prior to construction and upon completion of the reef construction. The notification of

completion must include a drawing which certifies the location and configuration of the deployed reef.

d. The permittee will be responsible for maintaining the vertical relief of the structure in substantial conformance with the approved design for 40 years.

e. In the event that, despite the permittee's best efforts, the required local approvals are denied, the permittee may enter into an alternative agreement with the State Department of Land and Natural Resources for participation in their ongoing artificial reef construction or other habitat enhancement/replacement program. Participation may be in the form of materials, moneys, research studies, or other equivalent commitment, provided that such participation directly benefits marine habitat along the Leeward Coast and substantially meets the site selection and design criteria in paragraph a. of this condition. Under this alternative, a copy of such agreement must be provided to the Corps prior to initiation of marina entrance channel construction.

The basis for the required size of the artificial reef that HASEKO must construct is contained in Item 25 of the Army Record of Decision for the permit, which reads:

(25) Special aquatic sites--Loss of coral reef: As noted earlier, excavation of the 400-foot-wide, 3,000-foot-long entrance channel constitutes the only physical alteration beyond the existing shoreline. Marine studies referenced and appended to the Final EIS show that the coral coverage over the approximately 28-acre reef area to be dredged ranges from 0.1% in the shallow intertidal area to 10% at the seaward end of the entrance channel, with an average of 4% coral coverage over the entire channel alignment.

In the years since Special Condition #13 was established, the scientific understanding of artificial reefs has moved forward significantly, and most scientists currently believe that the size of the artificial reef that would satisfy the requirements of this Special Condition (which would have a surface area of approximately 1.1 acres) would not be sufficient to create useful coral-reef habitat. Rather, a structure or aggregate of seafloor structures with a total surface area of this size would function primarily as a fish aggregation device. As such, it would tend to concentrate fish near the structures without providing productive habitat for community growth. Staff scientists in DLNR/DAR believe that this situation would lead to greater vulnerability of reef fish to over fishing, due to the concentration of fish at a site readily accessible to fishermen, with no enhancement of fish reproductive rates or growth.

As noted above, DLNR/DAR believes that, while creation of the specified area of artificial reef (4% of 28 acres, or about 1.1 acres) is sufficient to offset the impact to coral reef caused by the marina entrance channel, it would be undesirable if the area were to be provided as a stand-alone entity. For this reason, the Parties agree that it would not be possible to obtain the requisite permits for such an artificial reef. Thus, HASEKO is committed, through this MOA, to an alternative agreement, consistent with Item e of Special Condition #13. The following section describes the essential characteristics of this agreement.

4. Applications for a Large Artificial Reef in the Ewa Offshore Environment

The Parties agree to undertake the following tasks necessary for the establishment of an approved artificial reef site and constructing the first increment of reef within the Permitted

Area. HASEKO will contract with Planning Solutions, Inc. (subsequently referred to as "the Consultant") to complete Tasks 4a and 4b, described below.

a. Site Identification

Using the general criteria described in Special Condition #13, Items a(1) to a(5), and guidance from the other Parties, the Consultant will identify an appropriate seafloor area along the O'ahu Leeward Coast for the artificial reef structures. The Consultant will perform the necessary site survey work to select the site and to ensure that these criteria are met for the selected site. The Consultant, in collaboration with DLNR/DAR staff, will identify a target seafloor area of approximately 100 acres to be designated for the future construction of artificial reef structures.

b. Site Permitting

The Consultant will prepare the necessary applications and support documentation for permitting the artificial reef site. DLNR/DAR commits to be the applicant for these permitting actions and the Proposing Agency for the environmental documentation. The Parties anticipate that permitting will entail preparation of a CDUP application. Support documentation will include an Environmental Assessment or Environmental Impact Statement, consistent with Hawai'i Revised Statutes, Chapter 343. If it is determined that the existing Department of the Army Permit for the Ocean Pointe project does not provide completely for the artificial reef, then the Consultant will prepare a Department of the Army Permit Application as well and will prepare the EA/EIS as a joint Chapter 343/National Environmental Policy Act (NEPA) document. The Parties agree that if the CDUP or other required permits become the subject of a contested case hearing or legal challenge or are denied, then the resulting delay would make it impractical to complete the permitting process within a reasonable time frame. If this occurs, then HASEKO will provide funds to be used by DLNRDAR to support its artificial reef program at some other site as provided for in Section 4.c of this MOA. HASEKO's obligations under this MOA shall then be considered fulfilled, and it shall be relieved of any further obligation under Special Condition #13.

c. First Increment of Reef Construction

The permit applications and environmental documentation will be based on concept-level prototypical designs agreed to by the Parties. HASEKO will be responsible for preparing these plans in consultation with DLNR/DAR, which shall have final approval authority for the concept plans. DLNR/DAR will be responsible for the final design of artificial reef structures within the approved site, including the First Increment of Reef Construction.

HASEKO will provide funds for the construction of the First Increment of Reef Construction. This support will consist, at DLNR/DAR's discretion, of the direct purchase of services and materials by HASEKO as specified by DLNR/DAR or the transfer of funds to DLNR/DAR to be used for the purchase of those services and materials. In either case these services and materials would be only for the purpose of First Increment of Reef Construction. HASEKO commits up to $150,000.00 for this purpose.

Because Special Condition #13 must be satisfied before HASEKO is able to construct the entrance channel to its marina, the Parties agree that time is of the essence. Should DLNR/DAR be unable to complete the First Increment of Reef Construction within a time of less than 12

months after the acquisition of all required approvals, the Parties agree that the funds allocated for this purpose will be placed in trust for future use in constructing the artificial reef.

5. Fulfillment of Special Condition #13

All Parties agree that completion of the tasks described in item 4 above will satisfy the requirements of Special Condition #13 unless the permit applications are rejected as incomplete or environmental documentation is found to be inadequate. In such case, HASEKO will be responsible for the additional work needed to complete an acceptable application and/or environmental documentation.

6. Successors and Assigns

The provisions of this MOA shall apply to and be binding upon the Parties, and their respective employees, agents, successors and assigns.

7. Notices

All notices required by this MOA shall be made to the following representatives of the Parties:

HASEKO: Raymond Kanna, Project Manager, HASEKO (Ewa), Inc., 91-1001 Kaimalie Street Suite 205, 'Ewa Beach, HI 96706

COE: George Young, P.E., Chief, Regulatory Branch, U.S. Army Engineer District, Honolulu, Bldg. 230, Ft. Shafter, Honolulu, HI 96858-5440

DLNR/DAR: Peter T. Young, Chairperson, P.O. Box 621, Honolulu, HI 96809

8. Amendments

This MOA may be revised, modified or amended by the Parties to meet the purposes of Special Condition #13. Any revision, modification or amendment must be in writing and signed by all the parties to become effective.

9. Effective Date

This MOA shall take effect immediately when signed by all the Parties and shall remain in force until 30 days after the later of:

(a) State Board of Land and Natural Resources final action on the CDUP application and supporting Chapter 343, Hawai'i Revised Statutes environmental impact documentation and

(b) Corps of Engineers final action on the Department of the Army Permit application.

HASEKO will use its best efforts to complete and submit the required CDUA and supporting environmental documentation no later than June 30, 2005, allowing the Board to act by December 31, 2005.

HASEKO

Date: 10/7/04 By: _____

Toru Nagayama
President

COE

Date: 10/21/04 By: _____

David E. Anderson
Lieutenant Colonel, District Engineer

DLNR/DAR

Date: 9/22/04 By: _____

Peter T. Young, Chairperson
Board of Land and Natural Resources

APPENDIX C. KALAELOA ARTIFICIAL REEF DESIGN CONSIDERATIONS

By Dr. Richard Brock, University of Hawai‘i at Mānoa

KALAELOA ARTIFICIAL REEF: A SYNOPSIS OF DESIGN, PROPOSED LOCATION AND IMPACTS

EAC REPT. NO. 2006-23

PREPARED FOR:

PREPARED BY:
R.E. BROCK, PH.D.
ENVIRONMENTAL ASSESSMENT, LLC
1820 KIHI STREET
HONOLULU, HAWAI'I 96821

DECEMBER 2006

KALAELOA ARTIFICIAL REEF A SYNOPSIS OF DESIGN, PROPOSED LOCATION, & IMPACTS
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EXECUTIVE SUMMARY

HASEKO (Ewa), Inc. is working with the Division of Aquatic Resources (DAR) of the Hawai'i State Department of Land and Natural Resources (DLNR) to establish a site for an artificial reef on the seafloor off the southwestern coast of the island of O'ahu. This report has been prepared to guide site selection. Specifically, it discusses the role and impact of artificial reefs in coral reef settings, suggests a site and reef design, examines the possible impacts that deployment may have on both benthic and fish communities, and recommends a specific area that may be appropriate for the establishment of such a site.

The waters offshore of Kalaeloa[1] (i.e., from the tanker offloading facility on the west to the military controlled danger zone on the east) were examined in the field by divers to identify potential artificial reef sites. A suitable site was found approximately 1.9 km west of the Barbers Point (Honouliuli) sewage ocean disposal pipe and 1.1 km east of the offshore unloading facility. This proposed site is situated at depths between 60 and 120 feet and encompasses 224 acres. There are two biological zones or biotopes present in this area which are based on the dominant substratum and benthic community components; these are the biotope of scattered corals, which occupies no more than 5% of the bottom in the proposed site, and the biotope of deep featureless limestone, which occupies most of the remainder of the proposed artificial reef site. Mean live coral coverage is about 10% in the biotope of scattered corals and 0.3% in the biotope of deep featureless limestone.

The proposed artificial reef would be constructed using DLNR-approved concrete "Z" block modules. The costs to build and deploy these modules is about $150 each and their stability and fisheries enhancement capabilities are appropriate for Hawaiian waters. Borrowing from artificial reef technology developed in Japan, it is suggested that "Z" blocks be deployed in groups of about 1,200 units together to form a circle about 30 m in diameter and about 6 m high, which constitutes a reef "set". About five or so "sets" would be deployed within visual range of one another thus forming a reef "group". Spacing between reef "groups" would range from 50 to 150 m or so resulting in about 25 groups (of 5 sets each) deployed in this artificial reef site at final build-out. Depending on the rate of module construction, full build-out could occur over 20 or more years. In total, about 88,400 m^2 of substratum (or 9.8% of the total bottom of the site) would be covered by this artificial reef. If reef "sets" are deployed in the biotope of deep featureless limestone, there would be an initial loss of 263 m^2 of living coral; however the reef sets provide new hard substratum that is elevated above the bottom and protected from scouring by occasional high surf. On these elevated surfaces coral coverage would be greater than present (a realistic coral coverage estimate is 29%), thus the fully-deployed reef would "create" a several-fold increase in living coral at the site over the next 20 years.

Fish standing crops in the biotope of deep featureless limestone are estimated to be about 4 g/m^2 at present. Utilizing data from other Hawaiian artificial reef studies, the standing crop is expected to increase to a mean of 1,216 g/m^2 during the first two years and it is estimated that after 20 or more years, this standing crop would be about 265 g/m^2. In contrast, standing crops on most natural reef areas rarely exceed 200 g/m^2.

[1] The traditional Hawaiian name for the Barbers Point region of O'ahu

1.0 BACKGROUND INFORMATION

Coral reefs have attracted the attention of researchers since the time of Darwin, yet quantitative studies of reef structure and function have appeared in the literature only in the last 40 years. World reef fisheries potential have been estimated at 6 x 109 kg/yr (Smith 1978). At the time, this amounted to about 9 percent of the world's total fisheries landings. The importance of coral reef fisheries is particularly evident in many tropical insular areas where reefs supply much of the protein consumed; and due to the labor intensive methods of harvest, the fisheries may employ a large segment of the population. However, many of these fisheries are declining (Saila and Roedel 1979, Johannes 1981).

Declines in coral reef fisheries are due to a multitude of factors including overfishing, pollution and the dredging and infilling of reefs. Many aspects of these changes are beyond the scope of this report[2] and will not be presented here. Irrespective of the causal factor, human activities are responsible for many declines in reef fisheries.

Hawaiian coral reefs have suffered numerous perturbations, including nutrient loading and pollution, runoff, infilling of shallow nursery grounds, dredging of harbors, and the introduction of alien species. Population growth and technology have allowed high fishing pressure to occur, and have given fisherman the capability to effectively exploit many coral reef fish species throughout their entire range. In recent years, the numbers of commercial and recreational fishermen have increased markedly. Reported landings[3] from the Hawaiian inshore fisheries have declined from the turn of the century (Shomura 1987) and have continued up to today. In 1900, 59% of the fishery resources consumed (or 3.6 million pounds) were from Hawai'i's coral reefs while today less than 1% (or 279,000 pounds) comes from these ecosystems (data from Hawai'i reported commercial landings). Despite these low levels, the available data suggest that the Hawaiian inshore fishery resources are continuing to decline but remain culturally important.

One of the trends apparent in Hawai'i is the increasing utilization of inshore fishery resources by recreationally oriented users. Recreational fisheries now account for much of the economic value of the inshore fishery resource; recent economic studies of local marine enterprise (e.g., Van Poolen and Obara 1984, Miller 1984, Markrich 1984, 1986a, 1986b, Samples 1986) confirm that recreational and nonconsumptive uses of inshore fishery resources are of greater value than traditional commercial exploitation. A study conducted by the NMFS (Honolulu Laboratory) concluded that Hawaiian recreational fishing produces some 4545 metric tons of fish per year. The value of this mixed (i.e., inshore and pelagic) fishery is estimated at $239 million.

Yields of finfish from reef ecosystems have been summarized (Stevenson and Marshall 1974; Munro 1978, Stevenson 1979, Brock et al. 1979, Marten and Polovina 1982) and range from 2 to about 4.5 tons/km^2/yr. Localized and intensive gleaning on American Samoan reefs yield up to 27 tons/km^2/yr (Wass, in preparation). Such high yields are not representative of production over large areas for they do not include adjacent deeper waters from which there is considerable recruitment and little fishing.

Traditional methods of fisheries management in Hawai'i disappeared long ago (Titcomb 1952; Kosaki 1954). Applying modern management techniques to these fisheries is difficult; catch and effort data are lacking and the multitude of species exploited complicates the matter. As a result, inshore fisheries in Hawai'i and many other geographical localities are stagnant or diminishing

[2] For example, the impact of western values and cash economy on tropical insular cultures or damage to reefs due to storms such as Hurricane Iniki which heavily impacted Hawaiian reefs in September 1992

[3] Number of fish caught

(Johannes 1978). There are numerous challenges to achieving rational management of these resources, and a much better understanding of coral reef ecosystems is needed if they are to remain viable in the present cultural context (Bevan et al. 1979, Johannes 1981).

Artificial reefs have been recognized by the scientific community and governments across the world as a fisheries management technique capable of enhancing local fish production by increasing available habitat. Until the mid-1980's the technology of artificial reefs in the U.S. utilized scrap materials that were often indiscriminately dumped at sea. In many cases the primary justification for artificial reef construction was perceived and promoted as the disposal of wastes rather than as a resource enhancement tool (Buckley 1982). Reefs thus built provided some habitat improvement and increased fishery yields in otherwise barren areas, but the shapes, size, long-term physical stability, and biological productivity afforded by use of such materials are less than ideal (Sheehy 1982b). Clearly, artificial reefs can perform the secondary function of recycling specific types of solid wastes, but their primary role should be as a fishery management technique for marine waters which enhances habitat, increases resource production, and efficiently targets fishing locations (See also Brock et al. 1985, Brock and Norris 1989). Research on the use of various engineered reef modules in Japan has shed light on aspects of reef design that can enhance its effectiveness for those purposes, and U.S. deployed reefs such as the proposed Kalaeloa Artificial Reef are following suit in applying and developing reef design technologies.

The remainder of this Chapter is organized as follows: Section 1.1 provides a synopsis of artificial reefs in Japan and describes their contribution to current scientific thinking. Sections 1.2, 1.3, and 1.4 describe the history of artificial reef efforts in Hawai'i since the 1950s and the lessons learned from those experiences. Sections 1.5, 1.6, and 1.7 discuss the function, effectiveness, and overall impact of artificial reefs based on the scientific literature. Chapter 2 then goes on to discuss the site selection process for the proposed Kalaeloa Artificial Reef and provide a detailed description of the selected reef site. Chapter 3 introduces the design of the proposed reef, and Chapter 4 discusses some of the potential impacts that could result from its deployment.

1.1 ARTIFICIAL REEFS IN JAPAN

Japan is a nation heavily dependent on the sea for food production and has historically sought ways to improve its fisheries. These efforts have resulted in fishing and aquaculture industries which rank the highest in the world in terms of value and governmental support (Mottet 1985, Nakamura et al. 1991). The Japanese government instituted a national coastal fisheries program in response to the 1973 oil crisis, the growing impact of the 200-mile extended jurisdiction statutes, and increasing development-related coastal degradation. Since 1976, artificial reef programs in Japan have received federal subsidies of about $100 million per year (Nakamura 1985, Grove et al. 1989). Artificial reef research and development is expected to develop 5 percent of Japan's coastal waters into fishing zones with the placement of reefs at 2,500 sites. These reefs are expected to yield 4.8 million tons of fishery products annually (Mottet 1985). The large investment in artificial reefs by the government, universities, and private industry has resulted in dramatic advancements in reef module design (Nagahata 1991).

Japan puts considerable effort into reef module design and follows numerous criteria for their deployment (Nakamura 1991). The designs and arrangement of reef modules vary with the intended use of the reef, the ecology of the target species, the anticipated fishing methods, and the physical characteristics of the deployment area (Kakimoto 1991, Takeuchi 1991). Modern modules used in Japanese artificial reef structures are engineered for stability, durability, economy, and biological

effectiveness (Yamane 1989). Chambered structures with vertical relief are favored for their ability to increase the complexity of the local habitat and attract fish. Artificial reefs built with chambered structures have proportionally more void space (70 to 98 percent) relative to exposed surface area, permitting the construction of large module units with a minimum of material. Chambered designs are best suited to deeper, more protected environments because they lack stability characteristics for use in high energy environments.

Among the more intriguing designs for chambered modules are those built of fiberglass reinforced plastic (FRP modules). Many of these are made of bands of fiberglass woven into cylinders that are typically 1.5 x 7 m. Cylinders are strapped together forming reef modules. Concrete poured into the base lends stability to the unit and the entire module is assembled on land. It is then floated and towed to the artificial reef site and deployed with reusable air lift bags. Fiberglass reinforced plastic is expensive; however its strength permits the building of large units that are relatively inexpensive to deploy (Mottet 1985). This design has been used in Hawai‘i both for deepwater snapper enhancement studies (Moffitt et al. 1989) and for the enhancement of reef fish in the Atlantis Submarine artificial reef dive tour site offshore of Waikīkī.

One of the most popular module designs in Japan is the concrete "dice block." These consist of open framework cubes made of concrete; they have considerable void space. Their simplicity in design makes them easy to construct and their weight lends high stability to the design. Dice blocks were among the first designs to be sanctioned by the Japanese government (Mottet 1985). Government-approved designs must meet a number of criteria: 30 year life expectancy, reasonable cost, non-polluting, biological effectiveness and low breakage rate on deployment. Dice blocks have been used in government sponsored reefs since 1954.

Studies conducted in Japan on the effectiveness of artificial reefs show that catches range from 0.2 to 113 kg per cubic meter of enclosed space (Miyazaki and Sawada 1978). Small 1 to $2m^3$ chamber modules average about 20 kg/m^3 (Mottet 1985). Sato (1985) calculated that a break-even yield (i.e., the catch, if sold, that would be necessary to pay for the cost of reef construction and deployment in a given period of time, usually one to ten years) on Japanese artificial reefs is roughly 12 kg/m^3, however this is with many assumptions. Catches will vary on reefs according to fishing strategy (Mottet 1985), module design utilized, management techniques employed (Hagino 1991) and by the fauna present (i.e., temperate or tropical species).

Since 1984, Japanese artificial reef research efforts have focused on determining the impact of the large-scale marine enhancement program on fisheries enhancement as well as long-term ecosystem effects (Hagino 1991). While the diversity and complexity of the marine ecosystems under study have precluded a definitive conclusion on the impact of artificial reefs (see Hagino 1991), Japan has continued to fund artificial reef projects and studies in the hopes of increasing its own fisheries production and reducing dependencies on the fishery resources in the 200-mile economic zones of other nations (Mottet 1985, Nagahata 1991). In any case, Japan's experimentation with a wide variety of designed and fabricated artificial reef modules has resulted in a wealth of information of considerable potential for application in U.S. fisheries (Sheehy 1982a). The current transfer of this technology into the U.S. through the National Marine Fisheries Service Saltonstall-Kennedy Fishery Development grant program has led to successful demonstration projects using Japanese FRP modules and dice blocks off the coasts of Florida and Hawai‘i (Bohnsack et al. 1991, Brock and Norris 1989, Sheehy 1982b). More recently, a Japanese “Z” block design has been successfully used in Hawai‘i by the State’s artificial reef program.

1.2 EARLY HAWAIIAN ARTIFICIAL REEFS

In response to declining inshore fishery resources the Hawai‘i Division of Aquatic Resources (formerly Division of Fish and Game) undertook preliminary artificial reef studies in 1957. These studies suggested that a reasonable increase in the standing crop of fishes could be achieved by the placement of artificial shelters in otherwise barren habitats. Subsequently, three areas around O‘ahu and one on Maui were designated as artificial reef sites and scrap materials were used in the construction of artificial reefs at these sites (Kanayama and Onizuka 1973).

The Maunalua Bay Artificial Reef was initiated on O‘ahu in 1961. During a 12-year period, almost 1,600 stripped car bodies and 2,116 metric tons of damaged concrete pipe were placed at depths from 25 to 30 m. The Wai‘anae Artificial Reef off leeward O‘ahu was started in 1963 and over the next 9 years received 94 car bodies, 3,802 metric tons of concrete pipes, about 100 cement-filled tires, and a 52 m barge (623 metric tons). In 1982 a 50 m ship was scuttled at the site. These materials were dropped in waters from 9 to 37 m in depth. SCUBA surveys carried out in the late 1980's at the Wai‘anae and Maunalua Bay sites found that many of the concrete pipes were subsequently displaced during infrequent high wave events (hurricanes, etc.). The Kualoa Artificial Reef is located in a 4.1 km band paralleling the shore at Ka‘a‘awa, O‘ahu, at a depth of 18 to 30 m. This reef was established in 1972 with the dumping of 342 car bodies. Surveys conducted 6 months after deployment showed that the car bodies had disappeared into deeper waters, probably due to strong currents (Kanayama and Onizuka, 1973). The artificial reef off Maui was established in August 1962 with the placement of 150 car bodies in 24 to 26 m of water at Keawakapu.

Early assessments of Hawaiian artificial reefs were made by Kanayama and Onizuka (1973) and McVey (1970). Kanayama and Onizuka (1973) found a mean increase in standing crop from 10.9 to 110.7 kg/ha across all of the reefs studied. At Maunalua Bay, pre-deployment inventories noted a standing crop of 7 kg/ha. Following reef deployment the biomass was 154 kg/ha. Brock (unpublished) sampled the scattered concrete pipes at the Maunalua Bay site in 1986 and found a standing crop of fishes of 240 kg/ha suggesting that the reef enhanced standing crops over the long term. However, only a very small part of the original reef remained at the time of the survey and not all of the biomass measured in these studies is made up of desirable or culturally acceptable species. Only 20 percent of the standing crop consisted of commercially or recreationally important species (Brock and Norris 1987, 1989).

These early efforts at establishing artificial reefs in Hawai‘i used the technology then available, as did other reef programs in the U.S. Initially these reefs worked well, but over a long period of time many have proved to be relatively poor fish attractants because of the common practice of using unmodified scrap materials (here car bodies and concrete pipe) that are simply dumped at sea. The resulting reefs have had low profiles, little refuge space, poor stability characteristics (pipes roll and crush benthic organisms) and/or short life expectancies. If they remain in one location, car bodies usually corrode away in 3 to 5 years (Shepard 1974). The lack of stability in the materials used means that benthic communities which serve as a food source to many fish cannot become permanently established. The lack of refuge space provided by the materials used allows spear and net fishermen to overexploit resident fishes, and the absence of adequate topographical relief translates into less than maximal enhancement.

1.3 RECENT HAWAIIAN ARTIFICIAL REEF ACTIVITIES

The State Division of Aquatic Resources (DAR) of the Department of Land and Natural Resources has, in recent years, developed a multifaceted program for the improvement of inshore fisheries.

Artificial reefs are a key component of that program. The State artificial reef program has continued to deploy materials of opportunity in the designated artificial reef sites, including surplus vessels, barges, and a drilling platform accidentally scuttled in deep water (>350 m) offshore of Maile Point in 1985. Additionally, in 1991, approximately 200 sections of clean concrete pier (about 1,300 metric tons) were added to the Maunalua Bay, O'ahu site.

In 1986, the State legislature appropriated funds for the development of a new artificial reef 1.5 miles offshore of 'Ewa Beach at a depth of 50 to 80 m. The purpose of this reef was to enhance deepwater snapper populations. In 1987 the Navy deployed two barges and two caissons in this site. Since that time more than 5,000 metric tons of damaged concrete culvert, slabs and boulders have been placed at this artificial reef.

Artificial reefs within diving depths have also received considerable attention from State resource managers. In 1983-84 the State deployed 31 experimental mid-water tautline moored fish aggregation devices in the Wai'anae artificial reef site. These devices were not as successful as expected; wear on the mooring lines forced the State to sink these devices in place. The next effort focused on the construction and deployment of "tire modules". These modules were comprised of 8 to 10 scrap tire casings placed side by side, forming a tunnel which is embedded in a concrete base (1.8 x 0.6 x 0.3 m). These tire modules were built and deployed from 1986 through 1990. In total more than 50,000 tire casings were recycled and 1,500 m^3 of concrete used in this project. The Maunalua Bay site received 2,200 units set on 4,000 m^2 of substratum, the Keawakapu site received the same number of units placed on 6,000 m^2 of substratum, and the Wai'anae site received 1,500 modules on 8,000 m^2 of substratum.

In 1988 the State contracted for the construction and deployment of 100 pre-cast concrete dolos each weighing 5.5 metric tons. Dolos are used in breakwater construction; these units were deployed in the deepwater reef offshore of 'Ewa. In 1989, the National Marine Fisheries Service (Honolulu Laboratory) provided four "pipe houses" to the State for deployment in the Wai'anae artificial reef site. These "pipe houses" were comprised of three lengths of concrete culvert strapped together. Diver inspection of these units following deployment suggested that they were not successful because of a concrete plug in the middle of each pipe. Also in 1989, the State developed and deployed 65 "table modules". These modules were constructed of concrete and were approximately 2.4 x 1.2 m in size with short concrete legs. Thirty-five units were placed in the Keawakapu site and 30 in Wai'anae. Problems arose with the table modules in that when deployed they could land on the substratum upside down with the "legs" oriented upwards thus nullifying most of the desired shelter effect. This shortcoming led to the development of the "Z" block module which is concrete rectangle with a "Z" cross-section. One advantage of the "Z" block is that its effectiveness at providing shelter is not compromised by its orientation on the bottom. In 1990, 310 "Z" blocks were built and deployed in Maunalua Bay. Studies by State biologists have found that the units perform well and have excellent stability characteristics. As a result of their superior performance, the State has continued to construct and deploy "Z" blocks.

As with any State program, the artificial reef development program has been hampered by insufficient funds. Much of the cost of reef development lies with the cost of transportation and deployment of materials. To keep deployment costs to a minimum, the favored method of deployment has been barging the materials to the marked site and using a front end loader to push the materials overboard. This is probably the least expensive deployment technique available. The drawback to this deployment method is that there is limited control over the configuration of the materials as they land on the bottom. Maintaining some control over this is important, as the dispersion or aggregation of

the materials will determine the biological effectiveness of the reef to a significant extent (Brock and Norris 1989).

The State fishery managers do carry out visual assessments of the resulting fish community development around artificial reefs following deployment. For the deepwater reef offshore of 'Ewa Beach, they use handline fishing methods as well as a remotely operated video camera that records fish abundance. This information is summarized in annual Job Progress Reports developed by the Division of Aquatic Resources to meet Federal aid guidelines. In general, reef materials deployed in shallow waters have exhibited standing crops between 100 and 350 g/m^2.

Between July 2001 and June 2004, more than 3,600 "Z" blocks were deployed in the Maunalua and Wai'anae artificial reef sites, and an additional 1,500 units were constructed. The program worked closely with the local concrete industry to utilize surplus concrete for the "Z" blocks, which helped to minimize costs.

1.4 EXPERIMENTAL STUDIES ON HAWAIIAN ARTIFICIAL REEFS

Only since the 1980's have Western fishery biologists become aware of the artificial reef technology developed in Japan over the last 50 years. Preliminary studies on the feasibility of transferring the Japanese technology to Hawai'i commenced around 1982. Several programs were involved with this effort, including the National Marine Fisheries Service, the Hawai'i State Division of Aquatic Resources, the University of Hawai'i and several private enterprises.

The National Marine Fisheries Service explored the direct transfer of Japanese technology by utilizing an artificial reef module designed and fabricated in Japan. The design chosen was the fiberglass reinforced plastic (FRP) module; a single unit was purchased in Japan (at a cost of ~$10,000) and was deployed at a depth of 117 m off Penguin Bank in October 1985. This module, as well as several concrete pipe units, were placed at three sites and were monitored by Dr. J. Polovina and R. Moffitt using a submarine. The results of this study suggest that the depth of reef placement was more important than the reef structural material and configuration in aggregating fish. However, the reef structural material and design were more important than depth in determining the species diversity, richness and biomass of resident fishes of these deepwater reefs. The authors concluded that small-scale, deepwater reefs appear to function primarily by aggregating fish rather than increasing in situ production and that neither design nor materials are very important in aggregating transient species (Moffitt et al. 1989). Thus the use of expensive module designs fabricated in Japan did not appear warranted for the enhancement of deepwater snapper stocks.

The FRP module design was also tested offshore of O'ahu by a private submarine dive tour firm. They deployed four units in a designated 1.85 ha site offshore of Waikīkī at a depth of 24 to 36 m. In this instance, the FRP modules were used as part of a dive tour destination. Qualitative observations suggest that this design aggregates numerous fishes (primarily transient) for underwater viewing. Also present in this artificial reef site are six Japanese style concrete terrace reefs (each 6 x 10 m, 4 m high) that were deployed about 100 m away from the FRP modules. The majority of the fishes (both by weight as well as numerically) associated with this module design appear to be resident. A third component to this artificial reef is a 53 m yard oiler deployed at a depth of 29 to 32 m in July 1989. Prior to deployment a number of large holes were cut through the hull above the water line as well as on the decks down into the interior of the ship to enhance the utilization of shelter space, circulation, light penetration and movement of fishes through the vessel. Engineering analysis showed that for proper stability in the face of the 50-year wave, additional weight would be desirable, so approximately 2,000 metric tons of basalt gravel were added to the ship at the time of deployment.

University of Hawai'i personnel monitored the fish populations around the deployed ship and carried out a limited sampling program to estimate fish catches and the economic viability of the artificial reef as a dive tour destination. Prior to deployment of the vessel, visual transects identified three species of fish with an estimated biomass of 0.6 g/m^2; nearby natural hard bottom communities had a mean standing crop of 44g/m^2. Monitoring the fish community over a two- year period resulted in a mean of about 60 species and a grand mean standing crop of 1,165 g/m^2. The fish community of the ship was comprised of both resident and transient species. The transient species include coastal pelagic forms such as the mackerel scad or opelu (*Decapterus macarellus*) and occasionally, high seas pelagic species including the wahoo or ono (*Acanthocyium solandri*) and shibi or yellowfin tuna (*Thunnus albacares*). The biomass of transient species was about 29 percent of the total per census standing crop. The most conspicuous resident species on the vessel was the introduced blue-lined snapper or ta'ape (*Lutjanus kasmira*). The mean per census standing crop of ta'ape was 42 percent of the average per census biomass. Thus about 71 percent of the mean total estimated standing crop per census was comprised of transient species and ta'ape in the first two years since deployment.

Much of the fluctuation in the standing crop of fishes on the vessel was due to the activities of fishermen. Fishing activities primarily take place early or very late in the day when the dive tours are not operating. Methods used include hook and line fishing, spearing and netting. Sampling and observations suggest that fishermen remove approximately 31 kg of fish per day from the artificial reef site (Brock 1995).

The University of Hawai'i's artificial reef research program commenced in 1983 with State funding. The goal was to make a preliminary assessment of the feasibility of transferring Japanese artificial reef technology to Hawaiian reef habitats. A combination of federal and State funds supported this program through 1992; in 1985 an open framework concrete cube design was constructed and deployed in the Maunalua Bay artificial reef site. This design was modified from the Japanese "dice block". Prior to reef deployment the mean standing crop of fish at the deployment site was 61 g/m^2. After deployement, this reef maintained a mean standing crop of 1,266 g/m^2 (or a biomass about 6 times greater than the most productive natural reefs) despite considerable fishing pressure. Fully 85 percent of this standing crop was comprised of commercially valuable fish species in sizes appropriate for market. By contrast, in a nearby natural reef control area, the mean biomass of fish during the study was 53 g/m^2. Comparative analysis with some of the materials deployed by the State of Hawai'i showed the cube design to be superior in maintaining high standing crops, greater numbers of individuals, higher species diversity, and a greater mean size of individual fish present (Brock and Norris 1989). Further, the results suggested that a hierarchy of artificial reef effectiveness existed insofar as reef design was concerned: the least effective were reefs built of haphazardly dumped unmodified scrap materials; more effective were reefs using specifically designed modules deployed by dumping and the most effective were modules assembled into specifically designed reefs. Thus, insofar as shelter was concerned, a specifically designed set of shelter spaces appeared to be more effective that the highly variable shelter that result from the haphazard deployment of materials (Brock and Norris 1989).

Another area of research by the University of Hawai'i focused on improving the recruitment of juvenile fishes to the artificial reef habitat. This study quantitatively examined the impact that aspect ratio (reef height relative to water depth) had on the recruitment of juvenile fishes. The results showed that small reefs with high aspect ratios (as created by small tautline moored midwater fish aggregation devices) had significantly greater numbers of juvenile fishes recruiting from the plankton than did similar reefs with low aspect ratios. High aspect ratio reefs provide the first substratum encountered by larval fishes which triggers metamorphosis and movement to the benthic community

below (Brock and Kam 1995). Provision of benthic habitat at appropriate scales enhanced the survival of the juveniles. The focusing effect of juvenile recruitment may ultimately have application in the development of specifically designed nursery areas that would increase survivorship and result in larger adult populations.

1.5 HOW ARTIFICIAL REEFS "WORK"

It should be recognized that agriculture, forestry, fisheries, range and wildlife management share some principles and practices with aquatic habitat enhancement. For example, all of these sciences strive to understand the factors that limit ecological systems. They are also concerned with balancing the basic objective of enhancing biological yields with the political and economic realities of natural resource management. However, each of these sciences differs greatly in the time span of their application, sophistication of method, and degree of scientific understanding (Seaman and Sprague 1991). Aquatic habitat enhancement is the newest of these disciplines and draws heavily on information from the others.

Coral reefs function as relatively closed systems and thus, in a relatively stable, pristine situation may represent the accumulation of carbon over a considerable period of time (Johannes et al. 1972). Much of this is tied up in the living biomass of the reef of which fishes are only a part. Goldman and Talbot (1975) have suggested that a reasonable maximum biomass of coral reef fish is approximately 2,000 kg/ha (or 200g/m^2). Space, structural diversity, and cover are important factors governing the distribution of coral reef fishes (Sale 1977, Risk 1972). For example, Brock (1954), using visual techniques on Hawaiian reefs, estimated the standing crop of fishes to range from 40 kg/ha on sand flats to a maximum of 1,860 kg/ha in an area of considerable vertical relief. This suggests that if structural diversity, and hence fish biomass, are low in a given locality, the addition of structural relief in the form of artificial reefs usually results in an increase in the biomass of fish.

Construction of artificial reefs may be viewed as attempts to replicate naturally productive habitats in relatively unproductive locations. Artificial reefs lead to an increase in the amount of productive habitat in both temperate and tropical marine communities. It has been proven that this technology locally provides more fish, and artificial structures have been used by Japan, the United States, and other fishing nations for more than 200 years (Sheehy 1982a). Historical accounts and literature reviews concerning the development of artificial reefs in Japan and the United States are covered elsewhere (Iwasaki 1973, Steimle and Stone 1973, Stanton 1985, Stone et al. 1991, Grove et al. 1991). Given that their deployment usually results in dramatic local increases in fishery resources, current dogma states that artificial reefs "work."

A point of contention that has persisted from early applications of artificial reef enhancement to more recent projects centers on the question of whether the reefs add to the production of fish resources or simply aggregate stocks from surrounding areas. From a biological perspective, artificial reefs may function in several ways, by (1) redistributing existing exploitable fisheries, (2) increasing exploitable fisheries by aggregating unexploited fisheries, and/or (3) improving aspects of survival and growth, thereby contributing to fisheries production. In all three scenarios, artificial reefs can lead to changes in the frequency and intensity of fishing efforts, the type of gear used, the species targeted, and the composition of the catch (Polovina 1991). There are few studies that quantify the biological impact of reef deployment (Bohnsack and Sutherland 1985, Bohnsack 1989, Polovina 1991). However, numerous studies suggest that the first two functions occur but there are only a few that successfully demonstrate enhancement of fisheries production due to artificial reef deployment.

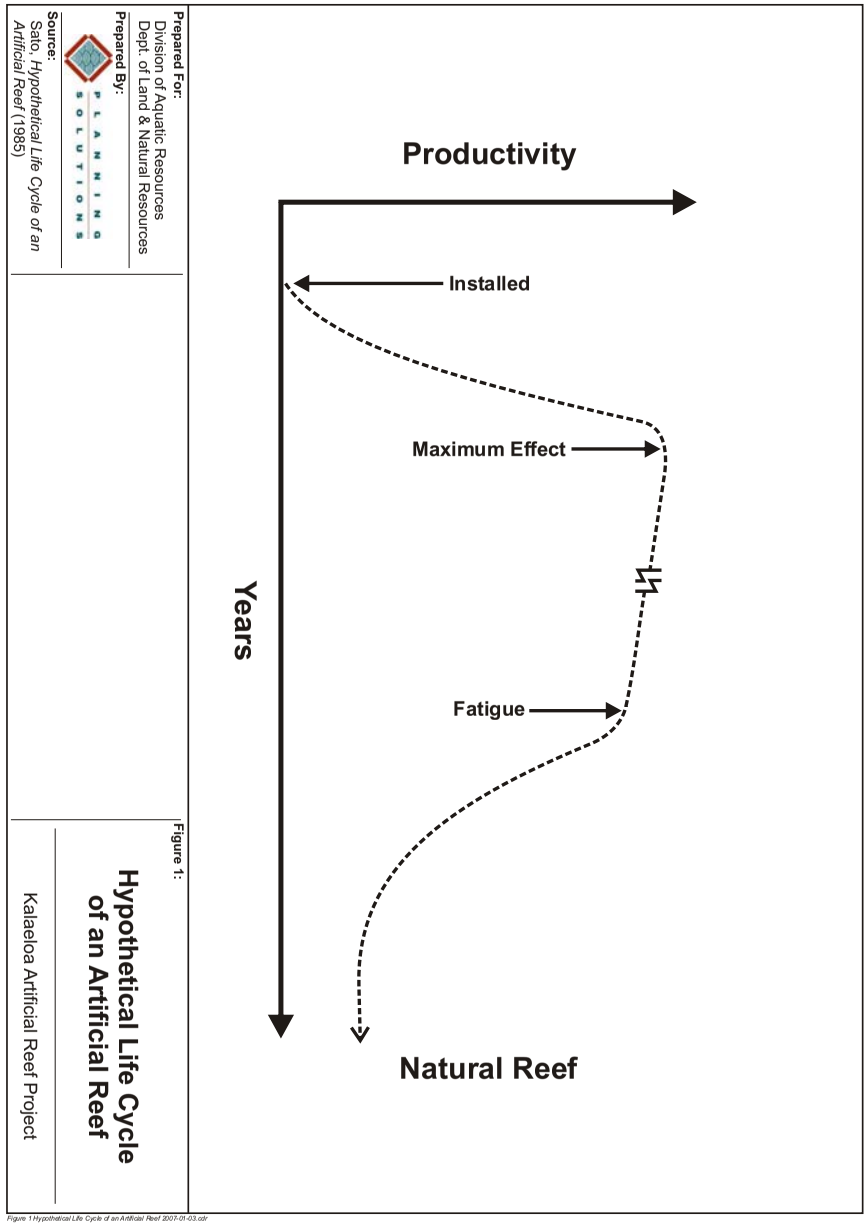
The lack of definitive data is often due to factors such as inappropriate experimental design, sampling on inadequate spatial and/or temporal scales, and the oversimplified expectation that the production enhancement capability of artificial reefs must be either "all or nothing". For example, studies often focus on the early stages of biological succession on a reef (i.e., from the time of deployment until one or two years later). This time scale is inadequate, as considerable time must elapse before benthic communities become established and sufficiently developed to support many resident fishes. A number of studies have demonstrated or hypothesized that the fish communities observed around artificial reefs in their early stages of development are dominated by transient or opportunistic species that as subadults or adults move in from elsewhere (Bohnsack 1989, Brock and Norris 1989, Brock 1995). Recently deployed reef materials do not provide the food resource base needed to support the recruiting fishes; these materials merely serve as a source of shelter for fishes that must feed elsewhere. In most settings transient and other opportunistic species will continue to visit the deployed reef, although artificial reefs also typically develop robust resident fish communities.

A number of earlier studies support the view that artificial reefs not only aggregate but increase local fishery productivity (Ogawa 1979, Stone et al. 1979, Buckley 1982, Buckley and Hueckel 1985). Studies of the relatively large scale reef developments in Japan that have been in place since the mid-1970's have provided significant insight to the question. According to Sheehy (1982a, p. vi): "Although most American reef researchers continue to debate whether artificial reefs actually increase productivity or merely attract and concentrate organisms from surrounding areas, Japanese scientists generally have little doubt that artificial reefs when properly designed, sited, and placed, can be used to increase the production of desired species."

Indeed, studies on Japanese reefs (e.g., Sato 1985) have documented rapid increases in fish biomass in response to recently deployed reefs. Japanese researchers note first a period of exponential growth, an asymptote, and then a slow decline to a point 5 to 15 years after deployment where the fish community rapidly declines and eventually levels off at a point similar to productive natural fish communities (see Figure 1). The standing crop in the latter phase suggests that the artificial reef may be self-supporting; prior to this point it probably is not. This suggests that considerable time is needed for artificial reefs (or any manmade object deployed in shallow waters) to develop the complex food webs needed to support a given standing crop of fish.

Polovina and Sakai (1989) reviewed the catch and effort data for octopus in Shimamaki Bay, Japan and found that artificial reefs have enhanced the catch of octopus without having an impact on catch per unit effort (CPUE) in adjacent regions lacking artificial reefs. Barnett et al. (1991) examined feeding habits, prey abundance, and fish biomass both on an artificial reef deployed 14 years earlier in Southern California waters and surrounding habitat and found that food availability was 100 times more abundant on the artificial reef than elsewhere. Tagging studies showed that fishes resident to the reef showed high site fidelity. Production of fish on the artificial reef was estimated to be 6.5 times greater than the production of fish on the surrounding sand flats.

Although the data are limited, they cumulatively suggest that artificial reefs deployed in appropriate habitats and given sufficient time to develop in situ benthic communities can be productive entities. In the case of Hawaiian reefs, there is little direct evidence to support the concept of enhanced productivity because most studies are of short duration. Brock and Norris (1989) do provide some information on standing crop on Hawaiian reefs of various ages from less than one year to more than 25 years in age. Despite high variability in design, artificial reefs constructed of surplus concrete culvert (pipe) deployed more than 20 years previously maintained a mean standing crop of 264 g/m^2 while nearby natural reefs supported a mean standing crop of 45 g/m^2. The biomass estimate on a



reef more than 20 years of age probably represents the standing crop value for the far right hand side of Sato's (1985) graph (see Figure 1). In contrast, the nearby experimental Japanese style reef maintained a standing crop of 1,266 g/m^2 through the first 2 years following deployment. This reef was probably in the early stages of development as depicted on the left side of Sato's (1985) graph (Figure 1). Similarly, the artificial reef developed as a dive tour destination offshore of Waikīkī has maintained a mean standing crop of fishes of 1,165 g/m^2 through the first two years following deployment despite considerable fishing pressure (Brock 1995).

On both of these recently deployed Hawaiian artificial reefs most of the fishes observed were adults or sub-adults. Clearly, during this initial phase of development, these reefs were aggregating fishes that came from elsewhere. In the case of the Japanese style experimental reef, the data collected from weekly visual censuses provided no evidence to suggest that the experimental reef had drawn any fish from the nearby natural control reef; recruits had come from elsewhere. The resident fishes to both reefs appeared to have considerable site fidelity suggesting that the reef was providing necessary shelter and the surrounding "open" substratum (i.e., with low coral coverage) served as appropriate forage grounds for these fishes. This period of exponential growth in biomass is probably caused by the immigration of itinerant individual fishes. This suggests that many inshore fish species may have some proportion of their population that, as adults, are constantly migrating and seeking appropriate habitat.

The qualitative observation that an artificial reef takes years to attain self-sufficiency suggests that prior to that time, the reef only aggregates fish and does not contribute to the overall productivity of the area. This argument is not completely correct. The deployment of an artificial reef which provides shelter in an area of low cover allows immigrant adult fish to more fully exploit food resources in the area surrounding the reef. The immigration of these fishes from areas removed from the artificial reef allows other fish to take up residence in the previously vacated sites. If this scenario is correct, then appropriate shelter rather than food resources may be the limiting resource for many Hawaiian reef fish communities. If correct, the addition of shelter in the form of reefs will increase the productivity of an area by increasing the carrying capacity of the local environment.

In summary, there is significant circumstantial evidence to suggest that if properly sited, artificial reefs do enhance local fishery stocks. This enhancement initially occurs because these systems are probably shelter limited rather than food limited. With time and the further development of benthic communities, the deployed reef surfaces will contribute a greater proportion of the forage for resident fishes, thus truly enhancing fishery resources.

1.6 IMPACT OF ARTIFICIAL REEFS

As noted above, artificial reefs serve to aggregate a variety of fishes, particularly in their early growth stages. Most Hawaiian artificial reefs have been constructed to target larger fishes, and thus their early immigrants are typically subadults or adults. All trophic categories are usually well represented in these early colonizers, from herbivores to top level carnivores. On Hawaiian artificial reefs most of the top level carnivores are itinerant species (other than the moray eels). Irrespective of whether habitat limitation or behavioral preferences are involved in this aggregation process, many of the fishes found on Hawaiian artificial reefs are targeted by recreational fishermen. Generally fishermen focus their effort where fishing is productive and on a number of desirable carnivorous species.

Many of the top carnivorous fishes are itinerant or wandering species; this group includes the jacks or uluas/papios (Family Carangidae), the grey snapper or uku (*Aprion virescens*), emperor or mu (*Monotaxis grandoculis*), goatfishes such as the yellowfin goatfish or weke‘ula (*Mulloides pflugeri*)

and the blue goatfish or moano kea (*Parupeneus cyclostomus*). Other smaller schooling itinerant species such as the opelu (*Decapterus macarellus*) may serve to attract larger pelagic species. At the Waikīkī artificial reef, Brock (1995) has observed kamanu or rainbow runner (*Elagatis bipinnulatus*), small tuna or kawakawa (*Euthynnus affinis*), ono (*Acanthocybium solandri*), shibi or yellowfin tuna (*Thunnus albacares*), mahimahi (*Coryphaena hippurus*) and striped marlin or kajiki (*Tetrapterus audax*). Fully 29 percent of the biomass of fish on a census at that reef were comprised of transient species which are all predators. Besides the transient species, ta’ape (*Lutjanus kasmira*) make up an additional 42 percent of the standing crop seen in a census. Analysis of the catch made by fishermen in the first two years from the deployment of the reef offshore of Waikīkī showed that they removed approximately 31 kg of fish per day which, if sold, was worth about $161/day. Many of the fishes caught are transient species or ta’ape. Brock (1995) noted that the amount of fish removed in one day is far in excess of any sustainable yield and the catch rates were only sustained by the immigration and removal of transient species. Thus in this early stage of succession, the artificial reef served to aggregate fishes thereby improving the ease of their exploitation.

Hawaiian inshore fisheries are badly depleted and stronger management is needed (Brock et al.1985, Shomura 1987, Smith 1991). Use of artificial reefs for consumptive purposes in over-exploited fisheries should only occur if careful resource management is part of the program (Bohnsack 1989, Brock 1995). In the over-exploited fishery, a newly deployed series of artificial reefs may serve only to aggregate the last few fish making them vulnerable to capture. This is probably the greatest potential negative biological impact of artificial reef construction and deployment. Thus the development of artificial reefs simply for fishery exploitation in Hawaiian waters should not be condoned unless these reefs are (1) part of a larger comprehensive management program or (2) established with sufficient shelter and scale to reduce the effectiveness of the fishing public.

However, use of artificial reefs for non-consumptive purposes has little negative impact to the fish stocks and, from an economic perspective, may be beneficial. Brock (1995) found that from the standpoint of economics, the fishery of on the Waikīkī artificial reef had a value to the fishermen (assuming all fish are sold and that there are no overhead costs for the fishermen) of $58,800 annually. In contrast, the non-consumptive dive tour operators using this same reef in their first year of operation (then one submarine and five independent SCUBA dive operators) had a pre-tax net profit of about $1.4 million, a value about one half the ex-vessel worth of the entire Hawaiian reported inshore catch at that time. Viewed solely from the standpoint of economics (and not cultural values) the technology of artificial reefs in highly exploited coral reef fisheries should not focus on reef development for consumptive activities but for the much greater economic returns that are part of well-planned tourist development.

1.7 ARTIFICIAL REEFS AND PREDATORS

Over the last fifteen years concern has surfaced over the possibility of artificial reefs serving to attract major reef predators that could be a threat to humans (i.e., sharks). There are few data to support or refute this hypothesis. As noted above, artificial reefs in early successional stages serve to attract many fishes. Aggregations of fish will, in turn, frequently serve to attract other fishes. This behavioral trait is capitalized on by local trap fishermen who frequently use half a coconut or an aluminum pie-plate hung in a trap to attract the first few fishes, which in turn, attract others.

Utilizing data from 1990 through 1992, there were 14 incidents involving humans and sharks in Hawaiian waters. Seven of the victims died (data from list compiled by George Balazs, NMFS). At the time of the interaction, one victim was diving, three were fishing either from shore or a boat (with

two of the people having fallen into the water and were swimming on the surface), two were actively swimming on the surface, and eight were surfing. Thus, 86 percent of the encounters occurred with people on the surface of the water.

Balazs documents 101 encounters spanning the period from 1779 through 1992; usually included are general locations of encounters. There are no reported shark encounters at any of the Hawaiian artificial reefs. Reviewing the author's fish transect data for the last 40 years that covers hundreds of underwater censuses made at numerous locations around the high Hawaiian Islands, there have been a number of shark sightings over natural substratum but never around an artificial reef. More than 300 man-hours were spent underwater deploying, constructing and monitoring (i.e., carrying out fish censuses) on an artificial reef in Moanulua Bay from 1985-1989 and no sharks were sighted. Similarly, more than 60 hours spent censusing fishes on the Waikīkī artificial reef did not result in any shark sightings. It should be noted, however, that two oceanic blacktip sharks (*Carcharhinus limbatus*) were reported near the Waikīkī artificial reef by submarine operators. This shark species is not usually a threat to humans. The author's fish census work has noted many other predator species both on and away from artificial reefs including large pelagic predators such as billfish, ono and tuna.

The National Oceanic and Atmospheric Administration and National Marine Fisheries Service have established a national policy and guidelines regarding the development of artificial reefs (Stone 1985). The National Marine Fisheries Service has a policy of "no net habitat loss" with coastal development, and artificial reefs play a major role in mitigating habitat losses due to coastal construction. The national guidelines call for carefully designed and constructed reefs to be used and the plan was developed with input from many experts in many states. Nowhere in these national guidelines have major reef predators (sharks) been noted; if this problem existed on artificial reefs deployed by other states, it would be a recognized problem that would probably curtail government support and involvement. This has not happened.

The largest US artificial reef program is in Florida. The first reef was constructed in 1918 and there are about 200 permitted sites that range as far as 40 miles from shore (Aska and Pybas (1983). Some sites have several reefs so the actual number of artificial reefs exceeds 200. Nowhere in the literature regarding Florida artificial reefs is there any mention of sharks being differentially attracted to the artificial reefs (see Aska 1978, Aska 1981, Bulletin of Marine Science volumes 37 and 44, D'Itri 1985, Seaman and Sprague 1991). Thus if the concern is that artificial reefs differentially attract sharks, there are no data to support the contention and a considerable literature base to refute it.

2.0 BIOLOGICAL CHARACTERISTICS OF THE KALAELOA AREA

2.1 GEOLOGICAL SETTING

Topographic maps of the Kalaeloa area show a subtidal bathymetry comprised of a series of relatively broad, often sand-covered, wave-cut terraces in the near shore region. The most landward of these terraces extends from shore gently sloping seaward to the 15 - 20 m isobath about a kilometer offshore; at this point the first shelf-break is encountered where depths rapidly increase to 23 - 30 m. The general geological features are a series of emergent limestone benches along the shoreline or sandy beaches. Sub-tidally, sand is common (as a veneer) but where limestone is encountered and elevated above the surrounding bottom, corals are found. In general, the development of corals is greatest commencing at depths greater than about 8 m, usually more than 250-300 m from shore. However, coral reef development is patchy on this inshore limestone platform. Local coverage may range up to close to 90% over scales from 5 to 50 m^2, but these "patches" may be spaced from 10 to over 100 m apart. Coral communities continue seaward but become less apparent along the seaward edge of the inshore limestone platform (i.e., at the shelf break). As discussed below, a major force structuring the distribution of coral communities on this platform is impact from occasional storm surf.

The shelf break between the inshore and more seaward platforms ranges from an obvious vertical face to areas where the limestone just dips seaward at angles ranging from 5 to about 30°. At the base of this first shelf break is a mix of limestone cobble, small corals, sand or barren limestone. The substratum across much of this deeper (~30 m) platform is relatively barren, with areas of sand veneer, emergent limestone and few corals. This more seaward, deeper limestone terrace continues seaward to depths in excess of 30 m (the lower boundary of the present study. As noted by Brock and Chamberlain (1968), there are at least five subtidal wave-cut limestone terraces present off the Kalaeloa/West Oahu region; these are found at -18 m, -55 m, -90 m, -550 m, and -1100 m. This study is confined to the two shallowest of these terraces.

2.2 MATERIALS AND METHODS

The objectives of this study are to (1) examine the marine communities offshore of the Ewa-Kalaeloa area and define an appropriate site for artificial reef development (2) propose a cost-effective artificial reef module design for deployment at this site, and (3) examine the impacts that may occur to surrounding marine communities with the deployment and operation of this proposed artificial reef.

2.2.1 BROAD-SCALE SITE SELECTION METHODOLOGY

The area considered suitable for possible artificial reef deployment was delineated offshore of the 'Ewa Beach-Kalaeloa area at depths between 60 and 120 feet. Side-scan sonar (100 kHz) and bathymetric (SHOALS; mapped at 1-m resolution) data of this area were provided by Planning Solutions, Inc. to guide the survey work Subsequently, divers conducted field reconnaissance at specific sites within the mapped area to obtain an overview of marine communities. Divers were either towed behind a vessel along transects or worked in pairs swimming on predetermined compass courses along the bottom, making notes on bottom types and the extent of coral coverage present. These overview data were combined with information obtained in the past by Brock as well as from discussion with other marine professionals at the Hawai'i State Division of Aquatic Resources and

the Oceanographic Team, Department of Environmental Services (City and County of Honolulu) to aid in narrowing down possible areas for artificial reef deployment.

In addition, existing offshore uses in the area were taken into account in identifying potential sites. Namely, the Hono'uli'uli WWTP discharge pipe (which is situated just east of longitude 158°01.8000' W), the oil tanker offloading facilities (just west of longitude 158°04.0000' W), the Cates aquaculture facility, and the military danger zone which is east of longitude W 158°00.5000' (i.e., near the entrance channel to Pearl Harbor) were all identified as areas that should be avoided when siting an artificial reef intended for recreational use.

Finally, several additional biological and regulatory criteria informed the selection of the proposed artificial reef site. Specifically, researchers looked for an area with the following characteristics: (1) of sufficient size to allow continued deployment of materials in the future (DAR specified a minimum of 50 acres); (2) relatively devoid of corals and coral reef habitat but having adequate benthic community development to support foraging by recruiting fishes; (3) in relatively close proximity to the 'Ewa Marina development and O'ahu's leeward coast, (4) sited within safe diving depths (from about 60 to 120 feet in depth), (5) sited seaward of the -18 m shelf break to avoid the well-developed coral communities and increased exposure to wave action that occur inward of the shelf, and (6) able to meet all regulatory agency criteria, including the U.S. Coast Guard requirement that water depth be great enough to have a minimum forty-foot clearance above any deployed materials and that the substratum be firm enough so that deployed materials do not sink into the bottom.

2.2.2 FINE-SCALE SITE SELECTION METHODOLOGY

The large-scale delineation of bottom types (sand, limestone, coral/no coral) as noted above was helpful in identifying broad areas that could serve as deployment sites. Once possible locations were identified, finer scale (i.e., quantitative) data collection was undertaken to describe fish and benthic community structure and determine sites that would meet all of the criteria listed above. The methods used in obtaining these finer-scale quantitative data are given below.

The quantitative sampling of the macrofauna comprising marine communities presents a number of problems, many of which are related to the scale on which one wishes to quantify organism abundance. Marine communities in the waters offshore of 'Ewa Beach may be spatially defined in a range of a few hundred square centimeters (such as the community residing in a cauliflower coral head), to many hectares (such as areas which are covered by major biotopes). Because considerable interest focuses on visually dominant corals, diurnally-exposed macroinvertebrates, and fishes, the sampling program is designed to quantify communities at this scale.

Fish abundance and diversity are often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., coral mounds, sand flats, and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25 m in length), which has proven adequate for sampling many Hawai'i benthic communities (Brock 1982, Brock and Norris 1989) was used.

Information was collected at each station using the following methods: 1) a visual assessment of fishes; 2) benthic quadrats for estimates of cover by sessile forms (e.g., algae, corals and colonial invertebrates); and 3) counting of diurnally-exposed motile macroinvertebrates along the transect line. Fish censuses were conducted over a 4 m x 25 m corridor and all fishes within this area to the water's surface were counted. A single diver equipped with scuba, slate and pencil entered the water, counted and recorded all fishes seen in the prescribed area (method modified from Brock 1954). Besides

counting the individuals of all fishes seen, the length of each was estimated for later use in the determination of fish standing crop using linear regression techniques (Ricker 1975). Species-specific regression coefficients have been developed over the last 30 years by the author and others at the University of Hawai'i, the Naval Undersea Center (Evans 1974) and the Hawai'i Division of Aquatic Resources from weight and body measurements of captured fishes; for many species, the coefficients have been developed using sample sizes in excess of a hundred individuals. The same individual performed all fish censuses to keep any bias relatively constant between different surveys.

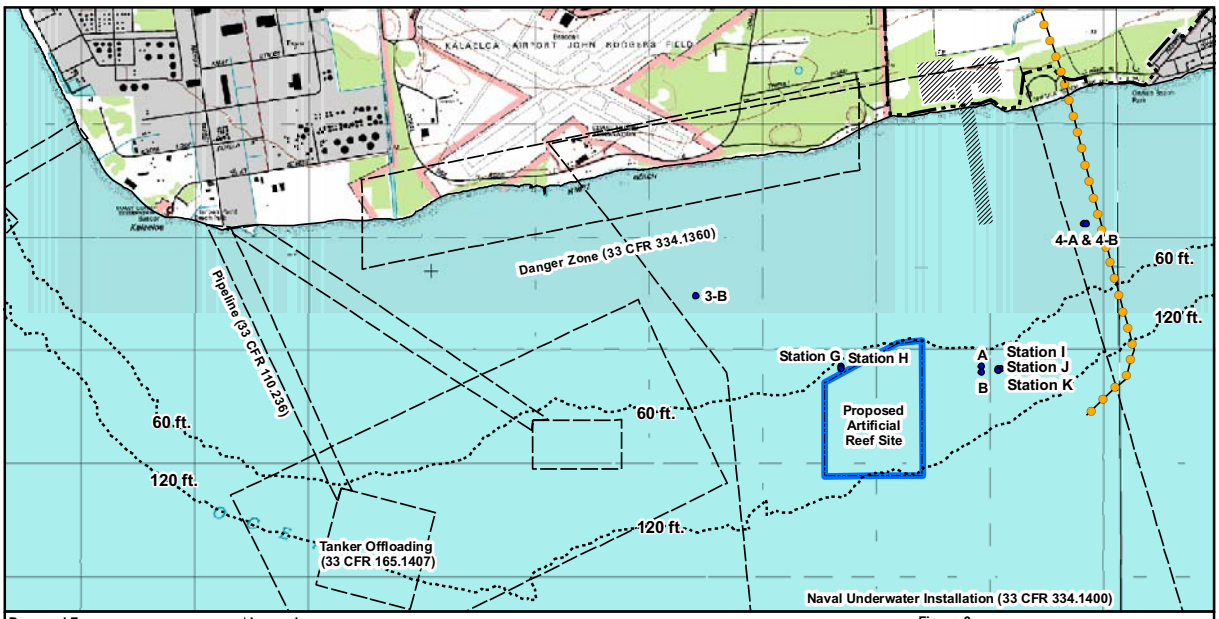
Besides frightening wary fishes, other problems with the visual census technique include underestimating the size of cryptic species such as moray eels (family Muraenidae) and nocturnal species such as squirrelfishes (family Holocentridate) and bigeyes or 'aweoweo (family Priacanthidae). This problem is compounded in areas of high relief and coral coverage that affords numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration, such as scorpionfishes or nohu (family Scorpaenidae) and flatfishes (family Bothidae), might still be missed. Another problem is the reduced effectiveness of the visual census technique in turbid water. This is compounded by the difficulty of counting fishes that move quickly or are very numerous. Additionally, bias related to the experience of the census taker should be considered in making comparisons between surveys. Despite these limitations, the visual census technique carried out by divers is probably the most accurate nondestructive assessment method currently available for counting diurnally active fishes (Brock 1982).

To quantitatively assess the exposed sessile benthic species, a 1 m x 1 m quadrat was used placing the quadrat at the 0, 5 m, 10 m, 15 m, 20 m, and 25 m points along the transect line. Diurnally exposed motile macroinvertebrates greater than 2 cm in some dimension were censused in the same 4 m x 25 m corridor used in censusing fishes. If macrothalloid algae were encountered in the quadrats, they were quantitatively recorded as percent cover. Emphasis was placed on those species that are visually dominant, and no attempt was made to quantitatively assess the multitude of microalgal species that constitute the "algal turf" so characteristic of many coral reef habitats. During the field work, an effort was made to note the presence of green turtles, porpoises or humpback whales within or near the sample sites.

2.3 RESULTS

2.3.1 DELINEATION OF THE PROPOSED ARTIFICIAL REEF SITE

Two areas were examined in the preliminary study for possible artificial reef deployment offshore of 'Ewa Beach-Kalaeloa, to the east and west of the Honouliuli Wastewater Treatment Plant (WWTP) Outfall, hereinafter called the eastern area and western area, respectively. The eastern area is bordered by the Honouliuli WWTP Outfall on the west extending easterly about 1.7 km to a point adjacent to the western boundary of the noted military danger zone (Figure 2). The substratum examined was primarily seaward of the -18 m isobath with depths ranging from 16 m to 30 m. A second area (the western area) examined in the preliminary study lies west of the Honouliuli Sewer Outfall and extends about 3.8 km along the coast to a point adjacent to the eastern boundary of the offshore oil tanker unloading facility (Figure 3).



Prepared For:
Division of Aquatic Resources
Dept. of Land & Natural Resources

Prepared By:
PLANNING SOLUTIONS

Sources:
–R. Brock
–HASEKO (Ewa), Inc.
–USGS 7.5' Quad Maps

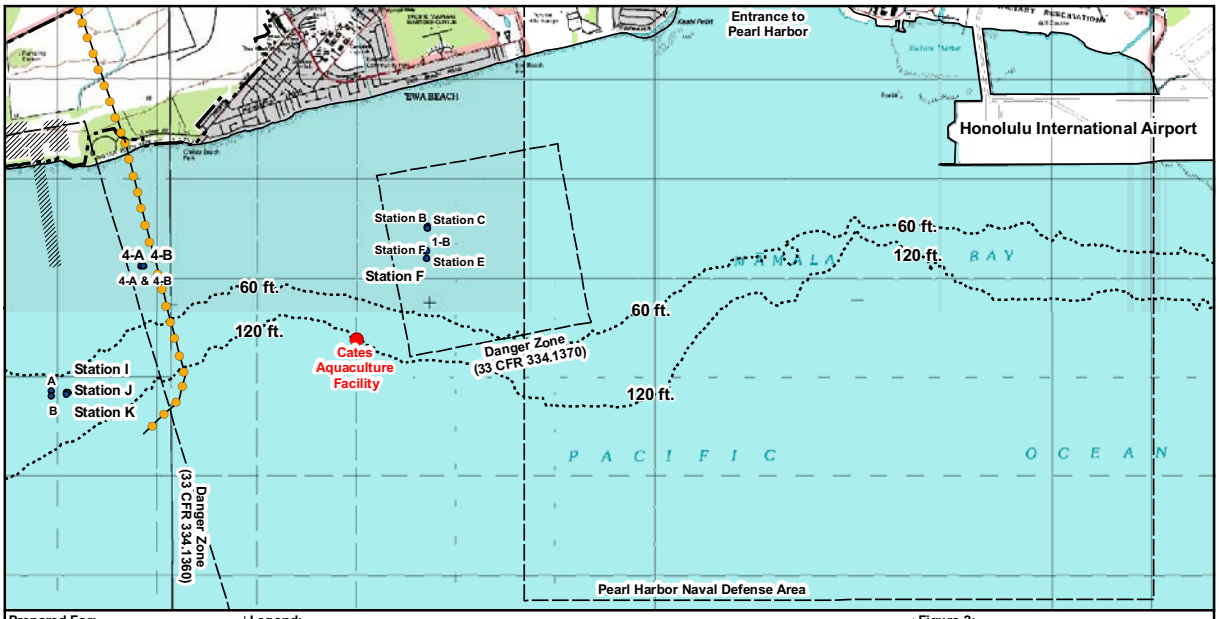
Legend:
- Biological Sampling Stations
- Hono'uli'uli Sewer Outfall
- Proposed Ocean Pointe Marina & Entrance Channel
- Restricted Areas

0 0.5 1 2
Miles

Figure 3:

Western Area Surveyed & Proposed Artificial Reef Site

Kalaeloa Artificial Reef Project



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Legend:
- Biological Sampling Stations
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- Proposed Ocean Pointe Marina & Entrance Channel
- Restricted Areas

0 0.5 1 2
Miles

Figure 2:

Eastern Area Surveyed

Kalaeloa Artificial Reef Project

2.3.1.1 Eastern Area Surveyed

Surveyors examined the bottom characteristics in the area bordered by the Honouliuli WWTP pipe on the west to a point about 1.7 km in an easterly direction to longitude 158°00.2000' W. The eastern end of the area surveyed is adjacent to the western boundary of a military danger zone delineated by (21°18'214"N, 157°59'14.2W; 21°18'11.0"N, 158°00'17.5"W; 21°17'11.8"N, 158°00'06.5"W; 21°17'22.5"N, 157°59'03.1W) (see Figure 2).

The substratum in the depths from about 15 m to 28 m, with emphasis on the areas seaward of the -18 m isobath (the not well-defined shelf break), was examined on 17 March 2005. Divers conducted underwater surveys with scuba along predetermined tracks and carried out biological surveys at selected points in the area using scuba. Water clarity was exceptionally good on the 17 March survey, and a major portion of the substratum types from the military danger zone on the east, west to a point about 1 km east of the Honouliuli WWTP Outfall was examined. The area covered in this survey is depicted in Figure 2 and is bounded by longitude 158°00.2400' W on the east to 158°00.8000'W and covered depths from about 15 m to about 28 m. The dominant substratum type is a mix of sand and coral rubble, most of which occurs as a veneer over limestone or as scattered deeper sand pockets. Below about 25 m most of the sand and rubble appears to have greater depth. Inshore of the broad sand-rubble flats is a limestone substratum which has areas of relatively high coral coverage. These coral communities are best developed at depths less than 20 m which is similar to the zonation found at the western site examined above. The coral rich areas occur in patches that cover from a few square meters of bottom to scales of several hundred square meters.

There is a commercial aquaculture operation using anchored subsurface cages for the raising of fish located in waters seaward of the area examined in this study. This commercial venture is located on a broad sand flat at 21°17.3000'N, 158°00.4120'W at depths of about 40 m and occupies an area with a radius of 500 feet around the center point.

While parts of the eastern area meet the biological and regulatory criteria for a suitable artificial reef site (in fact, a site delineated there and presented as the proposed reef site in the *Environmental Impact Statement Preparation Notice* (EISPN) for the proposed reef), its proximity to the military danger zone to the east raised concerns among several offshore stakeholders. Consequently, it was eliminated from further consideration during the EIS scoping process, and subsequent studies focused on the area west of the Honouliuli outfall.

2.3.1.2 Western Area Surveyed

The western area considered for a possible artificial reef site extended from the Honouliuli WWTP discharge pipe on the east (i.e., west of 158°01.8000'W) 3.8 km west along the coast near the tanker offloading facility (i.e., east of 158°04.0000'W) (see Figure 3). Because the deployed artificial reef materials must have a minimum overhead depth of 40 feet, the minimum depth examined for a possible artificial reef site was about 60 feet (~20 m) and extended seaward to about the 120-foot (~40 m) isobath.

The first field survey took place on 27 January 2005 with personnel from the Division of Aquatic Resources (DAR). To obtain an overall perspective of the status of marine communities situated at depths between -15 m to about -25 m, divers were towed behind the vessel. However, water clarity hampered visibility, so additional observations were made by diving with scuba at selected points. Preliminary observations suggested that an artificial reef could be sited anywhere between longitude 158°02.0000' W on the east to 158°03.3000' W on the west. Points further west of this boundary (158°03.3000' W), exhibited patches of well-developed coral growth at depths between about 15 m to

25 m, and thus this area would not be appropriate as an artificial reef site according to the criteria outlined above.

As discussed below, two transects were established to sample marine communities just inshore of the -18 m shelf break and just seaward of it on 27 January 2005. DAR personnel dove and swam a track from a point offshore at about 24 m depth (N 21°16.8720', W 158°02.0882') moving towards shore to a depth of ~14 m (N 21°16.8822', W 158°02.2513'). At the shallower depth, the divers encountered a sheathed cable about 8 cm in diameter lying on the bottom with an approximate onshore-offshore orientation. Subsequent enquiries with the U.S. Navy established that this cable is active and is located in a restricted zone (number 334.1400) as delineated in the U.S. Coast Guard Navigation Regulations page 233 and given by [Point A (shoreline) - 21°18'06"N, 158°04'24"W, Point B - 21°17'00"N, 158°03'30"W, Point C - 21°15'00"N, 158°03'18"W, Point D - 21°15'36"N, 158°01'06"W and Point E (shoreline) - 21°18'30"N, 158°02'00"W - see Figure 2].

The elimination of the eastern area as a potential artificial reef site led the Navy to review their operations and facilities in the restricted area west of the outfall. They confirmed that the proposed reef would not interfere with Navy uses of the area and gave DAR permission to site the proposed artificial reef within the restricted area, provided that: 1) DAR takes care to avoid any underwater structures during reef deployment (including the aforementioned cable), and 2) that DAR requires all recreational users to moor to buoys that DAR will provide at the site, rather than anchoring on the bottom.

In order to map the location of the active cable and to better define a boundary for the proposed reef site, a number of dives were made on 14 September 2006. The cable was not found, but biological studies were conducted well west of the approximate cable alignment. The cable was successfully located during further biological survey work conducted on 13 November 2006, at a depth of 29 m. DAR elected to delineate the proposed artificial reef site west of the cable alignment in order to avoid potential impacts to it. The boundaries and substrate types that characterize the proposed reef site are described in the following section.

2.3.1.3 Proposed Kalaeloa Artificial Reef Site

Data from the September and November 2006 surveys was used to delineate the proposed artificial reef site, which is bounded by the following turning points (WGS84 coordinate system), listed in a clockwise order starting from the northeastern corner:

21° 17.1470' N 158° 2.5000' W
21° 16.5000' N 158° 2.5000' W
21° 16.5000' N 158° 3.0000' W
21° 16.9500' N 158° 3.0000' W
21° 17.1370' N 158° 2.6260' W

The eastern boundary of the proposed artificial reef site lies 500 m west of the cable alignment and the proposed western boundary of the site is over 1.8 km from the offshore tanker unloading facility (see Figure 3). The shoreward boundary roughly follows the 20 m isobath and the seaward boundary falls approximately on the 36 m isobath. This proposed artificial reef site encompasses ~224 acres.

In the proposed site the dominant substratum type is a mix of sand and coral rubble, most of which occurs as a veneer over limestone or as scattered deeper sand pockets. Below about 25 m most of the sand and rubble appears to have greater depth. Interspersed with these sand-rubble areas are emergent limestone flats exhibiting little topographical relief. Shoreward of these deeper flats and

running roughly parallel to shore is a limestone ledge or rise which occurs along the -20 m (60-foot) isobath. The top of this ledge lies about 15-18 m in depth and the bottom is at 20-24 m depth. On the limestone rise and inshore of it are scattered areas of relatively high coral coverage. These coral communities are best developed at depths of -20 m or less, which is similar to the zonation found at the eastern area examined earlier in this study. The coral rich areas occur in patches that cover from a few square meters of bottom to scales of several hundred square meters. These features dictate that deployment of artificial reef materials should be seaward of this ~20 m deep limestone ledge/rise system on the deeper flat bottom areas to avoid any impact to these resources.

The following section describes the biological characteristics found offshore of Kalaeloa and in the proposed artificial reef site.

2.3.2 BIOLOGICAL CHARACTERISTICS OF HARD SUBSTRATUM COMMUNITIES OFFSHORE OF KALAELOA

The overview studies carried out to delineate an appropriate site for artificial reef development offshore of Kalaeloa noted several major biological zones or biotopes that are characteristic features along much of the coastline. Biotopes present in water from about 15 to more than 25 m depth offshore of Kalaeloa include: 1) the biotope of scattered corals found on the limestone substratum, which is generally inshore of the first shelf break that occurs at -20 m; 2) the biotope of deep featureless limestone found just seaward of the shelf break; 3) a transitional zone (i.e., ecotone) between the previous two biotopes; and 4) the biotope of sand which is generally seaward of the biotope of deep featureless limestone. In general, the biotopes all lie roughly parallel to shore with the biotope of scattered corals being situated at the shallowest depth (from ~10 to 20 m) and the other two biotopes found at increasing depths seaward of the first shelf break. Elements of each biotope may be found elsewhere and at other depths but usually occur at small spatial scales. It should be noted that the biotope of sand lies primarily seaward of the proposed artificial reef site. Because there are few macroinvertebrate and fish species found on the sand substratum (most coral reef species favor areas where shelter is present) quantitative sampling was limited in this area, but quantitative biological data are presented for each of the other major biological zones or biotopes. The sampling locations within each biotope are given in Table 1, and the sampling dates are presented in Table 2.

As noted above, one of the criteria used in the selection of an appropriate artificial reef site is of the absence (or scarcity) of live coral. Since much of the coral offshore of Kalaeloa at conventional diving depths is found inshore of the first (-20 m) shelf break, the focus of this study is on the area just seaward of this shelf break in the biotope of deep featureless limestone. Only where limestone is exposed and elevated away from sand and rubble (as occurs in some areas where vertical relief is present), coral communities may be relatively well-developed over small areas.

The following sections summarize the marine communities observed in each biotope, based on data from the project transects as well as information collected by the author for other marine community studies in the ‘Ewa-Kalaeloa region over the last 30 years. The study with the longest duration has been the 15-year monitoring program of marine communities in proximity to the Hono’uli’uli WWTP Deep Ocean Sewage Disposal system for the Department of Environmental Services, City and County of Honolulu (most recent report, Brock 2005). Other studies were carried out in support of the Barbers Point Harbor and the developments at Kapolei and West Beach (Krasnick et al. 1975, Bienfang and Brock 1980, Brock 1984, 1985, 1986, 1987a and b, 1988, 1989, 1990 a and b, 1991, 1992 a and b, 1993, 1997, 1998, 2001). To the extent possible, these data and field observations are used in the present study along with some old quantitative data collected by Brock in 1986.

Table 1. Locations of Sampling Stations

BIOTOPE AND STATION	COORDINATES
Biotope of Scattered Corals	
Station B (17 March 2005)	21°17.545'N, 158°00.696'W
Station BP 1-B (from Brock 2004)	21°17'46"N, 158°00'49"W
Station BP 3-B (from Brock 2004)	21°17'22"N, 158°03'39"W
Station BP 4-B (from Brock 2004)	25 m east of 21°17'42.5"N, 158°01'41"W
Ecotone Between Biotopes of Scattered Corals and Deep Featureless Limestone	
Station A (27 January 2005)	21°17.110'N, 158°02.117'W
Station C (17 March 2005)	20 m seaward of Station B
Station G (13 November 2006)	21°17.096'N, 158°02.518'W
Station I (14 September 2006)	21°17.072'N, 158°02.674'W
Biotope of Deep Featureless Limestone	
Station D (27 January 2005)	50 m seaward of Station A
Station E (17 March 2005)	21°17.460'N, 158°00.295'W
Station F (Brock 1986)	21°17.440"N, 158°00.250"W
Station H (13 November 2006)	25 m seaward of Station G
Station J (13 November 2006)	28 m east of Station I
Station K (13 November 2006)	20 m seaward of Station I
Note: The biotope of sand which lies primarily seaward and at greater depths (below -36 m or more) was not quantitatively sampled in this study.	

Table 2. Sampling Dates and Transect Locations

DATE	START	FINISH	ACTIVITY
27 January 2005	21°17.103'N 158°02.853'W	21°17.079'N 158°02.718'W	Tow/Swim
	21°17.149'N 158°02.397'W	21°17.110'N 158°02.099'W	Tow/Swim
	21°16.872'N 158°02.088'W	21°16.882'N 158°02.251'W	Tow/Swim
17 March 2005	21°17.494'N 158°02.853'W	N/A	Spot Dive
	21°17.511'N 158°00.267'W	21°17.384'N 158°00.341'W	Tow/Swim
	21°17.401'N 158°00.334'W	N/A	Spot Dive
	21°17.420'N 158°00.311'W	21°17.515'N 158°00.818'W	Tow/Swim
	21°17.402'N 158°00.611'W	21°17.429'N 158°00.718'W	Tow/Swim
14 September 2006	21°16.905'N 158°02.225'W	21°16.939'N 158°02.487'W	Tow/Swim
	21°17.077'N 158°02.247'W	21°17.133'N 158°02.487'W	Tow/Swim
	21°17.060'N 158°02.647'W	21°16.967'N 158°02.860'W	Tow/Swim
13 November 2006	21°17.371'N 158°01.627'W	21°17.246'N 158°02.029'W	Tow/Swim
	21°17.182'N 158°01.915'W	21°17.203'N 158°02.267'W	Tow/Swim
	21°16.861'N 158°02.224'W	N/A	Spot Dive

Note: Observations on bottom types and marine community development were made doing a combination of towing a diver behind the vessel when water clarity was high or by use of scuba and swimming with the prevailing current and pulling a surface float to aid in keeping the vessel nearby and are shown below as "Tow/Swim" activities. "Spot Dives" were made using scuba at given locations to examine the bottom.

2.3.2.1 Biotope of Scattered Corals

This biotope occurs along much of the region offshore of Kalaeloa. This biotope is situated in the middle of the shoreward-most limestone platform which was formed during the Pleistocene (B-K Dynamics. Inc. 1971). In this biotope, various species of corals exist in patches of less than 10 m^2 to over 100 m^2, resulting in a very heterogeneous series of communities. In shallower areas (about 7 m depth) corals are sparse, but farther offshore (i.e., at depths of 10 to 15 m), coral communities become more diverse and better developed. As might be expected, where the coral communities are better developed and provide greater topographical relief (i.e., shelter), fish communities are likewise better developed. Corals are the visually dominant organisms in this biotope and the lobate coral *Porites lobata* provides the greatest amount of cover (see photographs in Figure 4 for examples). Coverage varies from less than one percent up to about 60 percent over scales of up to 100 m^2. Other important corals include rice corals (*Montipora verrucosa*, *Montipora patula*) and the cauliflower coral (*Pocillopora meandrina*). Bienfang and Brock (1980) noted more fishes species (mean 41 per transect) in this biotope than any other.

Towards the deeper boundary of this biotope, coral coverage and colony sizes decrease such that exposed limestone substratum becomes more apparent between the patches of living coral. This more open substratum often has sand and rubble occurring in small depressions and is usually encountered in proximity to the -20 m shelf break. Along some sections of the coast, the -20 m shelf break is not readily apparent, but is replaced by a relatively smooth limestone substratum sloping away at a 5 to 30° slope into the next (deeper) biotope. In the deeper sections of the biotope of scattered corals there is a general lack of cover and shelter sites for organisms. Thus, where it occurs, many fishes and macroinvertebrates are aggregated about the available shelter. If this shelter is in proximity to the shelf-break and if it is pronounced (i.e., vertical or undercut with ledges), fishes and motile invertebrates may locally be quite numerous.

It is estimated that less than five percent of the substratum in the proposed artificial reef site is part of the biotope of scattered corals; mostly this biotope is concentrated shoreward of the site. State biologists will inspect the substratum prior to reef deployment to ensure that artificial reef structures are placed outside this biotope.

While nearly absent from the proposed artificial reef site, the biotope of scattered corals was sampled in this study because an artificial reef developed in proximity to this biotope (i.e., within 200 m), could influence the resident fish communities. Data collected in the biotope of scattered corals is given in Appendix A and Appendix C and summarized in Table 3. In general mean coral coverage is about 10 percent and in each transect, there is a mean of five coral species, 6 macroinvertebrate species, 27 fish species, 272 individual fish and 242 g/m^2 of fishes present. Fish census data are given in Appendix M.

The data from the biotope of scattered corals show that coral coverage ranges from 5 to 15% and that fish communities are relatively diverse (from 13 to 39 species, 82 to 517 individual fishes with standing crops up to 436 g/m^2 per 100 m^2 transect area). The coral coverage and fish community estimates are relatively high because sampling was carried out in the areas with the greatest coral coverage, and these coral rich areas allow for better fish community development. The selection of sample sites in the biotope of scattered corals focused on some of the best developed marine communities in the area so that these data could be compared to biological data from the relatively depauperate biotope of deep featureless limestone (see Section 2.3.2.3 below).

Table 3. Community Characteristics of the Biotopes in the Project Area

PART A: Biotope of Scattered Corals

Parameter	Stations 1-B	3-B	4-B	B	Grand Mean
% algal cover	1	0	0	1	1
% coral cover	15	5	7	14	10
No. coral species	6	5	4	6	5
No. invert species	6	8	5	5	6
No. fish species	39	26	13	30	27
No. fish individuals	517	236	82	251	272
Fish biomass (g/m^2)	436	311	145	75	242

PART B: Ecotone Between Two Biotopes

Parameter	Stations A	C	G	I	Grand Mean
% algal cover	5	1	0	0.03	2
% coral cover	12	3	1	2	5
No. coral species	5	3	2	4	4
No. invert species	7	5	6	7	6
No. fish species	20	8	20	33	20
No. fish individuals	252	22	70	150	124
Fish biomass (g/m^2)	119	2	32	78	58

PART C: Biotope of Deep Featureless Limestone

Parameter	Stations D	E	F	H	J	K	Grand Mean
% algal cover	0	7	0	0.1	0.2	0	1.2
% coral cover	0.2	0	0	0.4	1.4	0	0.3
No. coral species	4	0	0	2	2	0	1
No. invert species	7	1	1	3	7	3	4
No. fish species	5	1	1	5	10	5	5
No. fish individuals	13	3	1	10	40	11	13
Fish biomass (g/m^2)	2	8	0.1	0.6	11	0.5	4

NOTE: Data from Stations 1-B, 3-B and 4-B are from Brock (2004); other data are summarized from data as given in the appendices except for old 1986 data collected by Brock at Station F. In most cases, data are rounded to nearest whole number.

Lobate coral colony (*Porites lobata*) in the biotope of scattered corals, depth -18m, located 40m inshore of 21°17.072'N, 158°02.674'W. Also shown are surgeonfishes: kole, *Ctenochaetus strigosus*, ma'i'i'i (*Acanthurus nigrofuscus*), uhu (*Scarus psittacus*), and a single a'awa (*Bodianus bilunulatus*).

Cauliflower corals (*Pocillopora meandrina*) at -21 m depth about 25 m inshore of 21°17.072'N, 158°02.674'W. Also present are sea urchins (*Echinothrix calamaris*). Note the open substratum.

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Division of Aquatic Resources, Dept. of Land & Natural Resources

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PLANNING SOLUTIONS

Source:
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Figure 4:

Photographs of the Biotope of Scattered Corals

Kalaeloa Artificial Reef Project

Figure 4 Photographs of the Biotope of Scattered Corals 2007-01-05.cdr

2.3.2.2 Ecotone Between Two Biotopes

The boundaries of ecological zones or biotopes are not usually clear-cut or distinct. Rather, there usually exists an area or zone of transition (i.e., ecotone) between two biotopes. This phenomenon is evident between the biotope of scattered corals and the deep featureless limestone biotope. Four sampling stations were established in the ecotone between the biotope of scattered corals and the biotope of deep featureless limestone (see Table 1). The results of the quantitative surveys of these stations are given in Appendices B, D, H, and J and are summarized in Part B of Table 3). The mean percent coverage by corals is 5% and the mean number of coral species is 4, mean number of diurnally-exposed macroinvertebrate species is 6, mean number of fish species is 20, mean number of individual fish is 124 and the mean standing crop of fish per transect is 58 g/m^2. Figure 5 provides photographs taken within this ecotone. Table 3 shows that the mean values for biological parameters measured in the ecotone are less than those measured in the biotope of scattered corals but greater than those measured in the biotope of deep featureless limestone located just offshore. The area encompassed by this ecotone in the proposed artificial reef site is estimated to be less than 2 percent of the total site area.

2.3.2.3 Biotope of Deep Featureless Limestone

The biotope of deep featureless limestone occupies more than 90 percent of the substratum in the proposed artificial reef site. As the name implies, the biotope of deep featureless limestone is relatively flat with little topographical relief (see photos in Figure 6). This biotope occurs all along the Barbers Point region at depths from about 18 to over 36 m. In the areas west of the Honouliuli WWTP outfall, the biotope of deep featureless limestone is a relatively bare limestone substrate. To the east of the outfall, much of the limestone in this biotope has a veneer of sand and coral rubble present. This veneer may be as thin as a centimeter or two or may be deep enough in areas to fill depressions in the limestone. The relatively open, flat, and hard substratum characteristic of this biotope is ideal for artificial reef development because it provides a stable substratum on which reef materials may be deployed. It has also been found to provide productive forage grounds for many newly recruited fish species to deployed reefs, thus leading to higher abundances and standing crops of fishes resident to the artificial reef.

Where water clarity would permit, the substratum over much of the proposed artificial reef site was examined by towing divers behind a support vessel and/or following divers carrying a float while moving with the prevailing current. These activities allowed a “broad-brush” qualitative delineation of the dominant bottom types (i.e., sand, limestone, sand over limestone, corals, etc.), relative degree of benthic and fish community development, definition of obstacles in bottom topography which could hinder artificial reef development, and any other potential problem that could affect the usefulness of the site for artificial reefs (e.g., presence of manmade materials such as the previously mentioned cable). These observations, coupled with dives at specific points for the quantification of benthic and fish communities, provide the data used in delineating the boundaries of the artificial reef site above. The approximate start and finish points of these tows and swims are given in Table 2.

Biological data from the six sampling stations located within the biotope of deep featureless limestone (see Table 1) are given in Appendices E, F, G, I, K, and L. These data are summarized in Table 3. The percent coral cover ranges from zero to about 1.4 percent (mean 0.3%), the mean number of coral species is 1, the number of diurnally-exposed macroinvertebrate species is 4, the number of fish species is 5, the number of individual fishes is 13 and the mean biomass of fishes is 4 g/m^2 on the average transect carried out in this biotope.

Photograph looking shoreward at the ecotone or zone of transition between the biotopes of scattered corals and of the deep featureless limestone. Corals in the background are ~20 cm high (maximum).

Corals in the ecotone or zone of transition between the biotope of scattered corals and the biotope of deep featureless limestone. Colonies in the foreground are about 10 cm in diameter.

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Figure 5:

Photographs of the Transitional Ecotone

Kalaeloa Artificial Reef Project

Figure 5 Photographs of the Biotope of the Transitional Ecotone 2007-01-05.mxd

Biotope of deep featureless limestone about 40 m seaward of 21°17.072'N, 158°02.674'W, depth ~25 m. Note the near absence of topographical relief.

Biotope of deep featureless limestone overlain by a sand veneer; depth 27 m, about 70 m seaward of 21°17.072'N, 158°02.674'W.

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Figure 6:

Photographs of the Biotope of Deep Featureless Limestone

Kalaeloa Artificial Reef Project

Figure 6 Photographs of the Biotope of Deep Featureless Limestone 2007-01-05.mxd

In general the biotope of deep featureless limestone is characterized by poor development of most coral reef species. The relatively low diversity of macroinvertebrates and fish is related to the lack of topographical relief and shelter. Coral communities are not well-developed because of the relatively flat substratum is scoured by sand driven by occasional high surf that will cause sand and coral rubble to move across the bottom and abrade resident corals. However, where topographical relief is encountered in this biotope, fish and benthic communities may be locally well-developed. Such topographical relief is most often found around small escarpments and small areas of ledges but these features are rare in the proposed artificial reef site.

2.3.3 THREATENED AND ENDANGERED SPECIES AND OTHER SPECIES OF INTEREST

Because of declining population sizes, the green sea turtle (*Chelonia mydas*) was granted protection under the federally mandated Endangered Species Act in 1977-78. Green turtles as adults are known to forage and rest in the shallow waters around the main Hawaiian Islands. Reproduction in the Hawaiian population occurs primarily during the summer months in the Northwest Hawaiian Islands with adults migrating there during summer months and returning in late summer or early fall. In the main Hawaiian Islands, green turtles will rest along ledges, caves or around large coral mounds in coastal waters from 13 to 20 m in depth during the day. At night turtles travel inshore to shallow subtidal and intertidal habitats to forage on the algae or limu (Balazs et al. 1987). The normal range of these daily movements between resting and foraging areas is about one kilometer (Balazs 1980, Balazs et al 1987). Selectivity of algal species consumed by Hawaiian green turtles appears to vary with the locality of sampling, but stomach content data show *Acanthophora spicifera* and *Amansia glomerata* to be quantitatively the most important (Balazs et al. 1987); the preferences may be due to the ubiquitous distribution of these algal species. Along the Kalaeloa coastline these and a multitude of other algal species are known to occur in relatively high abundance. Indeed, the 'Ewa Beach-Kalaeloa area is known as a good place to "pick limu" for home consumption.

As noted above, the author has spent considerable time on and in the water offshore of 'Ewa Beach - Kalaeloa area over the last 30 years. As time has passed, green sea turtles have become increasingly common in the area from the Pearl Harbor entrance channel to the Tanker Offloading Facility. Their diurnal distribution appears to be correlated with the presence of high quality resting areas (i.e., undercuts, ledges, etc.). Returning towards Honolulu Harbor on the 17 March 2005 field effort, more than 30 turtles were counted on the surface in the area from the Barbers Point sewage discharge pipe to the entrance channel of Pearl Harbor. Many of these individuals were adults.

The endangered humpback whale (*Megaptera novaeangliae*) is known to frequent island waters in their annual migrations to Hawaiian wintering grounds. They normally arrive in island waters about December and depart by April. In general, their distribution in Hawai'i appears to be limited to the 180 m (100 fathom) isobath and in shallower waters (Nitta and Naughton 1989). Usually humpback whales are seaward of most coral reef sample sites; they were present offshore of the survey vessel during the field work carried out for this study. On 17 March 2005, two whales appeared in the area inshore of the commercial aquaculture venture located in waters between -30 m to -46 m west of the Pearl Harbor entrance channel. While this was an unusual event, it shows that humpback whales may occasionally enter relatively shallow waters around the Hawaiian Islands.

There is a well-known pod of spinner porpoises (*Stenella longirostris*; not threatened or endangered) that is frequently seen along the south shore of Oahu. This pod is often diurnally found anywhere from Diamond Head on the east to the area near the Barbers Point sewage discharge pipe on the west. On 17 March 2005 this pod was seen in the Navy Danger Zone (no. 334.1370). Typically spinner porpoises will rest in coastal water during the day and forage in more offshore waters at night.

3.0 PROPOSED ARTIFICIAL REEF DESIGN

Experimental studies on the design of artificial reefs in Hawaiian waters suggest that specifically designed and constructed artificial reefs have significantly better fishery enhancement advantages over reefs constructed of materials of opportunity or those where the deployment results in haphazard configurations on the bottom. Thus there is a hierarchy of artificial reef design in terms of their ability to enhance fishery production that is as follows (from best to worst): (1) specifically designed and carefully constructed/deployed reefs, (2) reefs constructed of specifically designed modules but utilizing deployment methods that result in a haphazard configurations on the bottom, and (3) reefs constructed of materials of opportunity and again deployed such that the final configurations result in random configurations on the bottom (Brock and Norris 1989).

The financial costs of reef construction and deployment closely follow the hierarchy of reef design. Building specifically designed artificial reef modules is more costly than using materials of opportunity (scrap materials and assuming that there are not high cleanup costs of these materials prior to deployment). Similarly, underwater construction of specifically designed modules randomly deployed to the seafloor and subsequently moved to form a reef requires skilled diving technicians, is dangerous and costly relative to the costs of deploying specifically designed modules by simply pushing them off of a barge and into the ocean to form the reef (resulting in a haphazard reef configuration).

Since the proposed artificial reef site is to be developed as part of the Hawai'i State DAR fisheries enhancement program, the majority of the reef will probably be made using the successful "Z" block modules. As mentioned, the DAR began using cast concrete "Z" blocks for artificial reef development in 1990. These modules are constructed of concrete in the shape of a "Z". Deployment has been accomplished by simply putting the barge carrying the modules on site and using a front-end loader to push the modules off the barge. If the barge is held in place, the resulting reef will have a relatively high aspect ratio (i.e., ratio of reef height to diameter of the reef base) which usually affords more effective shelter than a reef constructed of these modules scattered across the bottom. In their deployment, "Z" blocks will afford some shelter irrespective of how they land on the bottom due to their "Z" design. The long-time use has proven this design in terms of fishery enhancement characteristics as well as in module stability. The modules are relatively low cost to produce and deploy; costs are about $150 per module and existing artificial reef sites have received up to 1,800 modules per year (Brian Kanenaka, DAR, personal communication). It is recommended that these modules continue to be used and the deployment strategy should still consist of barges using front-end loaders to push them into the ocean. The resulting reefs will have haphazard configurations, but the overall fishery enhancement capabilities are good.

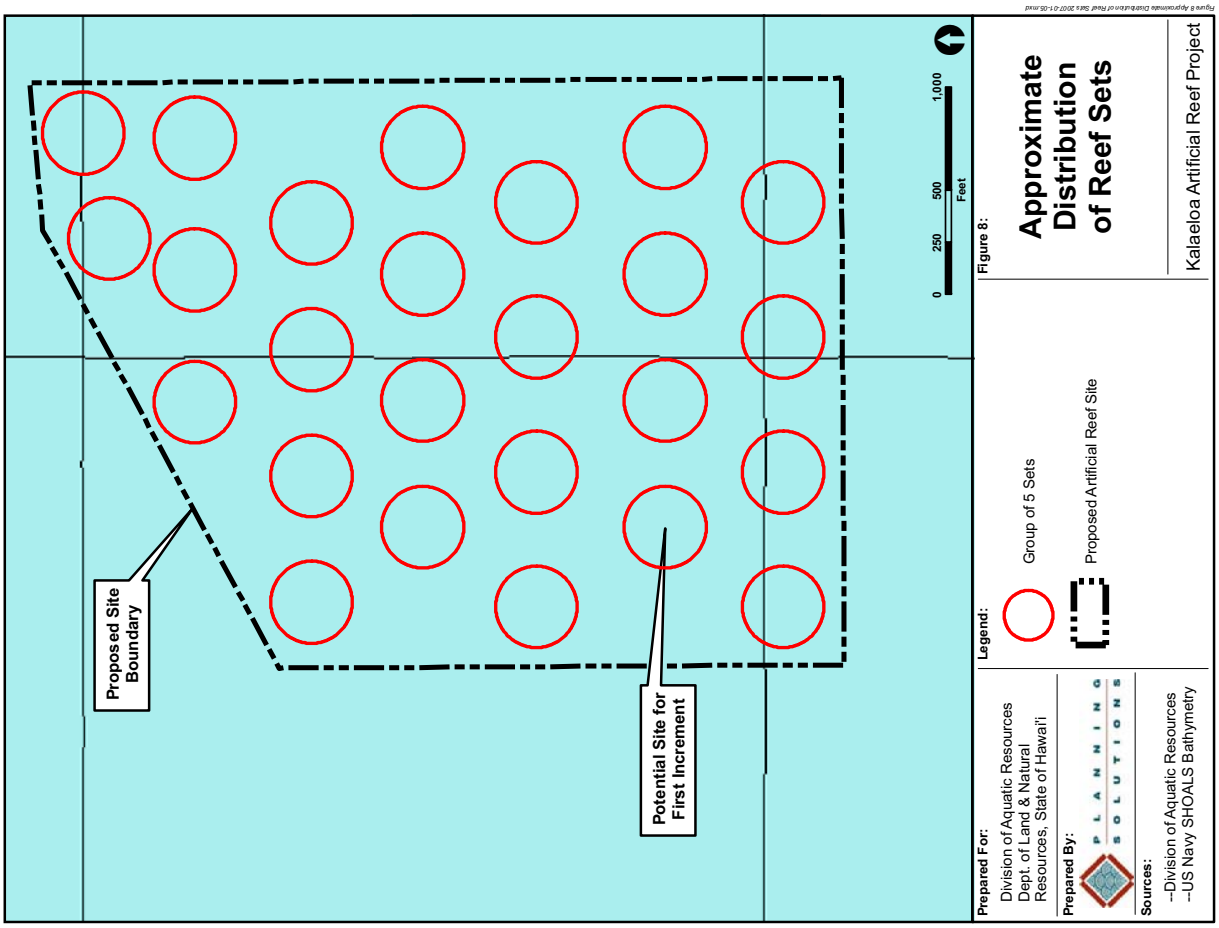
To be successful, an artificial reef must be situated on an appropriate substratum; for most reefs this means a firm or solid substratum. A second prerequisite is that the artificial reef should not directly compete with natural reefs, thus the deployment site should not have high natural coral cover immediately adjacent to deployed reef modules. Also, since conservation of corals has increased as an important issue in recent years and due to the fact that coral growth is often responsible for the development of much of the natural shelter for fishery resources, artificial reef materials must be deployed away from these natural features. Finally, hazardous materials that may be present in a reef area must be avoided. Finding ordnance on Hawaiian reefs is not unusual. The possibility of finding ordnance as well as the possible presence of significant coral development are additional reasons for a thorough examination of the substratum by divers and the marking (using buoys) of each deployment site prior to the deployment of reef materials.

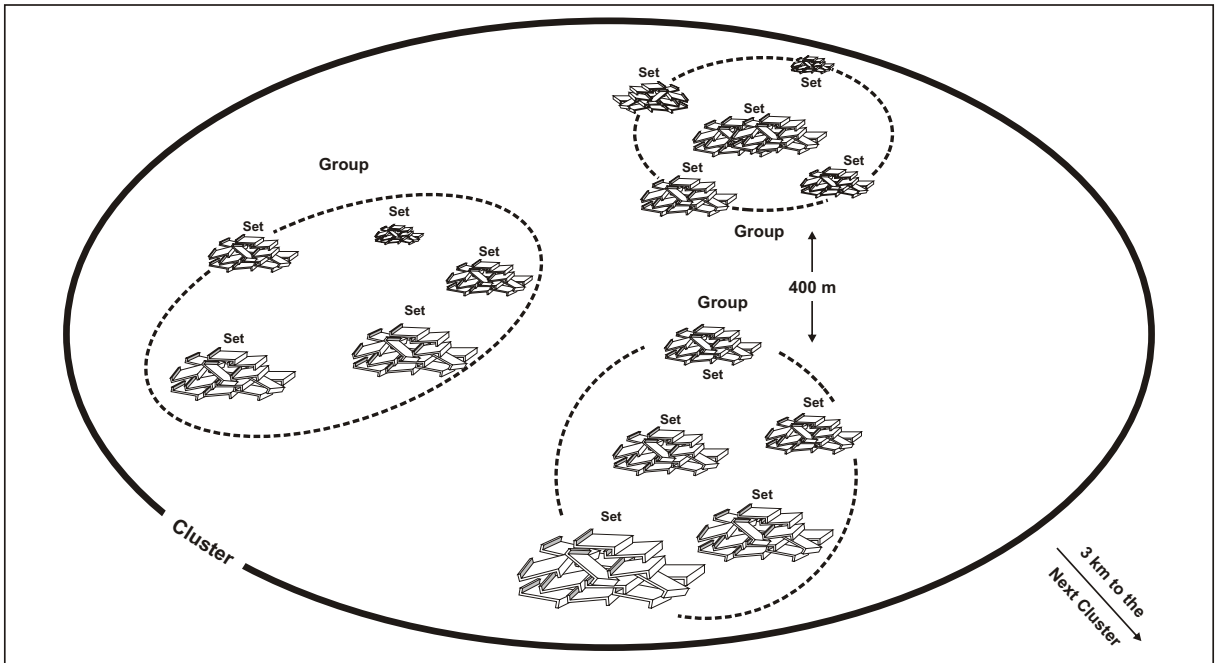
If deployed on soft or shifting substrates, the internal void spaces of most artificial reef materials will be filled up by loose material. Unconsolidated material is transported by currents and/or wave energy. If this energy is dissipated or decreased, the materials will winnow or settle out. This may occur where currents impinge on a reef resulting in a buildup of unconsolidated materials in and around the reef. This eventually may lead to partial reef burial and a reduction in shelter space and enhancement characteristics.

The large, open expanse of flat limestone in the proposed artificial reef site is a prerequisite for the success of the reef. Studies carried out on the development of fish communities on artificial reefs deployed on Hawaiian open limestone substratum show the tremendous enhancement of fishery resources that can be supported (Brock and Norris 1989). The reef design proposed for deployment has good proven stability characteristics, provides appropriate shelter for fishes and utilizes concrete as the construction material. The durability afforded by concrete, its high mass to volume ratio and the proven stability of the "Z" module design are among the important factors contributing to a long life expectancy in the deployed reef.

The Japanese approach to the construction of modern artificial reefs involves several levels of design (see Grove and Sonu 1983). The basic building block is the individual module. In the case of the proposed Kalaeloa artificial reef, the module of choice is the "Z" block used by the Hawai'i State DAR. Modules are clustered together to form a "set" and the Japanese approach is to have each "set" of modules occupy a volume from a minimum of 400 m^3 but preferably greater than 1,000 m^3. If the dimensions of "Z" blocks are 2 m in length, 1 m in width and 0.6 m on each of the two short sides, each module occupies a bulk volume of ~1.2 m^3. A normal reef set of Hawai'i "Z" blocks would occupy a circle of about 30 m diameter and have a height of about 6 m. Assuming a resulting cone shape, a reef of this size would have a bulk volume of about 1,400 m^3 and would probably require deployment of about 1,200 modules in that 30 m diameter circle. In Japan it is believed that the range of influence around an artificial reef set is about 200 m and individual sets are placed with that amount of spacing between them. Ten to twenty reef sets form a reef "group" and reef groups are spaced about 400 m apart. Reef groups form a reef cluster and reef clusters are separated by about 3 km between them. (Grove and Sonu 1983; see Figure 7 for an illustration). The distances between reef sets, groups and complexes in Japan are based on experimental evidence regarding the movement of sedentary fish species and the fact that the fishing activities on these reefs are carefully controlled by fishing cooperatives. Thus, over-harvest is not an issue as it might be in Hawai'i. Since the proposed Kalaeloa artificial reef is for public use, there will be little control on fishing effort and the design of the deployed reefs should be adjusted to allow better escapement by some proportion of the targeted species populations. Since the proposed artificial reef site has considerable potential area for deployment, reef construction would probably occur incrementally for many years to come, resulting in numerous reef groups using the spacing outlined above. A preliminary configuration of what full build-out of the reef might look like is presented in Figure 8.

Individual reef sets should, at a minimum, probably occupy about 700 m^2 of substratum (about the size of a circle 30 m in diameter) and have a bulk volume of about 1,400 m^3 (i.e., rise to a height of about 6 m). To reduce the effectiveness of nets in a reef set with this design (which would apportion more of the resources to a greater number of non-net fishermen), some of sets should probably be deployed within visual range of one another while some may have greater spacing between them.





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Source:
Grove & Sonu (1983)

Note: Scales of fishing reef as determined by researchers for sedentary species in Japanese temperate waters, after Grove & Sonu (1983).

Figure 7:

Configuration of Artificial Reef

Kalaeloa Artificial Reef Project

The proposed Kalaeloa site will occupy about 224 acres. The site was delineated between depths of about 18 and 36 meters (i.e., safe for diving, but deep enough to avoid excessive wave force and problems with U.S. Coast Guard overhead clearance). A site of this size using reef sets as described above would be large enough to allow the Hawai'i State artificial reef program to deploy materials there for many years to come. It is proposed that many reef sets be deployed within visual contact of one another (30 m apart) in groups of five "sets" that would comprise a reef "group". Spacing between these groups can range from 50 to 150 m or so. In this way, fish can easily move among the sets of a group. Assuming that all substratum in the proposed artificial reef site would be appropriate for the deployment of materials and using the 30 m diameter reef set size and five sets to comprise a group and spacing groups about 100 m apart, full build-out would result in the deployment of about 25 groups (of 5 sets each).

The proposed artificial reef site and the reef design recommended here satisfy all of the criteria identified above for successful reef development. Studies on the development of fish communities on artificial reefs deployed on Hawaiian open limestone substratum have demonstrated a tremendous enhancement of fishery resources (Brock and Norris 1989). The durability afforded by concrete, its high mass to volume ratio and the proven stability of the "Z" module design are among the important factors contributing to a long life expectancy for the proposed reef.

4.0 IMPACT OF REEF DEPLOYMENT ON MARINE COMMUNITIES

The first question that should be addressed is "why is there not more live coral present in the biotope of deep featureless limestone?" The answer is, wave energy impinging on the relatively flat limestone substratum will cause sand and coral rubble to move. The movement of these lighter weight materials across the flat limestone surfaces causes abrasion to any sessile organism that is present on the substratum. In deeper water, only the largest waves will have sufficient energy to cause this movement of materials and abrasion to occur, so these events do not happen with much frequency at the proposed artificial reef site. However, Hawaiian corals are slow growing with some colonies attaining ages in excess of 200 years, so these events do not need to happen very often to keep the communities on these relatively flat limestone areas at an early successional stage. These impacts are modified by topographical relief; where topographical relief is present, sessile species such as corals may be protected from the sand scour and wave impact if the topography blocks the prevailing wave direction. In areas lacking topographical complexity, benthic organisms are subject to scour if wave forces are of sufficient magnitude. Further evidence for the impact of occasional waves forces on the benthic communities of the biotope of deep featureless limestone is presented in Table 3. The mean coral coverage on the elevated armor stone at Station 4-A was recorded as 29% over a 12-year period while on the adjacent flat limestone (25 m away) it was 7%. At Station 4-A the corals were primarily found on the armor stone from a point of about 1 m and greater above the surrounding substratum. The occasional abrasion by sand along the lower meter or so of the armor stone probably serves to prevent successful recruitment and growth of corals in this area but above the one meter mark, recruiting corals are not exposed to the same levels of occasional sand scour and impact.

These results are not unexpected; physical disturbance from occasional storm surf is one of the most important parameters in determining the structure of Hawaiian coral communities (Dollar 1982). Numerous studies have shown that occasional storm generated surf may keep coral reefs in a non-equilibrium or sub-climax state (Grigg and Maragos 1974, Connell 1978, Woodley et al. 1981, Grigg 1983). The large expanses of near-featureless lava or limestone substratum present around much of the Hawaiian Islands at depths less than 30 m attest to the force and frequency of these events (Brock and Norris 1989).

There are a number of impacts that may occur if an artificial reef is deployed offshore of Kalaeloa and evaluated in the following sections. Negative impacts include: (1) coverage of the substratum and any extant communities by the deployed modules, (2) possible leaching of toxic substances from these materials, (3) possible movement of the deployed materials with impinging storm waves, and (4) the "production versus aggregation" issue if it is applicable. Potential positive impacts include: (1) the local enhancement of fishery resources, (2) the increased availability of hard substratum for benthic community development and (3) increased fisheries productivity for the fishermen.

4.1 COVERAGE OF EXISTING CORALS BY ARTIFICIAL REEF MATERIALS

The deployment of reef modules will impact communities on which they are placed. If the scenario given above is used (where 125 reef sets are deployed each having a footprint of about 700 m^2), there would be 22 acres covered by the artificial reef, out of a total of 224 acres in the artificial reef site. This amounts to approximately 10% coverage of the reef site.

Assuming that reef deployment will not occur in the biotope of scattered corals (which occupies ~5% of the total site area) and assuming that mean coral coverage is about 0.3% in the biotope of deep featureless limestone (Table 3) where reef materials would be deployed, there could initially be a loss of up to 263 m^2 of coral (of a total estimated 2,586 m^2 of live coral present throughout the 213 acres covered by biotope). In actuality, the loss will be much less, because coral patches are not evenly distributed throughout the site and most, if not all, can easily be avoided during reef deployment.

Further, assuming that the individual artificial reef sets rise 6 m above the substratum and that the bottom meter of height would be devoid of coral due to wave scour (as is the case on the Barbers Point sewage discharge pipe), the remaining 5 m of each reef set would provide suitable substrate for new corals to colonize. Utilizing a conical shape to calculate the surface area, this amounts to about 745 m^2 per set. All together, the 125 sets anticipated at full buildout would provide 93,125 m^2 (about 23 acres) of surface area. If the mean coral coverage on the armor stone (29%) is representative of the coral community that would form on the "Z" blocks elevated more than a meter off the substratum, there would be 27,006 m^2 of live coral present on the site after twenty or so years which is a 993% increase in coral coverage over the present condition. This estimated increase is low because it does not take into account the increased surface area caused by the individual "Z" blocks but just assumes a simple conical surface. Since the Honouliuli WWTP discharge pipe was deployed about 1980, the expected maximum increase in coral coverage on the artificial reef as calculated above would be expected to take about 20 years.

4.2 POSSIBLE LEACHING OF TOXIC MATERIALS

Concrete is used for many construction projects that require placement of materials in the marine environment. Concrete cures rapidly and has a long life-expectancy in seawater and thus is the material of choice for many projects. Studies have found that marine organisms rapidly colonize exposed concrete surfaces; one Hawaiian study found that up to five species of corals had recruited to concrete within 3 months and that coral recruitment and growth is best on concrete and natural limestone and significantly less so on other artificial substrata such as steel or automobile tires (Fitzhardinge and Bailey-Brock 1989). Artificial reefs constructed of concrete in Hawai'i exhibit significant growth of corals and other benthic species (McVey 1970). The data suggest that if there are any toxic materials leaching from concrete when immersed into seawater, the leaching must be at low levels and occur rapidly because primary algal colonizers are evident on concrete within two weeks after deployment. These species are rapidly replaced by a series of other species colonizing the surfaces, suggesting that there are few (if any) substances toxic to benthic marine species leaching from concrete (personal observations). Corals, which probably represent the climax community condition, become quite obvious to the causal observer within 1 to 1.5 years following deployment (see Fitzhardinge and Bailey-Brock 1989).

4.3 POSSIBLE MOVEMENT OF DEPLOYED MATERIALS

The potential impact of storm surf on deployed materials situated in 19 to 25 m of water is dependent on the magnitude of the given storm, its course (directional heading), the coefficient of friction, drag forces, and the weight of individual "Z" blocks as well as the design or configuration of the individual "Z" blocks with one another following their deployment. In general, deployed "Z" modules have shown little movement due to impinging waves.

Hurricane Iniki, which struck the Hawaiian Island in September 1992. created waves with estimated heights of 20 m or more (personal observations) that among other places, struck O'ahu's south and

western shores. "Z" modules remained in place despite the fact that much of the wave energy was dissipated at depths between 20 to 30 m in the Kalaeloa-Kahe Point region (Brock 1992b). In contrast, modified scrap materials (airplane shells from the defunct Mid-Pacific Airlines) which were not engineered for stability deployed at the Atlantis artificial reef site offshore of Waikiki in ~32 m of water where broken apart and carried away (to unknown areas) by this same wave event. Hurricane Iniki impacted coral communities in the Kahe Point area; field work carried out two weeks after the event found that in some cases communities appeared to be completely intact and not affected by the passage of the hurricane, while ten to twenty meters away these coral communities were almost completely destroyed. This "patchy" destruction was mirrored on land where the roof of one home was completely destroyed but the papaya trees across the street were left standing. Despite finding areas where hundreds of cubic meters of limestone rock, sand, and corals where completely removed (without any trace of them) in 30 m of water in the ecotone between the bitotope of scattered corals and the biotope of deep featureless limestone (Brock 1992b, 1993), the "Z" modules remained in place with relatively little movement. In summary, the "Z" modules show good stability characteristics will probably continue to do so under most prevailing wave conditions present along the Kalaeloa coastline.

4.4 IMPACTS TO THREATENED AND ENDANGERED SPECIES AND OTHER SPECIES OF INTEREST

Since green sea turtles are relatively common in the 'Ewa Beach-Kalaeloa area, some individuals would be expected to take advantage of the shelter created by the artificial reef and utilize these areas for diurnal resting. Fishermen are well aware of the protected status of green sea turtles and respect this; their presence will neither hinder the fishermen and the presence of fishermen using the artificial reef should not have an impact on any resident turtles. A possible exception could be the use of nets laid by scuba divers where fish are "herded" into the net for capture. Turtles could become entangled in these nets if they were left unattended but this kind of fishing is usually conducted in a single operation with several divers where the net is set, fish are herded to it and the net is retrieved. Under these circumstances, if a green sea turtles did become entangled in a net, the scuba divers would immediately free it not only because of the turtle's protected status, but because having a turtle in the net would make a successful catch difficult to achieve. In short, the development of an artificial reef as proposed herein would not be expected to impact any threatened or endangered Hawaiian species.

As noted above, spinner dolphins pass through the area proposed for artificial reef development. While not protected under endangered species legislation, their populations are widely thought to be in gradual decline. Since these porpoises feed on fish, the presence of an artificial reef could serve to improve their forage base although this author has only seen Hawaiian spinner porpoises feed on migratory species (i.e., mackeral scad or 'opelu *Decapterus macraellus*) or on the sand wrasse or nabeta (*Xyrichtys pavo*) during the day; 'opelu are sometimes attracted to artificial reefs but nabeta are not. Spinner porpoises have not been attracted to or necessarily repelled by artificial reefs built elsewhere in Hawaiian waters based on biological studies carried out by this author for more than 20 years on these structures. The construction or subsequent presence of an artificial reef should not have a negative influence humpback whales because they usually utilize the waters seaward of the proposed artificial reef site.

4.5 THE PRODUCTION VERSUS AGGREGATION ISSUE

It is well known that following deployment, artificial reefs are colonized by a number of reef fish species that are usually adults or subadults. Clearly the substratum on these reefs does not have the benthic community development necessary to support these diurnally-resident fishes so these individuals forage out on the surrounding substratum in the vicinity of the reef. In the introductory material above, the production versus aggregation issue is discussed; the bottom line is that development of appropriate shelter results in a locally more diverse, higher standing crop of fishes present than would otherwise be there. This is true on Hawaiian reefs after the first two weeks following deployment or after twenty-five years. Individuals that argue the deployment versus aggregation issue should realize that the development of fish communities on an artificial reef represent a continuum of feeding strategies and lifecycle stages which vary depending on the age of the reef when sampling is done. The circumstantial evidence suggests that even after many years, fish communities resident to a given artificial reef will have community structures that are significantly more robust than found on surrounding natural substratum (Brock and Norris 1989). It should be remembered that the deployed reef at a minimum provides shelter, and foraging occurs in the surrounding habitats, not necessarily on the artificial reef structure itself. Adult and subadult fish that move and take up residence in an artificial reef vacate natural space and shelter somewhere else that will be available for other fishes.

How would an artificial reef deployed in the proposed artificial reef site "perform" with respect to enhancing fishery resources? The biotope of deep featureless limestone is the dominant substratum type present in the artificial reef site. Using summary data from Table 3, mean fish biomass (all species) is about 4 g/m^2 in this biotope; if the mean fish standing crops for the first two years from the Waikīkī Atlantis artificial reef (here 1,165 g/m^2, Brock 1995) as well as concrete cube reef deployed in Moanalua Bay, Oahu (here 1,266 g/m^2 Brock 1989), are used as representative examples, we would expect an increase in biomass about 99.7% greater than is present on this substratum today. This would translate to a standing crop of about 1,216 g/m^2 on each reef set, or a total of about 851 kg of fish per reef set. These data are based on artificial reefs that received considerable fishing pressure during data collection. If we use data from materials deployed in Moanalua Bay with more than 20 years since deployment, mean fish standing crop is about 264 g/m^2. Using these data as an example, we could expect a similar standing crop on the deployed "Z" block sets and each set would have about 185 kg of fish present at any given time after twenty or more years have passed. Standing crops over the natural substratum would be about 4 g/m^2 (as above) and thus in a comparable 700 m^2 reef "set" footprint on this natural bottom, there would only be about 2.1 kg of fish present.

Most human activities that impact marine ecosystems do so in a negative way. Thus, construction activities that are of benefit to humans (such as the development of a harbor) often lead to permanent changes in nearby marine communities. These changes frequently involve the local loss of species (community simplification) and/or changes in the energy flow through the communities thus favoring a select suite of species over others. Manipulations involving habitat enhancement are among some of the few human activities that result in the improvement and/or restoration of marine communities. The establishment of appropriately designed artificial reefs is a proven means of habitat enhancement.

If allowed to occur, a program developing and deploying designed artificial reefs in the proposed Kalaeloa site will lead to substantial local increases in the abundance and diversity of fishes. Once established, this locus of high fish concentration (the deployed reef sets) will serve as a point source for the production and recruitment of larvae and/or immigration of adults to other locales, thus increasing the biological diversity and abundance over an area considerably larger than just the reef itself. The establishment of designed artificial reefs using the Hawai'i "Z" block design as proposed

herein will enhance fish and fisheries over a much greater area than might be initially realized. Not only would the designed artificial reef benefit fish communities, but the same benefits will accrue to hard bottom benthic communities. Artificial reefs such as the one proposed here provide appropriate stable substratum for the recruitment and growth of corals and other benthos. As these benthic communities develop and proceed through succession, they may serve as forage or forage sites for fishes resident to the reef, thus the artificial reefs will locally enhance the diversity of food webs utilized by some fish species.

The demonstrated efficacy of artificial reefs and the suitability of the proposed site for artificial reef deployment lead to the conclusion that the proposed Kalaeloa Artificial Reef will have cumulative, long term benefits for both marine communities and recreational users.

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APPENDIX A.

Summary of biological parameters measured at permanently marked stations sampled in the 1993 through 2004 period for two stations in coral rich communities (Station 3-B approximately 3.5 km west of the Honouliuli outfall pipe, Station 1-B about 1.7 km east of the outfall pipe), and two stations at the outfall: one on the caprock of the discharge pipe (4-A), the second, 20 m east on the natural flat limestone substratum (4-B). Note that fish biomass is given as g/m^2 and cover data are rounded to the whole numbers. Data from Brock (2004).

	Year												
Parameter	93	94	95	96	97	98	99	00	01	02	03	04	Means
In Coral (Station 1-B)													
%Algal Cover	0	0	1	0	0	2	1	1	1	2	1	3	1
%Coral Cover	7	22	25	24	14	17	13	11	11	11	10	9	15
No Coral Spp	4	5	6	6	7	5	6	7	8	7	7	6	6
No.Invert Spp	4	4	6	6	6	7	7	5	6	6	8	6	6
No. Fish Spp	44	42	38	40	34	33	41	37	48	42	39	32	39
No. Fish Ind	488	371	410	370	428	608	419	725	320	273	627	1165	517
Fish Biomass	490	202	109	290	471	141	211	427	330	161	828	1573	436
In Coral (Station 3-B)													
%Algal Cover	0	0	0	0	0	0	0	0	0	0	0	0	0
%Coral Cover	3	3	2	3	7	7	5	6	5	8	8	10	5
No Coral Spp	4	5	4	5	5	5	5	5	6	5	6	5	5
No.Invert Spp	6	8	6	7	6	9	8	10	9	10	8	8	8
No. Fish Spp	17	18	29	27	26	30	29	23	25	30	25	28	26
No. Fish Ind	161	109	156	393	302	473	199	145	135	247	167	342	236
Fish Biomass	311	445	128	282	550	499	359	213	111	118	218	497	311

APPENDIX A. Continued.

	Year												
Parameter	93	94	95	96	97	98	99	00	01	02	03	04	Means
On Caprock (Station 4A)													
%Algal Cover	0	4	2	1	1	1	2	2	2	3	2	5	2
%Coral Cover	20	27	28	28	27	22	40	31	29	33	34	28	29
No Coral Spp	4	3	1	2	3	2	2	2	2	3	3	3	3
No.Invert Spp	6	7	9	7	6	8	7	7	7	3	3	4	6
No. Fish Spp	49	51	48	52	42	50	38	41	40	37	35	37	43
No. Fish Ind	537	1563	934	1247	1081	2137	971	892	718	597	1222	640	1045
Fish Biomass	374	1305	440	685	821	1263	839	701	579	703	1457	413	798
On Limestone (Station 4B)													
%Algal Cover	1	0	0	0	0	1	0	0	0	1	0	0	0
%Coral Cover	0	4	4	6	6	6	8	8	10	11	12	12	7
No Coral Spp	2	3	3	4	3	4	4	6	5	6	5	5	4
No.Invert Spp	2	2	4	4	3	5	8	7	7	10	6	7	5
No. Fish Spp	2	10	10	12	13	17	18	20	13	18	12	10	13
No. Fish Ind	3	15	96	67	52	123	57	149	83	144	89	104	82
Fish Biomass	1	12	16	27	1027	115	62	280	22	73	42	62	145

APPENDIX B.

Summary of the benthic survey conducted at Station A (21°17.1100' N, 158°02.1172' W) on 27 January 2005 at a depth of 20 m in the ecotone or zone of transition between the biotope of scattered corals and the biotope of deep featureless limestone . This station is along the limestone bench about 10 m shoreward of the vertical face to the second deeper (seaward) biotope of deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 20 m and mean coral coverage is 11.7%.

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Desmia hornemannii				0.3		
Porolithon gardineri			9.0	18.0		1.5
Corals						
Porites lobata	1.5	16.0	1.0	0.2	17.0	6.0
Pocillopora meandrina	4.0	2.0	7.0	3.5		
Montipora patula	1.0	2.0			1.5	2.7
Montipora verrucosa		0.5				4.0
Montipora verrilli	0.1					
Sand		3.0	6.0		1.0	
Hard Substratum	93.4	76.5	77.0	78.0	80.5	85.8

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Mollusca	
Pinctada margaritifera	2
Phylum Annelida	
Spirobranchus gigantea	29
Phylum Echinodermata	
Echinothrix diadema	35
Echinothrix calamaris	2
Tripneustes gratilla	1
Echinostrephus aciculatum	1
Culcita novaeguineae	2

C. Fish Census (4 x 25 m)

20 Species
252 Individuals
Estimated Standing Crop = 119 g/m^2

APPENDIX C.

Summary of the benthic survey conducted at Station B (20 m inshore of 21°17.5450' N, 158°00.6960' W) on 17 March 2005 in the biotope of scattered corals. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 17-19 m and mean coral coverage is 13.8%.

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Porolithon gardineri	4.0			1.0		
Corals						
Porites lobata	17.0	3.0	0.2	27.0	2.8	
Porites compressa	2.3			1.3	18.0	6.0
Pocillopora meandrina	3.0		1.0			
Montipora patula						0.3
Montipora verrucosa		0.1				4.0
Fungia scutaria				1.0		
Sand		6.0	73.8		2.0	7.0
Rubble		71.9	15.0	13.0	57.2	77.7
Hard Substratum	73.7	19.0	10.0	56.7	20.0	9.0

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Mollusca	
Arca ventricosa	4
Phylum Annelida	
Spirobranchus gigantea	12
Loimia medusa	1
Phylum Echinodermata	
Echinothrix diadema	46
Tripneustes gratilla	10

C. Fish Census (4 x 25 m)

30 Species
251 Individuals
Estimated Standing Crop = 75 g/m^2

APPENDIX D.

Summary of the benthic survey conducted at Station C (21°17.5450' N, 158°00.6960' W) on 17 March 2005 on rubble substratum in the ecotone or zone of transition between the biotope of scattered corals and the biotope of deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 21 m and mean coral coverage is 2.9%.

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Dotyella hawaiiensis						0.3
Microcoleus sp.			0.7			
Spyridia filamentosa						4.0
Tolypiocladia sp.					0.3	
Sponges						
Spirastrella coccinea				0.1		
Chondrosia chucalla		0.1		0.2		
Plakortis simplex		0.2				
Corals						
Porites lobata	1.0				1.0	
Pocillopora meandrina	5.1	5.4	3.1		1.5	
Leptastrea purpurea	0.3					
Sand	6.0	4.0	5.0	3.0	35.0	8.0
Rubble	87.6	90.3	91.2	96.7	62.2	87.7

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Mollusca	
Arca ventricosa	1
Phylum Annelida	
Spirobranchus gigantea	2
Phylum Arthropoda	
Gonodactylus falcatus	1
Phylum Echinodermata	
Echinothrix diadema	39
Echinothrix calamaris	3

C. Fish Census (4 x 25 m)

8 Species
22 Individuals
Estimated Standing Crop = 2 g/m^2

APPENDIX E.

Summary of the benthic survey conducted at Station D situated 50 m seaward of Station A (21°17.1100' N, 158°02.1172' W) on 27 January 2005 in the biotope of deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 24 m; mean coral coverage is 0.2%.

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Laurencia nidifica		0.1				
Porolithon gardineri	0.2				1.1	
Porolithon onkodes						0.3
Corals						
Porites lobata	0.2			0.4		
Pocillopora meandrina			0.1			
Montipora patula	0.1				0.4	
Montipora verrucosa		0.1				
Sand			1.0		0.5	3.0
Rubble	92.5	99.8	95.9	99.6	82.0	25.7
Hard Substratum	7.0		3.0		16.0	71.0

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Mollusca	
Pinctada margaritifera	1
Mitra filistriata	1
Phylum Annelida	
Loimia medusa	1
Phylum Echinodermata	
Echinothrix diadema	2
Echinometra mathaei	2
Echinostrephus aciculatum	1
Holothuria atra	1

C. Fish Census (4 x 25 m)

5 Species
13 Individuals
Estimated Standing Crop = 2 g/m^2

APPENDIX F.

Summary of the benthic survey conducted at Station E (21°17.4600' N, 158°00.2950' W) on 17 March 2005 in the biotope of deep featureless limestone where sand occurs as a veneer. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 21 m and mean coral coverage is zero percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Caulerpa taxifolia	3.0	5.0	4.0	21.0	12.0	2.0
Spyridia filamentosa	0.5		0.2			
Seagrasses						
Halophila decipiens					2.0	
Sand	92.5	95.0	95.8	77.0	87.0	98.0
Rubble	4.0			2.0	1.0	

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Arthropoda	
Lysiosquilla maculata	1

C. Fish Census (4 x 25 m)

1 Species
3 Individuals
Estimated Standing Crop = 8 g/m^2

APPENDIX G.

Summary of the benthic survey conducted at Station F (located approximate at 21°17.4400' N, 158°00.2500' W) and sampled in 1986 (unpublished Brock data) in the biotope of deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 19.5 m and mean coral coverage is zero percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Caulerpa taxifolia	1.0					
Sand	97.0	100	97.0			3.0
Rubble	2.0		3.0			
Hard Substratum				100	100	97.0

B. Invertebrate Census (4 x 25 m)

Species	Number
Phylum Mollusca	
Conus pulicaris	1

C. Fish Census (4 x 25 m)

1 Species
1 Individual
Estimated Standing Crop = 0.1 g/m^2

APPENDIX H.

Summary of the benthic survey conducted at Station G (located approximately at 21°17.096' N, 158°02.518' W) and sampled on 13 November 2006 in the zone of transition or ecotone between the biotope of scattered corals and deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 24 m and mean coral coverage is 0.8 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Sponges						
Spirastrella vagabunda					0.2	
Corals						
Porites lobata	0.7			1.5	0.3	
Pocillopora meandrina				2.0		
Sand	83.8	97.0	99.0		4.0	6.0
Rubble	1.5		1.0	9.0		75.0
Hard Substratum	14.0	3.0		87.5	95.5	19.0

B. Invertebrate Census (4 x 25 m)

Species	Number
Phylum Mollusca	
Arca ventricosa	10
Pinctada margaritifera	1
Spondylus tenebrosus	2
Phylum Annelida	
Loimia medusa	1
Spirobranchus giganteus	12
Phylum Echinodermata	
Echinostrephus aciculatum	1

C. Fish Census (4 x 25 m)

20 Species
70 Individuals
Estimated Standing Crop = 32 g/m^2

APPENDIX I.

Summary of the benthic survey conducted at Station H located approximately 25 m seaward of Station G (at 21°17.096' N, 158°02.518' W) and sampled on 13 November 2006 in the biotope of deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 26 m and mean coral coverage is 0.4 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Spyridia filamentosa				0.4		
Sponges						
Chondrosia chucalla	1.0					
Clathria sp.	1.7					
Corals						
Porites lobata	1.0		0.2		0.8	
Montipora verrucosa		0.1				
Sand	15.0	6.0	79.0	60.6	28.2	40.0
Rubble	52.3	20.9	20.8	39.0	71.0	60.0
Hard Substratum	29.0	73.0				

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Annelida	
Spirobranchus giganteus	6
Phylum Echinodermata	
Echinothrix calamaris	2
Echinothrix diadema	2

C. Fish Census (4 x 25 m)

5 Species
10 Individuals
Estimated Standing Crop = 0.6 g/m^2

APPENDIX J.

Summary of the benthic survey conducted at Station I (located approximately at 21°17.072' N, 158°02.674' W) and sampled on 14 September 2006 in the zone of transition or ecotone between the biotope of scattered corals and deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 23 m and mean coral coverage is 2.1 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Lyngbya majuscula				0.2		
Sponges						
Spirastrella coccinea			1.1			0.4
Chondrosia chucalla			0.3			
Corals						
Porites lobata	0.3	8.0	0.9	0.2	0.4	0.1
Porites compressa		2.5				
Montipora verrucosa				0.1		
Montipora patula					0.2	
Sand	18.0	6.0	4.0	3.0	3.0	52.5
Rubble	41.0	18.0	78.7		12.0	47.0
Hard Substratum	40.7	65.5	15.0	96.5	84.4	

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Mollusca	
Arca ventricosa	17
Pinctada margaritifera	1
Conus leopardus	1
Phylum Annelida	
Loimia medusa	3
Spirobranchus giganteus	19
Phylum Echinodermata	
Echinostrephus aciculatum	1
Echinothrix diadema	24

C. Fish Census (4 x 25 m)

33 Species
150 Individuals
Estimated Standing Crop = 78 g/m^2

APPENDIX K.

Summary of the benthic survey conducted at Station J located approximately 28 m east of Station I (21°17.072' N, 158°02.674' W) and sampled on 13 November 2006 in the zone of transition or ecotone between the biotope of scattered corals and deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 24 m and mean coral coverage is 1.4 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Algae						
Lyngbya majuscula		0.5	0.5			
Sponges						
Spirastrella coccinea	1.0					0.4
Chondrosia chucalla				0.4		
Corals						
Porites lobata	0.2	2.0	2.5			2.5
Montipora patula					1.0	
Sand		4.0				
Hard Substratum	96.8	93.5	97.0	99.6	99.0	97.1

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Mollusca	
Arca ventricosa	3
Conus lividus	1
Octopus cyanea	1
Spondylus tenebrosus	2
Phylum Echinodermata	
Echinostrephus aciculatum	3
Echinothrix calamaris	2
Echinothrix diadema	25

Fish Census (4 x 25 m)

10 Species
40 Individuals
Estimated Standing Crop = 11 g/m^2

APPENDIX L.

Summary of the benthic survey conducted at Station K located approximately 20 m seaward of Station I (21°17.072' N, 158°02.674' W) and sampled on 13 November 2006 in the biotope of deep featureless limestone. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A and counts of invertebrates are in Part B. A short summary of the fish census is given in Part C. Water depth is 25 m and mean coral coverage is zero percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	**0m**	**5m**	**10m**	**15m**	**20m**	**25m**
Sand/Rubble	100	100	100	100	100	100

B. Invertebrate Census (4 x 25 m)

Species	**Number**
Phylum Mollusca	
Conus miles	1
Conus leopardus	1
Phylum Echinodermata	
Echinothrix diadema	1

C. Fish Census (4 x 25 m)

5 Species
11 Individuals
Estimated Standing Crop = 0.5 g/m^2

APPENDIX M.

Results of visual censuses of fish communities at eleven stations sampled in this study (except Station F sampled in 1986). Station B sampled fish communities in the biotope of scattered corals, Stations A, C, G and I sampled those communities in the ecotone or zone of transition between the biotope of scattered corals and the biotope of deep featureless limestone and Stations D, E, F, H, J, and K sampled fish communities in the biotope of deep featureless limestone. Sampling carried out on 27 January and 17 March 2005 as well as on 14 September and 13 November 2006 all offshore of Barbers Point, Oahu. In the body of the table are given the numbers of each species seen and at the foot of the table, the estimated standing crop of fish present at that station. Fish census data for other stations are given in Brock (2004).

	Stations										
Family and Species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Holocentridae											
Adioryx xantherythrus									10		
Myripristis amaenus									1		
Aulostomidae											
Aulostomus chinensis									1		
Apogonidae											
Apogon kallopterus									9		
Sparidae											
Monotaxis grandoculis		1					1				
Parapercidae											
Parapercis schaunslandi											1
Mullidae											
Parupeneus multifasciatus	16	4					12	1	30		
Parupeneus pleurostigma		1					4		4	5	
Chaetodontidae											
Forcipiger flavissimus		2									
Chaetodon ornatissimus		4							2		
Chaetodon kleini	47	24					4		3		
Chaetodon multicinctus	3	4					2		2		
Chaetodon miliaris									2		
Carangidae											
Decapterus macarellus					3						
Malacanthidae											
Malacanthus hoedti				1						1	2
Pomacanthidae											
Holocanthus arcatus	1										
Centropyge fisheri									2		
Centropyge potteri									2		

APPENDIX M. Continued.

	Stations										
Family and Species	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Pomacentridae											
Dascyllus albisella	19	5							4	9	2
Plectroglyphidodon johnstonianus		1					1		1		
Chromis hanui		14									
Stegastes fasciolatus		1							1		
Cirrhitidae											
Paracirrhitus arcatus	9		1				2	2	5		
Cirrhitops fasciatus		1					1		1		
Labridae											
Bodianus bilunulatus		1							3		
Labroides phthirophagus									1		
Thalassoma duperrey	15	6		2			5		6	2	
Coris gaimard		2					1		1	1	
Coris venusta							1			1	
Cheilinus bimaculatus	3		3	3				4	2		3
Xyrichthys pavo						1					
Pseudojuloides cerasinus	7		5	6				2	6	1	
Stethojulis balteata	6								4		
Macropharyngodon geoffroy							2		4		
Anampses chrysocephalus							5				
Scaridae											
Scarus sordidus		2									
Scarus psittacus		1									
Scarus sp.			8								
Gobidae											
Bathygobius fuscus			2								
Gnatholepis anjerensis			1								3
Blennidae											
Exallis brevis		1									
Acanthuridae											
Acanthurus nigrofuscus	23	17					4		22	18	
Acanthurus nigroris	24	8									
Acanthurus olivaceus	9	4					18		6	1	
Acanthurus thompsoni		50									
Ctenochaetus strigosus		54							8		
Zebrasoma flavescens		6									

APPENDIX M. Continued.

Family and Species	Stations A	B	C	D	E	F	G	H	I	J	K
Acanthuridae Continued:											
Naso lituratus	5	3									
Naso hexacanthus		26									
Naso brevirostris	12										
Zanclidae											
Zanclus cornutus	2	1									
Balistidae											
Melichthys vidua		2					1		2		
Sufflamen bursa	2	4	1				1				
Sufflamen fraenatus									2		
Xanthichthys auromarginatus	45								1		
Monacanthidae											
Cantherhines dumerili	1	1		1			2		1		
Tetradontidae											
Canthigaster coronata	3						2				
Canthigaster jactator			1				1	1	1	1	
Total Number of Species	20	30	8	5	1	1	20	5	33	10	5
Total Number of Individuals	252	251	22	13	3	1	70	10	150	40	11
Biomass (g/m^2)	119	75	2	2	8	0.1	32	0.6	78	11	0.5

APPENDIX D. SUMMARY OF OFFSHORE STAKEHOLDERS MEETING

April 13, 2006

Kalaeloa Artificial Reef
Offshore Stakeholders Meeting Notes
April 13, 2006

Planning Solutions, Inc.
2:30-4:00 p.m.

Participants:

Brian Kanenaka, DAR
Paul Murakawa, DAR
Charles Morgan, Planning Solutions, Inc.
Melissa White, Planning Solutions, Inc.
Richard Brock, Consultant
Ferd Jaramilla, C/C Honolulu Wastewater
Becky Hommon, Navy Region Counsel
John Andrews, Chevron Hawai'i
John Corbin, Aquaculture Dev. Program
J. Randy Cates, Cates International
John Naughton, NOAA-PIRO

Introductions/Purpose of the Meeting (DAR/PSI)

Paul Murakawa of DAR opened the meeting by thanking the parties for attending. Charles Morgan of Planning Solutions, Inc. (PSI) gave a brief overview of the history and scope of the proposed Kalaeloa Artificial Reef project based on the Environmental Impact Statement Preparation Notice that was published on March 8, 2006. He then stated that the purpose of the meeting was to identify the concerns of the various offshore stakeholders regarding the project so that the information they provide could inform the alternatives and impact analyses to be included in the Draft Environmental Impact Statement (EIS). After introductions, each stakeholder was invited to state his or her position on the project and raise any questions or concerns. Their responses are summarized below.

Chevron Hawai'i (John Andrews)

Chevron has not adopted an official position on the project. However, the company has three general concerns applying primarily to the western alternative site identified in the EISPN, but potentially applying to the eastern (proposed) site as well:

1) Potential effects of increased recreational boat traffic at the proposed reef on the navigation and maneuverability of the tankers transiting to and from the offshore tanker unloading facility.
2) Potential consequences to the reef in the case of an oil spill or other accident related to Chevron's operations.
3) Compatibility of the reef with the findings of the annual offshore survey that the University of Hawai'i conducts to determine impacts of Chevron's operations on offshore communities.

Mr. Andrews promised to consult with the appropriate parties within Chevron to determine what operational concerns needed to be accommodated in the siting and design of the proposed reef. He also promised to provide PSI a copy of the most recent offshore survey report referred to above.

Cates International (J. Randy Cates)

Cates International (CI) is concerned primarily about conflicts between the proposed reef sites and military operations. Mr. Cates' comments regarding the proposed (eastern) site include:

1) Its proximity to the Navy's explosives training zone could put recreational users in danger, potentially harm marine life utilizing the reef, and also interfere with the Navy's training operations.
2) The proposed (eastern) site is in close proximity to CI's aquaculture operations. While this would not interfere with CI's daily operations or their ability to expand the facility in the

future, the regular presence of sharks around the aquaculture cages could prove unattractive to recreational users of the proposed reef site.

CI offered the following comments about the western alternative site:

1) It is located within a military restricted zone, and locating a reef there may cause security concerns. The Navy, Coast Guard, and Hawai'i Operational Safety Team should be consulted in the development of the project.
2) If security concerns at the western site prove incompatible with the envisioned recreational uses of the reef, perhaps the reef could be established there for the sole purpose of creating marine habitat. If recreational benefits are a main objective CI suggests moving the proposed reef to the west around the Wai'anae side of Barbers Point.

City & County of Honolulu Wastewater Branch (Ferd Jaramilla)

The City Wastewater Branch is responsible for monitoring benthic communities and nutrient levels in proximity to the Honouliuli sewer outfall, and they have contracted researchers from the University of Hawai'i to conduct the monitoring and prepare an annual report. While the Wastewater Branch does not have an official position on the proposed reef, they are interested in any effects the reef might have on benthic communities and nutrient levels in that area.

In addition, they expressed concern that locating the artificial reef in proximity of the Barbers Point outfall diffusers could lead the State Department of Health to re-classify waters near the Honouliuli outfall as recreational waters, which invoke more stringent criteria for bacteria and nutrient levels.

State Aquaculture Development Program, Dept of Agriculture (John Corbin)

Their only concern is the proximity of the proposed (eastern) site to Cates International's aquaculture operations. The State would like to support CI and to encourage similar operations offshore of O'ahu. If increased recreational boat traffic associated with the reef proved disruptive to aquaculture it would be a concern. Therefore, they are interested in hearing about what siting alternatives are feasible for the proposed reef.

NOAA-PIRO (John Naughton)

In general, NOAA-PIRO is supportive of the State's artificial reef program. The agency is assisting with the NEPA process for the proposed reef and is pleased at the participation of the various stakeholders. Dr. Naughton is aware of the concerns noted by others at this meeting regarding the proposed (eastern) site, and agrees that its siting poses potential conflicts with adjacent uses. He is hopeful that the scoping process will help identify reef siting alternatives that are acceptable to everyone.

Navy (Becky Hommon)

The Navy has not developed an official position on the proposed reef. Becky does have serious concerns about the proposed (eastern) site's proximity to the explosives training area, and is making inquiries into the possible use of the western site. She offered the following comments:

1) The proposed (eastern) site is too close to the explosives training area. Explosives training activities require prior notification, surveillance, and coordination with offshore users. Currently, CI is the only user group that the Navy must coordinate with. If the area is to be used for public recreation it would increase the level of coordination needed to ensure safety.
2) Current research on concussive effects from underwater explosives indicates that a safe distance for recreational users and marine life would be a minimum of 3,000 yards from the danger zone boundary.

3) Becky has inquired into moving the explosives training area east into the Pearl Harbor Naval Defense Sea Area. The Navy has indicated that this is not feasible due to the volume of traffic entering and leaving the harbor and the need to maintain adequate surveillance.
4) Becky is looking into the possibility of using the western site for the proposed reef. She is in the process of identifying existing uses and interests there and will inform DAR & PSI of the results of her inquiry. She requested an additional meeting between DAR, PSI, & the Navy to discuss possible alternative reef sites in detail.

Conclusions/Wrap-Up

PSI and DAR thanked the participants and summarized the conclusions of the meeting as follows:

1) Most stakeholders agree that the alternative western site is preferable to the proposed (eastern) site. DAR, Dr. Brock, and PSI think that the western site also exhibits superior qualities for artificial reef deployment. If Becky's inquiries find that the Navy would permit use of the western site for the proposed reef and Chevron's needs can be accommodated, then that site will be presented as the preferred alternative in the EIS for the project.
2) The possibility of moving the proposed (eastern) site further west will be investigated for the EIS. The new site should be at least 3,000 yards from the Navy danger zone and should not encroach into the healthy coral communities in the vicinity of the Honouliuli sewer outfall.

The meeting was adjourned at approximately 4:00 pm.

APPENDIX E. LETTERS STATING NAVY'S SUPPORT FOR THE PROJECT

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
PEARL HARBOR HI 96860-5101

5090
Ser N00L/00033
19 SEP 2007

Ms. Laura Thielen
State of Hawaii
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

Dear Ms. Thielen:

SUBJECT: SITING CONSIDERATIONS FOR KALAELOA ARTIFICIAL REEF, 'EWA DISTRICT, O'AHU, HAWAI'I

This letter is written in response to a letter from Alan A. Smith dated June 20, 2007, requesting Navy review of revised siting and boundaries for a proposed artificial reef offshore at Kalaeloa and assessment of potential impacts to Navy facilities and activities in the area.

The proposed artificial reef site is located within a military restricted area defined at 33 C.F.R. Section 334.1400. Use of the area is noted on navigational charts as being limited. Boating within the area is authorized, but as stated in 33 C.F.R. Section 334.1400, anchoring and those fishing operations which might foul the underwater installations within the area are prohibited. Historically, the area contained a number of cable systems on the seafloor, many of which are not in use today. The Air Force found no evidence of any active Air Force-owned cables in the vicinity of the proposed reef site. As you are aware, the Navy continues to operate, through the Office of Naval Research, a live electrical cable within this restricted area which carries a lethal voltage should the protective sheathing be damaged or disturbed.

The original location of the artificial reef, as proposed in the draft Environmental Impact Statement (EIS) for the Kalaeloa Artificial Reef, dated February 23, 2007, was found to overlap a portion of the Navy cable. Placing the artificial reef directly on the cable would most certainly damage the cable and destroy its value to the Navy, while potentially exposing the public to electrical hazards. The revised siting plan, as depicted in attachment 3 of your letter dated June 20, 2007, indicates a reduced reef footprint of 108 acres and a shift of the eastern boundary of the reef site to a location at least 500 meters from the Navy cable alignment. This new location and configuration eliminates the overlap and reduces the potential for damage to the cable as a result of the deployment of concrete Z-blocks during reef establishment.

5090
Ser N00L/ 00039
19 SEP 2007

The Navy finds no objection to the revised artificial reef location and downsizing of the footprint and confirms that this proposal can be accomplished without conflicting with national security concerns, provided the following conditions are met:

a. The artificial reef shall maintain a minimum distance of 500 meters from any portion of the underwater Navy cable to prevent damage to the cable. Structures shall be situated to avoid any threat of potential movement towards the underwater cable over time.

b. Restrictions, as defined under C.F.R. Section 334.1400, shall remain in effect. Mooring buoys shall be installed and anchoring prohibited within said area.

c. Future users of the marina and artificial reef shall be informed of the location, restrictions, and potential hazards relative to the existing military training areas to the east of the proposed Ocean Pointe Marina and anchoring restrictions and potential hazards associated with the Navy cable to the west of the marina.

The decision on where to place this public attraction remains with the State. We have advised your staff of the potential risks associated with placing this attraction in proximity to this cable. Therefore, any liability generated from introducing this new use to the area would rest with the State and not the United States government or the Navy.

Thank you for the opportunity to participate in this very important matter. The Navy fully supports the State of Hawaii's marine resource sustainment efforts through the artificial reef program. We appreciate your patience while we sought input from other entities outside Navy Region Hawaii and willingness to work with us to find a mutually beneficial solution that addresses the interests and concerns of both organizations. If any further questions arise, please contact Rebecca Hommon, Navy Region Hawaii Counsel, at (808) 473-4731 or via e-mail to rebecca.hommon@navy.mil.

Sincerely,

T. G. ALEXANDER
Rear Admiral, U. S. Navy
Commander

Copy to: Commander, Naval Facilities Engineering Command, Hawaii
(ARE2LT, ARE1CY, BDJF)

5090
Ser N00L/ 30039
19 SEP 2007

Copy to (Cont'd):

Mr. Paul Muraoka, State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources
Mr. Charles Morgan, Planning Solutions, Inc.
Dr. Ellen S. Livingston, Office of Naval Research, Code 3210A
Professor James A. Mercer, Applied Physics Laboratory, and Dept. of Earth and Space Sciences, University of Washington

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
PEARL HARBOR HI 96860-5102

5090
Ser N00L/008
MAY 17 2006

Mr. Peter T. Young, Chairperson
State of Hawai'i
Department of Land and Natural Resources
1151 Punchbowl Street, Room 130
Honolulu, HI 96813

Dear Mr. Young:

SUBJECT: PROPOSED USE OF WESTERN SITE FOR THE KALAELOA ARTIFICIAL REEF PROJECT, EWA DISTRICT, O'AHU, HAWAI'I

It is my understanding that through meetings with Mr. Paul Murakawa, of your Division of Aquatic Resources (DAR), that a mutually positive outcome has been developed regarding the potential siting of a new State of Hawaii artificial reef for the Kalaeloa area.

The Navy is very supportive of the State's artificial reef program. We would like to see the DAR meet its objectives of establishing additional artificial reefs for marine habitat and public recreation off the Ewa coast. At the same time, the Navy had concerns about potential conflicts with existing national defense uses that would have possibly emerged with use of the eastern site identified in the *Environmental Impact Statement Preparation Notice (EISPN)* for the project.

As was discussed, introducing a publicly available artificial reef to the eastern location described in the EISPN would generate foreseeable conflicts between the Navy's ongoing training activities within the area described at 33 C.F.R. Section 334.1370; the existing aquaculture operation; and any potential users of the artificial reef. Encouraging unmanaged human use of that area was recognized as not in the best interests of the public.

The western site, located within the area described at 33 C.F.R. Section 334.1400, appeared to be preferable and fortunately now appears to be quite feasible. As long as the existing Navy underwater installations are avoided; no structures are placed on them; any introduced structures are located in such a way as to avoid any threat of potential movement towards the existing underwater installations; and DAR installs mooring buoys and maintains its usual practice of requiring all boaters to use the mooring buoys so that no anchoring occurs in the area,

5090
Ser N00L/008
MAY 17 2006

establishing the proposed Kalaeloa Artificial Reef at the western site apparently can be accomplished without conflicting with existing national defense uses of the area.

Provided that DAR implements the program consistent with the above, the Navy's concerns with the proposed western location, identified in the EISPN, have been addressed. We understand that the exact site boundaries of the proposed artificial reef will be finalized following further consultation with the current Navy users of the cables (Drs. Livingston and Mercer, noted below), other offshore stakeholders and a confirmatory biological survey. We are pleased to understand that the new western site, once finalized, will be presented as the preferred site in the *Draft Environmental Impact Statement* (*DEIS*) for the project.

Thank you again for helping to achieve a mutually positive outcome for this proposal. If any further questions arise, please contact Mr. Norman Messinger at 473-2974 or via e-mail to norman.messinger@navy.mil.

Sincerely,

TAYLOR W. SKARDON
Captain, U.S. Navy
Chief of Staff

Copy to:
NAVSTA Port Ops
FACSFAC
PACFLT (N7)
NAVFACPAC (J. Takeuchi, L. Tanaka)
EOD

Mr. Randy Cates, Cates International, Inc.
P.O. Box 335
Kailua, HI 96734

Mr. Brian Kanenaka
Department of Land and Natural Resources
Division of Aquatic Resources
State of Hawai'i
1151 Punchbowl Street, Room 330
Honolulu, HI 96813

Peter,
Am glad we folks could work this out. Will be a great asset for the Public!
Taylor

Copy to: (cont'd)
Mr. Charles Morgan, Planning Solutions, Inc.
210 Ward Avenue, Ste. 330
Honolulu, HI 96814

Dr. Ellen S. Livingston
Office of Naval Research, Code 3210A
One Liberty Center - Room 1076
875 N. Randolph Street
Arlington, VA 22203-1995

Professor James A. Mercer
Applied Physics Laboratory and
Dept. of Earth and Space Sciences
University of Washington
1013 NE 40th Street
Seattle, WA 98105

APPENDIX F. EISPN COMMENTS AND RESPONSES

LINDA LINGLE
GOVERNOR

RUSS K. SAITO
COMPTROLLER

KATHERINE H. THOMASON
DEPUTY COMPTROLLER

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
P.O. BOX 119, HONOLULU, HAWAII 96810

(P)1072.6

MAR 10 2006

Mr. Perry J. White
Planning Solutions
210 Ward Avenue, Ward Plaza, Suite 330
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: Kalaeloa Artificial Reef Project
Environmental Assessment and Environmental Impact Statement
Preparation Notice

Thank you for the opportunity to review the subject project. This project does not impact any Department of Accounting and General Services projects or existing facilities and we have no comments to offer.

If you have any questions, please have your staff call Mr. Allen Yamanoha of Planning Branch at 586-0488.

Sincerely,

ERNEST Y. W. LAU
Public Works Administrator

AY:jp
c: Ms. Genevieve Salmonson, OEQC

PLANNING SOLUTIONS

March 16, 2006

Mr. Ernest Y.W. Lau, Public Works Administrator
Department of Accounting & General Services
State of Hawai'i
P.O. Box 119
Honolulu, HI 96810

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Lau:

Thank you for your March 10, 2006 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project. We appreciate the time you and your staff spent reviewing the *Environmental Assessment/Environmental Impact Statement Preparation Notice* and preparing your letter.

We are pleased that the project does not impact any of your Department's projects or existing facilities and we understand that you have no comments to offer at this time. If you have any further questions concerning the proposed Kalaeloa Artificial Reef, please call me at (808) 550-4483.

Sincerely,

Perry J. White

cc: Mr. Brian Kanenaka, DAR
Mr. Paul Murakawa, DAR
Office of Environmental Quality Control

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

LINDA LINGLE
GOVERNOR
THEODORE E. LIU
DIRECTOR
MARK K. ANDERSON
DEPUTY DIRECTOR
LAURA H. THIELEN
DIRECTOR
OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING
235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824

Ref. No. P-11290

March 10, 2006

Mr. Perry J. White
Planning Solutions, Inc.
210 Ward Avenue, Suite 330
Honolulu, Hawaii 96814

Dear Mr. White:

Subject: Kalaeloa Artificial Reef Environmental Impact Statement Preparation Notice

The Environmental Impact Statement Preparation Notice for establishing a new artificial reef site on the seafloor off of Kalaeloa, Oahu, was reviewed by the Hawaii Coastal Zone Management (CZM) Program. It is our understanding that the establishment of the new artificial reef site and construction of the first increment of the artificial reef are covered by the existing Department of the Army (DA) Permit for the Ocean Pointe project. On the basis of this understanding, CZM federal consistency review is not required for establishing the artificial reef site and constructing the first increment. However, CZM federal consistency review will be necessary if constructing subsequent phases of the artificial reef requires additional DA Permits. CZM federal consistency review will also be necessary if it is determined that the existing DA Permit does not completely cover the new artificial reef site and a new or modified DA permit is required.

If you have any questions, please call John Nakagawa with our CZM Program at 587-2878.

Sincerely,

Laura H. Thielen
Director

c: U.S. Army Corps of Engineers, Regulatory Branch
Department of Health, Clean Water Branch
Department of Land & Natural Resources,
Division of Aquatic Resources
Office of Conservation and Coastal Lands
Department of Planning and Permitting, City & County of Honolulu

PLANNING SOLUTIONS

March 16, 2006

Ms. Laura H. Thielen, Director
Office of Planning
Department of Business, Economic Development, & Tourism
State of Hawai'i
P.O. Box 2359
Honolulu, Hawai'i 96804

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Ms. Thielen:

Thank you for your March 10, 2006 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project. We appreciate the time you and your staff spent reviewing the *Environmental Assessment/Environmental Impact Statement Preparation Notice* and providing written comments.

We share your understanding, as expressed in your letter, that the establishment of the new reef and the construction of its first increment are covered by the existing Department of the Army permit for the Ocean Pointe project and the associated Coastal Zone Management (CZM) federal consistency certification. We understand that the subsequent reef increments are not covered under these existing approvals and may therefore be subject to additional permitting and CZM federal consistency review.

Thank you again for your comments. If you have any questions or would like to discuss this further, please call me at (808) 550-4483.

Sincerely,

Perry J. White

cc: Mr. Brian Kanenaka, DAR
Mr. Paul Murakawa, DAR
Mr. Farley Watanabe, Corps of Engineers
Office of Environmental Quality Control

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

LINDA LINGLE
GOVERNOR
STATE OF HAWAII

MICAH A. KANE
CHAIRMAN
HAWAIIAN HOMES COMMISSION

BEN HENDERSON
DEPUTY TO THE CHAIRMAN

KAULANA H. PARK
EXECUTIVE ASSISTANT

STATE OF HAWAII

DEPARTMENT OF HAWAIIAN HOME LANDS

P.O. BOX 1879

HONOLULU, HAWAII 96805

March 22, 2006

Mr. Perry White
Planning Solutions
210 Ward Avenue
Ward Plaza, Suite 330
Honolulu, Hawaii 96814

Dear Mr. White:

Subject: Kalaeloa Artificial Reef, Environmental Assessment/ Environmental Impact Statement Preparation Notice (EA/EISPN), Kalaeloa, Island of Oahu

This is in response to your letter, dated March 3, 2006, requesting our input regarding your Environmental Impact Statement Preparation Notice (EISPN) for the proposed construction of the Kalaeloa Artificial Reef.

The content of the EISPN appears to be thorough and adequately details the project in its entirety. The new artificial reef should be a boon to sea life living and propagating in this area of the Pacific Ocean. Currently, we do not have any comments or suggestions concerning this project.

Please call Mr. Kaipo Duncan, Land Agent, at 586-3855, should you have any questions regarding this matter.

Aloha and mahalo,

for Linda Chinn, Administrator
Land Management Division

PLANNING SOLUTIONS

March 31, 2006

Ms. Linda Chinn, Administrator
Land Management Division
Department of Hawaiian Homelands
State of Hawai'i
P.O. Box 1879
Honolulu, Hawai'i 96805

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Ms. Chinn:

Thank you for your March 22, 2006 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project. We appreciate the time you and your staff spent reviewing the *Environmental Assessment/Environmental Impact Statement Preparation Notice* and providing written comments.

We are very pleased that your Department finds that the EISPN is thorough and believes that the project will be beneficial to marine life. We understand that you have no further comments or suggestions.

Should you have any questions in the future, please call me at (808) 550-4483.

Sincerely,

Perry J. White

cc: Mr. Brian Kanenaka, DAR (via e-mail)
Mr. Paul Murakawa, DAR (via e-mail)
Office of Environmental Quality Control (via e-mail)

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
EMD / CWB

03097CEC.06

March 22, 2006

Mr. Perry J. White
Planning Solutions
Ward Plazza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: Kalaeloa Artificial Reef
Comments on Environmental Assessment/Environmental Impact Statement Preparation Notice (EA/EISPN)

The Department of Health (Department), Clean Water Branch (CWB), appreciates the opportunity to review and provide comments on the subject EA/EISPN.

As stated in the EA/EISPN:

> "[T]he State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources (DAR) is proposing to establish an artificial reef site offshore from the Ewa District of the Island of Oahu. For this purpose, DAR has delineated a 75-acre area located between depths of 50 and 110 feet that is mostly devoid of coral and other valuable marine habitat. It is applying for a Conservation District Use Permit (CDUP) to formally and permanently designate the site to be used for the emplacement of reefs.
>
> The proposal also includes installation of the first increment of artificial reef within the site boundaries. At least two separate piles (sets) of concrete Z-blocks will be emplaced on the ocean floor approximately 50 to 100 feet apart. A total of approximately 700-800 blocks will be used, covering a seafloor area of about 8,000 square feet. This will provide between 1.3 and 1.5 acres of hard surface for marine community habitat. Over time, DAR will add additional increments to create a large reef habitat area capable of hosting diverse marine communities."

Based on the "Memorandum of Agreement" (Appendix B of the EA/EISPN) amongst HASEKO (Ewa), Inc.; U.S. Army Corps of Engineers, Pacific Ocean Division; and the Department of Land

and Natural Resources, Division of Aquatic Resources, the proposed installation of the first increment by the HASEKO (Ewa), Inc. is to fulfill the special Condition #13 to HASEKO's Department the Army (DA) Permit (File No. PODCO 2117).

Based on the scope of the proposed artificial reef construction, it is our understanding that a DA Permit under the authorization of Federal Clean Water Act (CWA), Section 404, and Rivers and Harbors Act of 1899, Section10, is required. Therefore, a Section 401 Water Quality Certification (WQC) authorized under CWA, Section 401; Hawaii Revised Statutes, Chapter 342D; and Hawaii Administrative Rules, Chapter 11-54, from the Department is also required.

The Section 401 WQC application form and Guidelines may be picked up at our office or downloaded from our website at http://www.hawaii.gov/health/environmental/water/cleanwater/forms/forms/wqc-index.html.

The CWB will provide detailed comments on the draft EA/EIS.

Should you have any questions regarding this matter, please contact Mr. Edward Chen of the Engineering Section, CWB, at 586-4309.

Sincerely,

DENIS R. LAU, P.E., CHIEF
Clean Water Branch

EC:np

c: PICO, Region 9, EPA
Regulatory Branch, HED, COE
NMFS
USFWS
CZM Program, Office of Planning, DBEDT
DAR, DLNR
EPO, DOH

PLANNING SOLUTIONS

March 31, 2006

Mr. Denis R. Lau, P.E., Chief
Clean Water Branch
Department of Health
State of Hawai'i
P.O. Box 3378
Honolulu, Hawai'i 96801-3378

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Lau:

Thank you for your March 22, 2006 letter (your reference 03097CEC.06) concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project. We appreciate the time you and your staff spent reviewing the *Environmental Assessment/Environmental Impact Statement Preparation Notice* and preparing your letter.

Thank you for the information you provided about the need for a Department of the Army (DA) permit and Section 401 Water Quality Certification for the project. We have discussed the permitting aspects with Mr. Edward Chen of your office and will make sure that these processes are coordinated with both agencies as we move forward with the project.

If you have any further questions, please call me at (808) 550-4483.

Sincerely,

Perry J. White

cc: Mr. Brian Kanenaka, DAR (via e-mail)
Mr. Paul Murakawa, DAR (via e-mail)
Office of Environmental Quality Control (via e-mail)

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

DANIEL K. AKAKA
HAWAII

WASHINGTON OFFICE:
141 HART SENATE OFFICE BUILDING
WASHINGTON, DC 20510
TELEPHONE: (202) 224-6361

HONOLULU OFFICE:
3106 PRINCE JONAH KUHIO
KALANIANAOLE FEDERAL BUILDING
P.O. BOX 50144
HONOLULU, HI 96850
TELEPHONE: (808) 522-8970

United States Senate
WASHINGTON, DC 20510-1103

COMMITTEES:
ARMED SERVICES
ENERGY AND NATURAL RESOURCES
HOMELAND SECURITY AND GOVERNMENTAL AFFAIRS
INDIAN AFFAIRS
VETERANS' AFFAIRS

March 24, 2006

Mr. Perry J. White
210 Ward Avenue
Ward Plaza, #330
Honolulu, HI 96814-4012

Dear Mr. White:

Thank you for providing me with a copy of the "Kalaeloa Artificial Reef: Environmental Assessment/Environmental Impact Statement Preparation Notice."

I appreciate your apprising me of the State of Hawaii Department of Land and Natural Resources, Division of Aquatic Resources proposal for an artificial reef. I support efforts to encourage biodiversity and enable our aquatic resources to thrive. As such, conservation efforts should to be pursued in an effective and efficient manner. I recognize the importance of proper marine resource management, and will monitor the progress of this project.

Mahalo again for contacting me.

Aloha pumehana,

Daniel K. Akaka

DANIEL K. AKAKA
U.S. Senator

PLANNING SOLUTIONS

March 31, 2006

The Honorable Daniel K. Akaka
United States Senate
3106 Prince Jonah Kuhio
Kalaiana'ole Federal Building
P.O. Box 50144
Honolulu, Hawai'i 96850

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Senator Akaka:

Thank you for your March 24, 2006 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project.

We appreciate your interest in the project and your expressed support of efforts to protect and manage Hawai'i's marine resources. We will keep you apprised of further developments throughout the Chapter 343 *Environmental Impact Assessment* process.

If you have any questions regarding the project, please call me at (808) 550-4483.

Sincerely,

Perry J. White

cc: Mr. Brian Kanenaka, DAR (via e-mail)
Mr. Paul Murakawa, DAR (via e-mail)
Office of Environmental Quality Control (via e-mail)

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

Cates International, Inc.
P.O. Box 335
Kailua, HI 96734
Ph. 808 841-4956
Fax 808 841-4955

Cates International, Inc.

April 4, 2006

Planning Solutions
Ward Plaza,
Suite 330
Honolulu, Hawaii 96814-4012
Attn: Perry J. White

Dear Mr. White,

Thank you for inviting me to comment on this Proposed EIS, and the artificial reef. As you may know, I own and operate a commercial open ocean fish farm adjacent to the proposed area, and have been on site for everyday for nearly seven years now, with exception to a few weather days. I feel we have vast experience in working in this area, and also know of the EA/EIS process. I have some concerns with this proposed area, and would like to address these concerns further in a meeting with other user groups.

While I fully support artificial reefs, I must say that there are better sites to consider such an artificial area. Many things must be taken into consideration prior to investing in such an artificial reef, and I look forward to be able to give any input at the meeting that is planned on April 13, 2006. I am fully confident when taking in all of the information, a suitable site will be found for this project.

Once again thank you for the opportunity to comment on this project, and I look forward to further input.

Sincerely,

John R. Cates
President

PLANNING SOLUTIONS

April 27, 2006

Mr. John R. Cates, President
Cates International, Inc.
P.O. Box 335
Kailua, HI 96734

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Cates:

Thank you for your April 4, 2006 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project and for meeting with us, DAR, and other offshore stakeholders on April 13, 2006 to discuss your comments and concerns regarding the project. We appreciate the time you spent reviewing the EISPN and sharing your extensive experience working in the project area.

We have taken note of your concerns regarding the proposed site's compatibility with nearby uses. They, along with the concerns expressed by other stakeholders and information obtained in future scoping, will be addressed in the *Draft EIS* and will help to guide the permitting and decision-making process.

Thank you again for your input on the project. We will send you a copy of the *Draft EIS* when it is completed. If you have any further questions regarding the project, please call me or Melissa White at (808) 550-4483.

Sincerely,

Charles L. Morgan

Charles Morgan

cc: Mr. Brian Kanenaka, DAR (via e-mail)
Mr. Paul Murakawa, DAR (via e-mail)
Office of Environmental Quality Control (via e-mail)

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 523-4432 • FAX: (808) 527-6743
DEPT. INTERNET: www.honoluludpp.org • INTERNET: www.honolulu.gov

MUFI HANNEMANN
MAYOR

HENRY ENG, FAICP
DIRECTOR

DAVID K. TANOUE
DEPUTY DIRECTOR

2006/ELOG-503(ST)

April 7, 2006

Mr. Perry J. White
Planning Solutions
210 Ward Avenue, Suite 330
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Re: Environmental Impact Statement Preparation Notice (EISPN)
Kalaeloa Artificial Reef - Off shore of Tax Map Key Zone 9 Sec 1

This responds to your March 10, 2006 request for comments on the above-referenced project. Based on the description of the proposal, the Department of Planning and Permitting (DPP) has no jurisdiction over the proposed off-shore construction activities. Thus, no permits will be required from our department. We note that this proposal is pursuant to Condition No. 13 of HASEKO's Department of the Army Permit (PODCO 2117), which is intended to offset impacts to coral-reef habitat associated with the construction of the entrance channel to the Ocean Pointe Marina.

Thank you for the opportunity to comment on this matter. If you have any questions, please contact Steve Tagawa of our staff at 523-4817.

Very truly yours,

for Henry Eng, FAICP, Director
Department of Planning and Permitting

HE:cs

cc: DLNR-OCCL
OEQC

G:landuse\posseworkingdirectory\SteveT\EISPNReef.DAR

PLANNING SOLUTIONS

April 10, 2006

Mr. Henry Eng, FAICP, Director
Department of Planning and Permitting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawai'i 96813

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Eng:

Thank you for your April 7, 2006 letter (your reference 2006/ELOG-503(ST)) concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project. We appreciate the time you and your staff spent reviewing the *Environmental Assessment/Environmental Impact Statement Preparation Notice* and preparing your letter.

Thank you very much for confirming that no permits are required from your Department for the proposed Kalaeloa Artificial Reef project. However, we offer the clarification that management of the reef site and emplacement of all subsequent increments will be the sole responsibility of DAR. Hence, while you are correct in noting that the permitting of the reef site and the emplacement of the first increment will allow HASEKO to fulfill Special Condition No. 13 of its Department of the Army Permit (PODCO 2117), the establishment of the artificial reef site should be viewed solely as a DAR project.

Thank you again for your comments. If you have any further questions, please call me at (808) 550-4483.

Sincerely,

Perry J. White

cc: Mr. Brian Kanenaka, DAR (via e-mail)
Mr. Paul Murakawa, DAR (via e-mail)
Office of Environmental Quality Control (via e-mail)

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
PEARL HARBOR HI 96860-5102

AQUATIC RESOURCES: 06-191

DIRECTOR	
COMM. FISH.	
AQ RES/ENV	
AQ REC	5090
PLANNER	Ser N00L/004
STAFF SVCS	
RCUH/UH	MAR 31 2006
STATISTICS	
ABCC/FED AID	
EDUCATION	
SECRETARY	
OFFICE SVCS	
TECH ASST	
Paul Murakawa	
Return to:	
No. Copies	
Copies to:	
Due Date:	

Mr. Brian Kanenaka
Department of Land and Natural Resources
State of Hawaii
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, HI 96813

Dear Mr. Kanenaka:

Thank you for the opportunity to comment on the Division of Aquatic Resources' proposal to establish an artificial reef site off Kalaeloa as described in the Environmental Impact Statement Preparation Notice as published in the Office of Environmental Quality Control Bulletin of March 8, 2006. The complete notice was kindly provided to us by Planning Solutions, Inc.

It is our understanding that if the proposal were implemented, the public would be attracted to these locations for diving and fishing. Given that expectation, both sites tend to present potential conflicts with existing national defense uses of the area. We would appreciate the opportunity to discuss our concerns with you at your earliest convenience. By those discussions, additional alternatives may be identified for consideration in the draft environmental impact statement.

Thank you for the opportunity to participate in this important matter. Please contact me at 473-2974 or via e-mail to norman.messinger@navy.mil so that we may arrange a meeting to discuss the proposal further.

Sincerely,

NORMAN H. MESSINGER
Program Director
Operating Forces Support
By direction of the Commander

RECEIVED
APR 5 2005
AQUATIC RESOURCES

PLANNING SOLUTIONS

April 27, 2006

Mr. Norman H. Messinger, Program Director
Operating Forces Support
Department of the Navy
Navy Region Hawai'i
850 Ticonderoga Street, Suite 110
Pearl Harbor, Hawai'i 96860-5102

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Messinger:

Thank you for your March 31, 2006 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project. We appreciate the time that you and Ms. Rebecca Hommon of your Department spent reviewing the EISPN and meeting with us, DAR, and other offshore stakeholders to discuss your comments and concerns regarding the project.

Based on the April 13, 2006, and April 20, 2006 meetings that Ms. Hommon and yourself attended, we understand that, while the Navy has concerns regarding the establishment of an artificial reef at the easternmost location identified in the EISPN, it is supportive of DAR's alternative artificial reef site located west of the Honouliuli WWTP outfall. We appreciate your expressed commitment to working with DAR and we understand that the Navy will inform DAR soon after it has made a final determination as to the proposed reef's compatibility with Navy activities. We look forward to continuing to work with you and Ms. Hommon on this issue.

Thank you again for your input. If you have any further questions, please call me or Melissa White at (808) 550-4483.

Sincerely,

Charles Morgan

cc: Mr. Brian Kanenaka, DAR (via e-mail)
Mr. Paul Murakawa, DAR (via e-mail)
Office of Environmental Quality Control (via e-mail)

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR - LAND

DEAN NAKANO
ACTING DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

April 20, 2006

Mr. Perry J. White
Planning Solutions
210 Ward Avenue, Suite 330
Honolulu, Hawai'i 96814-4012

LOG NO: 2006.1117
DOC NO: 0604AJ11
Archaeology

Dear Mr. White:

SUBJECT: Chapter 6E-8 Historic Preservation Review (State/DAR) –
Kalaeloa Artificial Reef
Environmental Assessment/ Environmental Impact Statement Preparation Notice
Hono'uli'uli Ahupua'a, 'Ewa District, Island of O'ahu
Pacific Ocean

Thank you for the opportunity to comment on the aforementioned project. We received your cover letter and the Environmental Impact Statement (EIS) Preparation Notice on March 13, 2006. The State of Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources (DAR) proposes to establish an artificial reef site offshore. DAR has delineated a 75-acre area located between depths of 50 and 110-feet to be used for the establishment of an artificial reef. The artificial reef will be created through the emplacement of numerous concrete Z-block piles placed 50 to 100-feet apart. The proposed undertaking consists of the installation of the first increment of artificial reef, which will displace approximately 8,000 square feet of seabed, within the site boundaries.

According to your documents divers surveyed the project area along set transects to assess the biologic resources of the proposed project area. No evidence of submerged cultural resources was observed during the survey. However, submerged historic resources may be located in buried/partially-buried contexts and may be difficult to initially discern. To aid in identifying the presence/absence of any submerged cultural resources within the project area, we suggest that a remote-sensing survey (*e.g.*, proton magnetometer or side-scan sonar) be conducted. We recommend the remote-sensing survey be designed specifically to search for any historically-significant sites. In addition, we believe the socio-economic effects of the proposed undertaking in relation to the opening of the Ocean Pointe Marina should be further investigated.

If you have any questions regarding this letter please contact Mr. Adam Johnson at (808) 692-8015.

Aloha,

Melanie Chinen, Administrator
State Historic Preservation Division

AJ:cmm

PLANNING SOLUTIONS

April 27, 2006

Ms. Melanie Chinen, Administrator
State Historic Preservation Division
Department of Land and Natural Resources
State of Hawai'i
601 Kamokila Boulevard, Room 555
Kapolei, Hawai'i 96707

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Ms. Chinen:

Thank you for your April 20, 2006 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project. We appreciate the time you and your staff spent reviewing the *Environmental Assessment/Environmental Impact Statement Preparation Notice* and providing written comments. Item-by-item responses to your comments are provided below. To simplify your examination, we have reproduced the text of your comments in *italics* before each response.

Comment 1:

To aid in identifying the presence/absence of any submerged cultural resources within the project area, we suggest that a remote-sensing survey (e.g., proton magnetometer or side-scan sonar) be conducted. We recommend the remote-sensing survey be designed specifically to search for any historically-significant sites.

Response: I discussed this issue with Mr. Adam Johnson of your staff in an April 25, 2006 telephone conversation. We will expand our discussion of potential impacts to historic and cultural resources in the *Draft EIS* to include a description of the survey work that has occurred at the proposed site and the measures that DAR will take to avoid impacts to historic and cultural resources as a result of the project.

Comment 2:

In addition, we believe the socio-economic effects of the proposed undertaking in relation to the opening of the Ocean Pointe Marina should be further investigated.

Response: In accordance with your second recommendation, the *Draft EIS* will discuss potential socioeconomic impacts of the reef that relate to the opening of the Ocean Pointe marina.

Thank you again for your comments. If you have any further questions, please call me or Melissa White at (808) 550-4483.

Sincerely,

Charles Morgan

cc: Mr. Brian Kanenaka, DAR (via e-mail)
Mr. Paul Murakawa, DAR (via e-mail)
Office of Environmental Quality Control (via e-mail)

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

PHONE (808) 594-1888 FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD06/2294

July 5, 2005

Perry J. White
Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, HI 96814

RE: Request for consultation on an Environmental Impact Statement Preparation Notice for the proposed Kalaeloa Artificial Reef, Kalaeloa, O'ahu

Dear Perry White,

The Office of Hawaiian Affairs (OHA) is in receipt of your request for comments on the above-referenced proposal, which would allow for the establishment of an artificial reef site within 75 acres offshore of Kalaeloa. OHA apologizes for the delay and offers the following preliminary comments.

OHA generally does not approve of any additions to the ocean floor, particularly as submerged lands are ceded lands and because any change to the sea floor's ecosystem has ripple effects throughout an area regularly used for a variety of Native Hawaiian cultural and traditional purposes. This region is used for limu cultivation, canoe paddling, surfing, fishing, diving, etc.

Should approval be granted, consideration must be given to applicable cultural gathering and access rights during and after construction activities. Recognized Native Hawaiian traditional gathering rights and access should not be restricted – even during construction – except as necessary to ensure safety. If such safety-related restrictions are put in place, alternate public access routes must be provided.

Thank you for the opportunity to comment, and we look forward to the opportunity to review the forthcoming Draft Environmental Impact Statement more thoroughly. If you have further questions or concerns, please contact Heidi Guth at (808) 594-1962 or e-mail her at heidig@oha.org.

Sincerely,

Clyde W. Nāmu'o
Administrator

PLANNING SOLUTIONS

July 14, 2006

Mr. Clyde W. Nāmu'o, Administrator
Office of Hawaiian Affairs
State of Hawai'i
711 Kapi'olani Boulevard, Suite 500
Honolulu, Hawai'i 96813

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Nāmu'o:

Thank you for your July 5, 2006 letter [your reference HRD06/2294] concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef Project. Although the letter arrived well after the April 7, 2006 deadline for comments, we appreciate the time you and your staff spent reviewing the *Environmental Assessment/Environmental Impact Statement Preparation Notice* and have addressed your comments below. To simplify your examination, we have reproduced the text of your comments in *italics* before each response.

Comment 1:

OHA generally does not approve of any additions to the ocean floor, particularly as submerged lands are ceded lands and because any change to the sea floor's ecosystem has ripple effects throughout an area regularly used for a variety of Native Hawaiian cultural and traditional purposes. This region is used for limu cultivation, canoe paddling, surfing, fishing, diving, etc.

Response: Both of the potential artificial reef sites presented in the EISPN are located more than a mile offshore. The water is far too deep for there to be any potential effect on surfing. No limu is present, and the kinds of activities associated with installation and operation of the proposed artificial reef do not have the potential to affect limu beds, shoreline fishing, or other traditional and customary activities. Similarly, the location of the proposed artificial reef makes it extremely unlikely that the boats that would use the area would interfere with existing or future canoeing activities.

As discussed in the EISPN, the seafloor in this area is relatively barren and fish stocks are low. Existing uses at both sites are limited to recreational fishing and pleasure boating, and there is no indication that either site is particularly valued for these uses. The addition of the proposed artificial reef at either site would benefit both marine life and recreational users by providing enhanced recreational opportunities and marine habitat. Native Hawaiians are among those users who would benefit from the proposed reef.

Comment 2:

Should approval be granted, consideration must be given to applicable cultural gathering and access rights during and after construction activities. Recognized Native Hawaiian traditional gathering rights and access should not be restricted – even during construction – except as necessary to ensure safety. If such safety-related restrictions are put in place, alternate public access routes must be provided.

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

Response: As described in the *EISPN*, construction and operation of the project will have no effect on shoreline access. The reef modules would be deployed to the ocean floor from a barge, and once in place, the site will be accessible to native Hawaiians and other recreational users. Because the modules can be emplaced quickly, typically in a day, there is no need to close the area for an extended period of time. Boats passing through the area would need only a slight change in course to stay clear of the activities.

Thank you again for your comments. If you have any further questions, please call me at (808) 550-4483.

Sincerely,

Perry J. White

cc: Mr. Brian Kanenaka, DAR (via e-mail)
Mr. Paul Murakawa, DAR (via e-mail)
Office of Environmental Quality Control (via e-mail)

APPENDIX G. DRAFT EIS COMMENTS & RESPONSES

LINDA LINGLE
GOVERNOR

#1

RUSS K. SAITO
COMPTROLLER

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
P.O. BOX 119, HONOLULU, HAWAII 96810

(P)1061.7

MAR 1 6 2007

MEMORANDUM

TO: Mr. Dan Polhemus, Administrator
Division of Aquatic Resources
Department of Land and Natural Resources

ATTENTION: Mr. Paul Murakawa

FROM: Ernest Y. W. Lau
Public Works Administrator

SUBJECT: Kalaeloa Artificial Reef
Draft Environmental Impact Statement, Oahu

Thank you for the opportunity to provide comments to the subject project's Draft Environmental Impact Statement. This project does not directly impact any of the Department of Accounting and General Services' projects or existing facilities, and we have no comments to offer at this time.

If you have any questions, please have your staff call Mr. Bruce Bennett of the Planning Branch at 586-0491.

BB:mo
c: Ms. Genevieve Salmonson, DOH-OEQC
Dr. Charles Morgan, Planning Solutions, Inc.

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR-LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATIONAND RESOURCESENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

March 28, 2007

Mr. Ernest Y.W. Lau, Public Works Administrator
Department of Accounting and General Services
State of Hawai'i
P.O. Box 119
Honolulu, Hawai'i 96810

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Lau:

Thank you for your March 16, 2007 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter.

We are pleased that the project does not directly impact any of your Department's projects or existing facilities, and we understand that you have no further comments to offer at this time.

If you have any future questions about this project, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

#2

March 15, 2007

Mr. Paul Murakawa
State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawaii 96813

Dear Mr. Murakawa:

Subject: Your Letter Dated March 6, 2007 Regarding Draft Environmental Impact Statement for Kalaeloa Artificial Reef

Thank you for the opportunity to comment on the proposed project.

The Board of Water Supply does not have any water systems in the project area, and thus has no comments or objections to the proposed project.

If you have any questions, please contact Robert Chun at 748-5440.

Very truly yours,

K. Shida

KEITH S. SHIDA
Principal Executive
Customer Care Division

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

March 28, 2007

Mr. Keith S. Shida, Principal Executive
Customer Care Division
Board of Water Supply
City & County of Honolulu
630 South Beretania Street
Honolulu, Hawai'i 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Shida:

Thank you for your March 15, 2007 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter

Thank you for confirming that the Board of Water Supply does not have any water systems in the project area. We understand that you have no comments or objections to offer on the project.

Should you have any future questions about this project, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
KAPOLEI HALE • 1000 ULUOHIA STREET, SUITE 309 • KAPOLEI, HAWAII 96707
TELEPHONE: (808) 692-5561 • FAX: (808) 692-5131 • INTERNET: www.honolulu.gov

#3

MUFI HANNEMANN
MAYOR

LESTER K.C. CHANG
DIRECTOR

DANA TAKAHARA-DIAS
DEPUTY DIRECTOR

March 16, 2007

Mr. Paul Murakawa
State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawaii

Dear Mr. Murakawa:

Subject: Draft Environmental Impact Statement Kalaeloa Artificial Reef

Thank you for the opportunity to review and comment on the Draft Environmental Statement relating to the Kalaeloa Artificial Reef.

The Department of Parks and Recreation has no comment and as this project will not impact any program or facility of the department, you are invited to remove us as a consulted party to the balance of the EIS process.

Should you have any questions, please contact Mr. John Reid, Planner, at 692-5454.

Sincerely,

LESTER K. C. CHANG
Director

LKCC:mk
(198821)

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATIONAND RESOURCESENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

March 28, 2007

Mr. Lester K.C. Chang, Director
Department of Parks & Recreation
City & County of Honolulu
1000 Uluohia Street, Suite 309
Kapolei, Hawai'i 96707

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Chang:

Thank you for your March 16, 2007 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter.

We are pleased that the project will not impact any of your Department's programs or facilities, and, per your request, we will remove you from the list of consulted parties for this project.

If you have any questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

DEPARTMENT OF FACILITY MAINTENANCE

CITY AND COUNTY OF HONOLULU

1000 Uluohia Street, Suite 215, Kapolei, Hawaii 96707
Phone: (808) 692-5054 • Fax: (808) 692-5857
Website: www.honolulu.gov

MUFI HANNEMANN
MAYOR

LAVERNE HIGA, P.E.
DIRECTOR AND CHIEF ENGINEER

GEORGE "KEOKI" MIYAMOTO
DEPUTY DIRECTOR

#4

IN REPLY REFER TO:
DRM 07-267

March 21, 2007

Mr. Paul Murakawa
State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawaii 96813

Subject: Kalaeloa Artificial Reef
Draft Environmental Impact Statement (DEIS)

Dear Mr. Murakawa:

Thank you for giving us the opportunity to comment on the subject DEIS. We have no comments to offer at this time.

If you have any questions, please contact Larry Leopardi, Chief of the Division of Road Maintenance, at 484-7600.

Sincerely,

Laverne Higa

Laverne Higa, P.E.
Director and Chief Engineer

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR- LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATIONAND RESOURCESENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

March 28, 2007

Ms. Laverne Higa, P.E., Director & Chief Engineer
Department of Facility Maintenance
City and County of Honolulu
1000 Uluohia Street, Suite 215
Kapolei, Hawai'i 96707

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Ms. Higa:

Thank you for your March 21, 2007 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter.

We understand that your Department has no comments to offer on the project at this time. If you have any questions in the future, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

LINDA LINGLE
GOVERNOR

#5

BARRY FUKUNAGA
INTERIM DIRECTOR

Deputy Directors
FRANCIS PAUL KEENO
BRENNON T. MORIOKA
BRIAN H. SEKIGUCHI

IN REPLY REFER TO:

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION
79 SOUTH NIMITZ HIGHWAY
HONOLULU, HAWAII 96813-4898

HAR-EP
2647.07

March 27, 2007

Mr. Perry J. White
Planning Solutions, Inc.
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814

Dear Mr. White:

Subject: Kalaeloa Artificial Reef Draft Environmental Impact Statement

Thank you for the opportunity to review the subject project. Because this project does not impact our commercial harbor facilities, we have no comments to offer.

Please call Mr. Dean Watase of our Harbors Division Engineering Planning Section at 587-1883 if you have any questions.

Very truly yours,

GLENN OKIMOTO
Harbors Administrator

c: Mr. Paul Murakawa
Division of Aquatic Resources
Department of Land and Natural Resources

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR-LAND

AQUATIC RESOURCES
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BUREAU OF CONVEYANCES
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

March 30, 2007

Mr. Glenn Okimoto, Harbors Administrator
Harbors Division
Department of Transportation
State of Hawai'i
79 South Nimitz Highway
Honolulu, Hawai'i 96813-4898

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Okimoto:

Thank you for your March 27, 2007 letter [your reference HAR-EP 2647.07] concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter.

We are pleased to hear that the project does not impact your Division's commercial harbor facilities, and we understand that you have no comments to offer. If you have any questions in the future, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

DEPARTMENT OF EMERGENCY MANAGEMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

#6

Mufi Hannemann
MAYOR

PETER J. S. HIRAI
Acting Direrctor

March 23, 2007

Mr. Paul Murakawa
State of Hawaii
Department of Land and
Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawaii 96813

Dear Mr. Murakawa:

Subject: Kalaeloa Artificial Reef:
Draft Environmental Impact Statement

Thank you for the opportunity to review and comment on the Kalaeloa Artificial Reef: Draft Environmental Impact Statement. The Department of Emergency Management does not have any comments at this time.

Sincerely,

PETER J. S. HIRAI, CEM
Acting Director

/ms

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR- LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

April 2, 2007

Mr. Peter J.S. Hirai, CEM, Acting Director
Department of Emergency Management
City & County of Honolulu
650 South King Street
Honolulu, Hawai'i 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Hirai:

Thank you for your March 23, 2007 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter.

We understand that your Department has no comments to offer at this time. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

POLICE DEPARTMENT

CITY AND COUNTY OF HONOLULU

801 SOUTH BERETANIA STREET · HONOLULU, HAWAII 96813
TELEPHONE: (808) 529-3111 · INTERNET: www.honolulupd.org

#7

MUFI HANNEMANN
MAYOR

BOISSE P. CORREA
CHIEF

GLEN R. KAJIYAMA
PAUL D. PUTZULU
DEPUTY CHIEFS

OUR REFERENCE BS-DK

March 27, 2007

Mr. Paul Murakawa
Division of Aquatic Resources
Department of Land and Natural Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawaii 96813

Dear Mr. Murakawa:

This is in response to your letter of March 6, 2007, requesting comments on a Draft Environmental Impact Statement for the Kalaeloa Artificial Reef project in Ewa.

This project should have no significant impact on the facilities or operations of the Honolulu Police Department.

If there are any questions, please call Major Michael Moses of District 8 at 692-4253 or Mr. Brandon Stone of the Executive Office at 529-3644.

Sincerely,

BOISSE P. CORREA
Chief of Police

By
JOHN P. KERR
Assistant Chief of Police
Support Services Bureau

Serving and Protecting With Aloha

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR- LAND

AQUATIC RESOURCES
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LAND
STATE PARKS

April 2, 2007

Mr. Boisse P. Correa, Chief
Police Department
City & County of Honolulu
801 South Beretania Street
Honolulu, HI 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Chief Correa:

Thank you for your March 27, 2007 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and providing written comments.

Thank you for confirming that the project should have no significant impact on the facilities or operations of the Honolulu Police Department. If you have any further questions concerning the project, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 523-4567
Web site: www.honolulu.gov

#8

MUFI HANNEMANN
MAYOR

EUGENE C. LEE, P.E.
DIRECTOR

CRAIG I. NISHIMURA, P.E.
DEPUTY DIRECTOR

April 4, 2007

Mr. Paul Murakawa
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawaii 96813

Dear Mr. Murakawa:

Subject: Draft Environmental Impact Statement
Kalaeloa Artificial Reef

Thank you for giving us the opportunity to comment on the above Draft Environmental Impact Statement.

The Department of Design and Construction has no comments to offer at this time.

Very truly yours,

Eugene C. Lee, P.E.
Director

ECL:lt (198719)

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR LAND

AQUATIC RESOURCES
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 11, 2007

Mr. Eugene C. Lee, P.E., Director
Department of Design & Construction
City & County of Honolulu
650 South King Street, 11th Floor
Honolulu, Hawai'i 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Lee:

Thank you for your April 4, 2007 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter.

We understand that your Department has no comments to offer on the project at this time. If you have any questions in the future, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

LINDA LINGLE
• GOVERNOR OF HAWAII

832
PM

#9

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

April 5, 2007

Division of Aquatic Resources
1151 Punchbowl Street Room 330
Honolulu, Hawaii 96813

Attention: Mr. Paul Murakawa

Gentlemen:

Subject: Draft Environmental Impact Statement for Kalaeloa Artificial Reef, Kalaeloa, Oahu

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR) Land Division distributed or made available a copy of your report pertaining to the subject matter to DLNR Divisions for their review and comment.

Other than the comments from Division of Boating & Ocean Recreation, Engineering Division, Division of State Parks, Office of Conservation & Coastal Lands, Division of Water Resource Management , Land Division – Oahu District, the Department of Land and Natural Resources has no other comments to offer on the subject matter. Should you have any questions, please feel free to call our office at 587-0433. Thank you.

Sincerely,

Russell Y. Tsuji
Administrator

RECEIVED
APR 9 2007
AQUATIC RESOURCES

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR- LAND

AQUATIC RESOURCES
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BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 11, 2007

Mr. Russell Y. Tsuji, Administrator
Land Division
Department of Land & Natural Resources
State of Hawai'i
P.O. Box 621
Honolulu, Hawai'i 96809

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Tsuji:

Thank you for your April 5, 2007 letter forwarding comments from DLNR's various divisions concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement,* circulating it, and providing us with written comments.

We have responded to the comments of DLNR's various divisions individually, and those response letters will be reproduced, along with the comment letters, in the *Final EIS.* In the meantime, we understand that your Division has no additional comments to offer on the project.

If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

LINDA LINGLE
GOVERNOR OF HAWAII

#10

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

March 8, 2007

MEMORANDUM

TO: **DLNR Agencies:**
__ Div. of Aquatic Resources
_x_ Div. of Boating & Ocean Recreation
_x_ Engineering Division
__ Div. of Forestry & Wildlife
_x_ Div. of State Parks
_x_ Div. of Water Resource Management
_x_ Office of Conservation & Coastal Lands
_x_ Land Division – Oahu District

RECEIVED
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2007 MAR 16 A 10:51

FROM: Russell Y. Tsuji
SUBJECT: Draft Environmental impact Statement for Kalaeloa Artificial Reef
LOCATION: Kalaeloa, Oahu
APPLICANT: Planning Solutions, Inc. on behalf of DLNR, Division of Aquatic Resources

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by April 20, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

(X) We have no objections.
( ) We have no comments.
( ) Comments are attached.

Signed:
Date: 3/15/07

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 11, 2007

Mr. Edward Underwood
Division of Boating & Ocean Recreation
Department of Land & Natural Resources
State of Hawai'i
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Underwood:

Thank you for your March 8, 2007 communication concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement*.

We understand that your Division has no comments to offer on the project at this time. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

LINDA LINGLE
GOVERNOR OF HAWAII

#11

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

March 8, 2007

MEMORANDUM

TO: **DLNR Agencies:**
__Div. of Aquatic Resources
_x Div. of Boating & Ocean Recreation
_x Engineering Division
__Div. of Forestry & Wildlife
_x_Div. of State Parks
_x Div. of Water Resource Management
_x Office of Conservation & Coastal Lands
x Land Division – Oahu District

FROM: Russell Y. Tsuji
SUBJECT: Draft Environmental impact Statement for Kalaeloa Artificial Reef
LOCATION: Kalaeloa, Oahu
APPLICANT: Planning Solutions, Inc. on behalf of DLNR, Division of Aquatic Resources

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by April 20, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
(X) We have no comments.
( ) Comments are attached.

Signed: Eric T. Hirano
Date: 3/16/07

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR- LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 11, 2007

Mr. Eric T. Hirano
Engineering Division
Department of Land & Natural Resources
State of Hawai'i
1151 Punchbowl Street, Room 221
Honolulu, Hawaii 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Hirano:

Thank you for your March 16, 2007 communication concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement*.

We understand that your Division has no comments to offer on the project at this time. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

45881

#12

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
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DEPT OF LAND & NATURAL RESOURCES

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

March 8, 2007

TO:
ADMINISTRATOR
ASST ADMIN
DEV BR
PLAN BR
RES MGT BR
CLERICAL
ADMIN ASST
INTERP BR

FOR:
CIRC/POST/STAFF RM
COMMENTS & REC
DRAFT REPLY
FILE
FOLLOW UP
INFO
RUN COPIES
RUSH DUE
SEE ME
FAX/SEND COPY TO

MEMORANDUM

TO: **DLNR Agencies:**
__Div. of Aquatic Resources
_x_ Div. of Boating & Ocean Recreation
_x_ Engineering Division
__Div. of Forestry & Wildlife
_x_ Div. of State Parks
_x_ Div. of Water Resource Management
_x_ Office of Conservation & Coastal Lands
_x_ Land Division – Oahu District

FROM: Russell Y. Tsuji
SUBJECT: Draft Environmental impact Statement for Kalaeloa Artificial Reef
LOCATION: Kalaeloa, Oahu
APPLICANT: Planning Solutions, Inc. on behalf of DLNR, Division of Aquatic Resources

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by April 20, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed:
Date: 3/15/07

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR-LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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FORESTRY AND WILDLIFE
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 11, 2007

Mr. Dan Quinn
Division of State Parks
Department of Land & Natural Resources
State of Hawai'i
1151 Punchbowl Street, Room 310
Honolulu, Hawaii 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Quinn:

Thank you for your March 15, 2007 communication concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement*.

We understand that your Division has no comments to offer on the project at this time. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

4-16-07

LINDA LINGLE
GOVERNOR OF HAWAII

#13

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

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LAND DIVISION
2007 MAR 27 P 1:36

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

March 8, 2007

RECEIVED
07 MAR 9 P3:47
COMMISSION ON WATER RESOURCE MANAGEMENT

MEMORANDUM

TO: **DLNR Agencies:**
__Div. of Aquatic Resources
_x_ Div. of Boating & Ocean Recreation
_x_ Engineering Division
__Div. of Forestry & Wildlife
_x_ Div. of State Parks
_x_ Div. of Water Resource Management
_x_ Office of Conservation & Coastal Lands
_x_ Land Division – Oahu District

FROM: Russell Y. Tsuji
SUBJECT: Draft Environmental impact Statement for Kalaeloa Artificial Reef
LOCATION: Kalaeloa, Oahu
APPLICANT: Planning Solutions, Inc. on behalf of DLNR, Division of Aquatic Resources

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by April 20, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed: Edwin T. Sakoda
Date: 3/23/07

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR- LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 11, 2007

Mr. Edwin Sakoda
Commission on Water Resource Management
Department of Land & Natural Resources
State of Hawai'i
1151 Punchbowl Street, Room 227
Honolulu, Hawaii 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Sakoda:

Thank you for your March 23, 2007 communication concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement*.

We understand that the Commission has no comments to offer on the project at this time. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

LINDA LINGLE
GOVERNOR OF HAWAII

#14

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
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LAND
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AND COASTAL LANDS
2007 MAR -9 P 3:20

DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

RECEIVED
LAND DIVISION
2007 MAR 15 A 8:51

March 8, 2007

MEMORANDUM

TO: **DLNR Agencies:**
FROM: DLNR
__Div. of Aquatic Resources
_x_Div. of Boating & Ocean Recreation
_x_Engineering Division
___Div. of Forestry & Wildlife
_x_Div. of State Parks
_x_Div. of Water Resource Management
_x_Office of Conservation & Coastal Lands
_x_Land Division – Oahu District

TO
FROM: Russell Y. Tsuji
SUBJECT: Draft Environmental impact Statement for Kalaeloa Artificial Reef
LOCATION: Kalaeloa, Oahu
APPLICANT: Planning Solutions, Inc. on behalf of DLNR, Division of Aquatic Resources

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by April 20, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

(✓) We have no objections.
( ) We have no comments.
(✓) Comments are attached.

Signed: [signature]
Date: 03/14/07

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF.:OCCL:TM

Correspondence: OA 07-158

FEB 21 2007

MEMORANDUM

TO: Division of Aquatic Resources (DAR)
ATTN: Brian Kanenaka
Paul Murakawa

FROM: Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands (OCCL)

SUBJECT: Kalaeloa Artificial Reef Proposal

The Office of Conservation and Coastal Lands (OCCL) has reviewed the subject draft Environmental Impact Statement (EIS) regarding the establishment of an artificial reef and we offer the following comments.

Staff notes the approving agency should be the Department of Land and Natural Resources not the Office of Conservation and Coastal Lands. This needs to be clarified in the Project Summary and Section 6.2.2 STATE LAND USE LAWS.

According to the information presented, DAR is proposing to designate and establish a new seabed area of ≈ 224 acres for the construction of artificial reefs within a location that is over 1 mile from the shore between the depths of 60-120 ft. According to the report prepared by Richard Brock in support of the EIS, the proposed artificial reef, which would be composed of concrete "Z" blocks, would initially result in a loss of 263 square meters of live coral due to their placement of the seafloor. However, upon full build out of the artificial reef, Mr. Brock estimates at least 27,000 square meters of live coral coverage after 20 years, which represents almost a 1000 percent increase in corals.

The project is one of the requirements of HASEKO's Department of the Army permit to compensate for the loss of 1.1 acres of reef surface area due to the impending excavation of the Ocean Pointe (Hoakalei) marina entrance channel. Although an equal area of 1.1 acres would suffice to compensate for the loss of reef surface, advances in artificial reef research conclude that a structure of 1.1 acres may not provide productive habitat for marine community growth and may lead to over fishing as the structure may perform as a fish aggregate device. Therefore a larger habitat area would be less vulnerable to over fishing and would increase efficiency to achieve habitat and species replenishment.

Staff notes the proposal is within a restricted military underwater installation area. According to the information presented, the Navy reviewed its operations and facilities in the area to confirm their compatibility with the proposal. The Navy notes that the proposal should not interfere with Navy operations provided that: 1) Any underwater structures during reef deployment should be avoided; and 2) that DAR require all recreational users to moor to buoys that DAR shall provide at the site rather than anchoring on the seafloor. DAR has agreed to prohibit bottom anchoring at the site and shall provide mooring buoys. However, no impact/mitigation analysis or siting of the proposed moorings are included in the draft EIS.

During the Chapter 343 and Conservation District Use Application processing, staff recommends that much more discussion and outreach take place with various community groups, environmental organizations and existing and potential users of the area. The draft EA should also be sent to the Kapolei Library and DAR may wish to consult with the Makakilo/Kapolei Neighborhood Board.

Should you have any questions regarding this correspondence, please contact our Office of Conservation and Coastal Lands at 587-0377.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 11, 2007

Mr. Sam Lemmo, Administrator
Office of Conservation & Coastal Lands
Department of Land & Natural Resources
State of Hawai'i
1151 Punchbowl Street, Room 131
Honolulu, Hawai'i 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Lemmo:

Thank you for your February 21, 2007 letter (your reference OA 07-158) concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and providing written comments. Item-by-item responses to your comments are provided below. To simplify your examination, we have reproduced the text of your comments in *italics* before each response.

Comment 1:

Staff notes the approving agency should be the Department of Land and Natural Resources not the Office of Conservation and Coastal Lands. This needs to be clarified in the Project Summary and Section 6.2.2 STATE LAND USE LAWS.

Response: Thank you for your comment. The project summary and Section 6.2.2 of the *Draft EIS* specify the Department of Land and Natural Resources as the approving agency.

Comment 2:

Staff notes the proposal is within a restricted military underwater installation area. According to the information presented, the Navy reviewed its operations and facilities in the area to confirm their compatibility with the proposal. The Navy notes that the proposal should not interfere with Navy operations provided that: I) Any underwater structures during reef deployment should be avoided; and 2) that DAR require all recreational users to moor to buoys that DAR shall provide at the site rather than anchoring on the seafloor. DAR has agreed to prohibit bottom anchoring at the site and shall provide mooring buoys. However, no impact/mitigation analysis or sitting of the proposed moorings are included in the draft EIS.

Response: As discussed in Section 3.1.2 of the *Draft EIS,* 95% of the seafloor within the proposed artificial reef site is bare limestone that is devoid of corals. The final locations of the reef sets and mooring

buoys will be determined during pre-construction surveys to ensure that all structures are installed in areas where no corals or underwater Navy structures are located. So long as these structures are avoided, there will be no impacts requiring mitigation.

Comment 3:

During the Chapter 343 and Conservation District Use Application processing, staff recommends that much more discussion and outreach take place with various community groups, environmental organizations and existing and potential users of the area. The draft EA should also be sent to the Kapolei Library and DAR may wish to consult with the Makakilo/Kapolei Neighborhood Board.

Response: As described in Chapter 8 of the *Draft EIS,* DAR has consulted extensively with potential stakeholders and contacted representatives of local user groups. A presentation was made to the 'Ewa Neighborhood Board and the project has been publicized in local newspapers and radio. DAR sent copies of the *Draft EIS* to the recipients listed in Table 8.3 of the document. The listed recipients include the Kapolei Library and the chairperson of the Makakilo/Kapolei Neighborhood Board. DAR will continue to involve those organizations and individuals in the reef development and consultation process, and will arrange additional presentations to appropriate organizations as needed during the processing of the Conservation District Use Permit for the project.

Thank you again for your comments. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

LINDA LINGLE
GOVERNOR OF HAWAII

#15

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

March 8, 2007

MEMORANDUM

TO: **DLNR Agencies:**
__Div. of Aquatic Resources
_x_Div. of Boating & Ocean Recreation
_x_Engineering Division
__Div. of Forestry & Wildlife
_x_Div. of State Parks
_x_Div. of Water Resource Management
_x_Office of Conservation & Coastal Lands
_x_Land Division – Oahu District

FROM: Russell Y. Tsuji
SUBJECT: Draft Environmental impact Statement for Kalaeloa Artificial Reef
LOCATION: Kalaeloa, Oahu
APPLICANT: Planning Solutions, Inc. on behalf of DLNR, Division of Aquatic Resources

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by April 20, 2007.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(X) Comments are attached.

Signed: Cyril Santos
Date: 3/13/07

** Comments: It would seem that to install and manage the artificial reef, there would need to be a disposition of the submerged land for the installation and management purposes. The disposition would be a Governor's Executive Order issued by the Land Division.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 11, 2007

Mr. Cecil B. Santos
O`ahu District Office
Land Division
Department of Land & Natural Resources
State of Hawai'i
1151 Punchbowl Street, Room 131
Honolulu, Hawai'i 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Santos:

Thank you for your March 13, 2007 communication concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing and commenting on the *Draft Environmental Impact Statement*. Our response to your comment is provided below. To simplify your examination, we have reproduced the text of your comment in *italics* before the response.

Comment 1:

It would seem that to install and manage the artificial reef, there would need to be a disposition of the submerged land for the installation and management purposes. The disposition would be a Governor's Executive Order (GEO) issued by the Land Division.

Response: Thank you for your comment, and for subsequently discussing it with Paul Murakawa of our Division. DAR will follow up with your Division regarding issuance of the appropriate GEO once we have successfully obtained a Conservation District Use Permit for the proposed reef.

Thank you again for your comments. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control
Mr. Sam Lemmo, OCCL

HONOLULU FIRE DEPARTMENT

CITY AND COUNTY OF HONOLULU

636 South Street
Honolulu, Hawaii 96813-5007
Phone: 808-723-7139 Fax: 808-723-7111 Internet: www.honolulu.gov/hfd

MUFI HANNEMANN
MAYOR

KENNETH G. SILVA
FIRE CHIEF

ALVIN K. TOMITA
DEPUTY FIRE CHIEF

#16

April 13, 2007

Mr. Paul Murakawa
Department of Land and Natural Resources
Division of Aquatic Resources
State of Hawaii
1151 Punchbowl Street, Room 330
Honolulu, Hawaii 96813

Dear Mr. Murakawa:

Subject: Kalaeloa Artificial Reef
Draft Environmental Impact Statement

In response to your letter dated March 6, 2007, regarding the above-mentioned subject, the Honolulu Fire Department (HFD) reviewed the material you provided and is concerned with the potential increase in recreational diving and boating activities in the immediate vicinity of the artificial reef, thereby increasing the HFD's rescue responses due to mishaps or accidents. As such, please inform us of the global positioning system coordinates of the proposed site location in order to expedite emergency response when necessary.

Should you have any questions, please call Battalion Chief Lloyd Rogers of our Fire Prevention Bureau at 723-7151.

Sincerely,

KENNETH G. SILVA
Fire Chief

KGS/WM:jl

cc: Office of Environmental Quality Control
Mr. Brian Kanenaka, Department of Land and Natural Resources
Dr. Charles Morgan, Planning Solutions, Inc.
Mr. Raymond Kanna, Haseko (Ewa), Inc.

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATIONAND RESOURCESENFORCEMENT
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 23, 2007

Mr. Kenneth G. Silva, Chief
Honolulu Fire Department
City and County of Honolulu
636 South Street
Honolulu, Hawai'i 96813-5007

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Chief Silva:

Thank you for your April 13, 2007 letter concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and providing written comments. To simplify your examination, we have reproduced the text of your comment in *italics* before our response.

Comment:

In response to your letter dated March 6, 2007, regarding the above-mentioned subject, the Honolulu Fire Department (HFD) reviewed the material you provided and is concerned with the potential increase in recreational diving and boating activities in the immediate vicinity of the artificial reef, thereby increasing HFD's rescue responses due to mishaps or accidents. As such, please inform us of the global positioning system coordinates of the proposed site location in order to expedite emergency response when necessary.

Response: Thank you for your comment. We understand Jeff Faris of your Department spoke with our environmental consultant Dr. Charles Morgan of Planning Solutions, Inc. on April 20, 2007. Mr. Faris requested that DAR continue to keep HFD apprised of the actual as-built coordinates of the reef increments as they are emplaced. As such, we will make it a policy to send HFD copies of the coordinates when the reef increment locations are selected.

Thank you again for your comments. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc. ✓
Office of Environmental Quality Control

LINDA LINGLE
GOVERNOR OF HAWAII

#17

GENEVIEVE SALMONSON
DIRECTOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186
E-mail: oeqc@health.state.hi.us

April 20, 2007

Mr. Peter Young, Chair
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawai'i 96809

Dear Mr. Young:

Subject: Draft Environmental Impact Statement for Kalaeloa Artificial Reef

Thank you for the opportunity to review the DEIS. We have no comments.

Should you have any questions, please call Jeyan Thirugnanam at 586-4185.

Sincerely,

for Genevieve Salmonson
Director

c: Planning Solutions

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR-LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 23, 2007

Ms. Genevieve Salmonson, Director
Office of Environmental Quality Control
Department of Health
State of Hawai'i
235 South Beretania Street, Suite 702
Honolulu, Hawai'i 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Ms. Salmonson:

Thank you for your April 20, 2007 letter concerning the State Division of Aquatic Resources' proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter.

We understand that your Department has no comments to offer on the project at this time. If you have any future questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc. ✓

FAX TRANSMITTAL SHEET

#18

ENVIRONMENTAL CENTER
University of Hawaii
2500 Dole Street, Krauss Annex 19, Honolulu, HI 96822
Telephone: (808) 956-7361 Fax: (808) 956-3980

DATE: 4/23/2007

FROM: Peter Rappa
Environmental Review Coordinator

TO: Paul Murakawa, DAR (587-0115)

Charles Morgan, Planning Solutions (550-4549)

OEQC (586-4186)

SUBJECT: **REVIEW OF DRAFT EIS**
KALAELOA ARTIFICIAL REEF
OFFSHORE EWA DISTRICT, OAHU

No. of Pages: including cover sheet: _____

UNIVERSITY OF HAWAI'I AT MANOA
Environmental Center

April 23, 2007
RE:0761

Mr. Paul Murakawa
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, HI 96813

Dear Mr. Murakawa:

Draft Environmental Impact Statement
Kalaeloa Artificial Reef
Kalaeloa, Oahu

The State of Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources (DAR) is proposing to establish an artificial reef site on the seafloor offshore from the Ewa District of the Island of Oahu that is properly placed and of sufficient size to accommodate substantial development of artificial-reef structures. For this purpose, DAR has delineated a 224-acre area located between depths of 60-120 feet that is mostly devoid of coral and valuable marine habitat. DAR is applying for a Conservation District Use Permit to formally designate the site to be used for the construction of artificial reef. The DEIS covers the proposed designation of the site as an artificial reef development area with particular attention to the construction of the first increment of artificial reef within the site boundaries. At least two separate piles (sets) of concrete Z-blocks will be emplaced on the ocean floor approximately 50-100 feet apart. A total of approximately 700-800 blocks will be used for the first increment, covering a seafloor area of about 8,000 square feet. This will provide shelter and surface area that will improve marine habitat quality at the site.

This review was prepared with the assistance of Robert Grace, Department of Civil Engineering.

General Comments

Inshore fisheries resources around the main Hawaiian Islands have been devastated due to a number of factors including habitat destruction and overfishing. Creating more marine resource habitats is one way to address the problem of declining stocks of sea life. Artificial reefs have been recognized by the scientific community and marine resource agencies around the world as a way to enhance local fishery's stock by increasing the available habitat. This proposed project would designate the third artificial reef site around the island of Oahu. The proposed Kalaeloa site utilizes the experience the Department of Land and Natural Resources (DLNR) has learned from building and managing the other two sites in Waianae and Maunalua Bay to develop a new artificial reef. Like in the other two areas which DLNR built and maintains, we believe that this proposed will work to fulfill its intended purpose. We generally agree with the information presented in the DEIS, but would like to point of some areas for further elaboration.

2500 Dole Street, Krauss Annex 19, Honolulu, Hawai'i 96822-2313
Telephone: (808) 956-7361 • Facsimile: (808) 956-3980

Purpose and Need (p. 1-1)

On page 1-1, DAR states nine objectives it expects to achieve by this project. To this list we would like to add a tenth objective: establishing a monitoring program that will determine whether the artificial reef enhancing the number of fish in the area. This would be a great time to set up a study that can add to the scientific knowledge of the performance of artificial reefs on Hawaiian waters.

Agricultural and Soils (p. 4-18)

The statement in the mitigative subsection of the Agricultural and Soils section that the loss of a small amount of agriculture land is offset by the socio economic benefits may be technically correct, but in the future Hawaii may wish it had all the agriculturally suitable lands back to grow food. As fuel prices rise, we may be forced to produce our own food here.

Construction of the First Reef Increment (p. 2-3 – 2-5)

We would have appreciated some details concerning the reinforcing steel network used within each Z unit. How much concrete cover is there over the steel? Both the cover of the report and Figure 2-3B appear to show a length of reinforcing bar that has clearly been exposed. What has been the experience of the State of Hawaii, at other sites, in keeping unit breakage to a minimum during bulk dumping?

Construction Schedule (p. 2-6)

The construction schedule listed in section 2.2.4 can no longer be met by the proposed project. The final EIS should contain an up-to-date schedule.

Wind Driven Currents (p. 3-3)

The word "coast" is misspelled as "cost" in the next to the last line on the page.

Surface Waves (p. 3-9)

A glance at Table 3.2 reveals that the wave lengths given are far too small, and calculation indicates that every listed number is too low by a factor of ten. There is confusion (between the preceding paragraph and the table title) about whether the waves indicated are really for Hawaiian waters or for this part of Mamala Bay. There is no mention of whether the wave height numbers given are maximum or significant. Are the heights "local" or deep water?

It cannot be accepted that a north or northwest swell could refract into this area. A period of 22 seconds would only be obtained from the "forerunners" of a big north swell, not when the waves were at their height. If there were a strong easterly wind, then you might get "tradewind" waves of the size shown, but you have limited such wind directions to north of 45 degrees. Last week we observed that the wind has been blowing a steady east, at 20 knots, for four straight days. It is unlikely that even in the monster south swell of June 1974 there were peak wave heights of 6 m, let alone significant.

Impacts to Surface Waves (4-2 – 4-3)

Changes to Table 4.1 will be necessary because of what is said above in our comment on Surface Waves. The equation given on page 4-2 would appear to contain the local wave length, not that in deep water. Also, this relationship gives a zero transmission coefficient for H approaching zero, so really cannot be taken seriously. The researchers Friebel and Harris (2004) actually left out Ahrens' data in developing their own equation. How did you represent the "nominal diameter" for a system of off-shape plates? (See H.C. Friebel and L.E. Harris, "A new wave transmission coefficient model for submerged breakwaters", 29th International Conference on Coastal Engineering, Lisbon. Portugal, September 2004.)

Marine Species of Concern (p. 4-9)

Although there were no whales spotted in the area of the proposed artificial reef, wouldn't it be prudent to schedule construction in the months that the Humpback whales are migrating to or in Alaska? This would minimize any chance that humpback whales in the area could delay the deployment of artificial reef components.

Competition Between Recreational User Groups (p. 4-11)

How many anchor buoys will be provided for the proposed artificial reef in the first phase and for the project as a whole?

Appendix A. Hawaii's Artificial Reef Program (p. A-1)

There is no date cited for the draft report by Brian Kanenaka.

Appendix D. Summary of Offshore Stakeholders Meeting (p. D-1)

Among the stakeholders attending the April 13 meeting, we could find no one like Frank Farm, who fishes individually with cage traps, and has already been displaced from the reef runway area by the extension of the Fort Kamehameha outfall. Were there any fishermen invited to the stakeholders meeting?

Thank you for the opportunity to review this DEIS

Sincerely,

Peter Rappa
Environmental Review Coordinator

cc: OEQC
Charles Morgan, Planning Solutions, Inc.
James Moncur, WRRC
Robert Grace

LINDA LINGLE
GOVERNOR OF HAWAII

ALLAN A. SMITH
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

PETER T. YOUNG
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

May 14, 2007

Mr. Peter Rappa, Environmental Review Coordinator
Environmental Center
University of Hawai'i
2500 Dole Street, Krauss Annex 19
Honolulu, Hawai'i 96822

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Rappa:

Thank you for your April 23, 2007 facsimile (your reference 0761) concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your colleagues spent reviewing the *Draft Environmental Impact Statement* and providing written comments. Item-by-item responses to your comments are provided below. To simplify your examination, we have reproduced the text of your comments in *italics* before each response.

Comment 1 (Purpose and Need, p. 1-1):

On page 1-1, DAR states nine objectives it expects to achieve by this project. To this list we would like to add a tenth objective: establishing a monitoring program that will determine whether the artificial reef [sic] *enhancing the number of fish in the area, This would be a great time to set up a study that Can add to the scientific knowledge of the performance of artificial reefs on Hawaiian waters.*

Response: Your comment about adding a tenth objective is a good one; DAR currently has a monitoring program for its artificial reefs. DAR surveys its artificial reefs periodically to get an idea of the fish abundance and diversity. These surveys date back to when the artificial reef program was established. DAR has plans to monitor the proposed Kalaeloa artificial reef in the same manner as previous artificial reef locations. Consequently, the *Final EIS* will reflect this change.

Comment 2 (Agricultural and Soils, p. 4-18):

The statement in the mitigative subsection of the Agricultural and Soils section that the loss of a small amount of agriculture land is offset by the socio economic benefits may be technically correct, but in the future Hawaii may wish it had all the agriculturally suitable lands back to grow food. As fuel prices rise, we may be forced to produce our own food here.

Response: The page number and section that this comment refers to does not exist in the *Kalaeloa Artificial Reef Draft EIS* and nowhere in the document is there reference to agricultural impacts, since the project occurs offshore. It appears that this comment was included by mistake, perhaps in reference to a previously reviewed document.

Comment 3 (Construction of the First Reef Increment, p. 2-3 - 2-5):

We would have appreciated some details concerning the reinforcing steel network used within each Z unit. How much concrete cover is there over the steel? Both the cover of the report and Figure 2-3B appear to show a length of reinforcing bar that has clearly been exposed. What has been the experience of the State of Hawaii, at other sites, in keeping unit breakage to a minimum during bulk dumping?

Response: Each Z-module contains approximately 90 linear feet of ½" steel rebar. This rebar is covered with approximately 3-4" of concrete except for a few exposed areas, which are used for moving the modules with a crane or forklift.

DAR has learned through experience that some breakage is ideal for creating smaller spaces for fishes to hide for protection. Of course, DAR does not want the modules to break apart completely, so deploying multiple modules at a time is more beneficial than dropping them individually to minimize breakage and to create structures with high vertical relief.

Comment 4 (Construction Schedule, p. 2-6):

The construction schedule listed in section 2.2.4 can no longer be met by the proposed project. The final EIS should contain an up-to-date schedule.

Response: Thank you for pointing this out. The *Final EIS* will include an updated schedule.

Comment 5 (Wind Driven Currents, p. 3-3):

The word "coast" is misspelled as "cost" in the next to the last line on the page.

Response: Thank you for catching this. The typo will be corrected in the *Final EIS.*

Comment 6 (Surface Waves, p. 3-9):

A glance at Table 3.2 reveals that the wave lengths given are far too small, and calculation indicates that every listed number is too low by a factor of ten. There is confusion (between the preceding paragraph and the table title) about whether the waves indicated are really for Hawaiian waters or for this part of Mamala Bay. There is no mention of whether the wave height numbers given are maximum or significant. Are the heights "local" or deep water?

It cannot be accepted that a north or northwest swell could refract into this area. A period of 22 seconds would only be obtained from the "forerunners" of a big north swell, not when the waves were at their height. If there were a strong easterly wind, then you might get "tradewind" waves of the size shown, but you have limited such wind directions to north of 45 degrees. Last week we observed that the wind has been blowing a steady east, at 20 knots, for four straight days. It is unlikely that even in the monster south swell of June 1974 there were peak wave heights of 6 m, let alone significant.

Response: Thank you for catching this. We have replaced this table with the data collected from the NOAA Buoy #51027, which is located due south of Moloka'i, Lana'i and Maui (latitude: 20° 27'N, longitude 157° 7' 54" W), and which recorded wave data directly applicable to the project site between December 1994 and November 1995 (see Table below). The deep-water wavelengths of these waves are on the order of 20 – 150 m.

Table 3.1 NOAA Buoy 51027 Surface Wave Data Summary

	Trades (50°-150°)		Kona & S. Swell (150°-230°)		North Swell (230°-360°)	
	Period (sec.)	Significant Height (m)	Period (sec.)	Significant Height (m)	Period (sec.)	Significant Height (m)
% of Data	48		20		32	
Minimum	4.2	0.7	4.5	0.6	4.7	0.7
Maximum	8.3	3.3	8.7	2.8	11	3.3
Median	5.3	1.7	5.8	1.3	6.5	1.5
Mean	5.4	1.7	6.0	1.4	6.8	1.6
Std. Dev.	0.4	0.4	0.8	0.4	1.2	0.4

Source: NOAA (2007)

Comment 7 (Impacts to Surface Waves, pp. 4-2 - 4-3):

Changes to Table 4.1 will be necessary because of what is said above in our comment on Surface Waves. The equation given on page 4-2 would appear to contain the local wave length, not that in deep water. Also, this relationship gives a zero transmission coefficient for IT approaching zero, so really cannot be taken seriously. The researchers Friebel and Harris (2004) actually left out Ahrens' data in developing their own equation. How did you represent the "nominal diameter" for a system of off-shape plates? (See H.C. Friebel and LE, Harris, "A new wave transmission coefficient model for submerged breakwaters", 29th International Conference on Coastal Engineering, Lisbon, Portugal, September 2004.)

Response: Mr. Friebel graciously provided his model and a very helpful spreadsheet when we contacted him to address this issue. Unfortunately, we found that the physical models used as the basis of his and most previous models did not determine K_t values for situations close to those that would represent the Kalaeloa Reef structures. The tests all involved submerged structures that are, relative to the artificial reef structures, larger and shallower. We discussed this with Friebel, and he agreed that it is probably not a good idea to use his or the earlier models in this situation. Thus, we have confined the discussion in the impact analysis to a qualitative consideration of the impacts. The conclusion of this analysis, that there will be little if any impacts, is based primarily on the fact that the reef structures will be deeper and farther from shore than the 40-ft. shelf and will also be relatively small and separated from each other.

Comment 8 (Marine Species of Concern, p. 4-9):

Although there were no whales spotted in the area of the proposed artificial reef, wouldn't it be prudent to schedule construction in the months that the Humpback whales are migrating to or in Alaska? This would minimize any chance that humpback whales in the area could delay the deployment of artificial reef components.

Response: From past experience, DAR has estimated that a deployment of 800 Z-modules will take approximately 2 hours. At first, the deployment is slow because of the confined space the forklift has to work with. But after a short while, the operator becomes more comfortable and can deploy approximately 10 modules per minute. DAR also works with the tug and barge company to conduct deployments in September and October at the Maunalua Bay Artificial Reef and July and August deployments at the Wai'anae Artificial Reef. These two factors minimize the chance of any interaction or disturbance with humpback whales.

Comment 9 (Competition Between Recreational User Groups, p. 4-11):

How many anchor buoys will be provided for the proposed artificial reef in the first phase and for the project as a whole?

Response: As you may know, the proposed artificial reef area is delineated within a no-anchor zone. The amount of mooring buoys for the first phase and for the entire project depends greatly on the number of users at the proposed artificial reef. For the first increment, it is envisioned that two or three mooring buoys may be installed. As DAR obtains a more accurate idea of the number of users, more anchor buoys may be installed as the project progresses.

Comment 10 (Appendix A. Hawaii's Artificial Reef Program, p. A-1):

There is no date cited for the draft report by Brian Kanenaka.

Response: The date of this draft report is 1991.

Comment 11 (Appendix D, Summary of Offshore Stakeholders Meeting, p. D-1):

Among the stakeholders attending the April 13 meeting, we could find no one like Frank Farm, who fishes individually with cage traps, and has already been displaced from the reef runway area by the extension of the Fort Kamehameha outfall, Were there any fishermen invited to the stakeholders meeting?

Response: As stated in Section 4.7.1 in the DEIS, consultation occurred with both William Aila (the Wai'anae Harbor Master) and Carl Jellings, a knowledgeable local fisherman, during preparation of the EIS. Both of these individuals were contacted well in advance of the stakeholders meeting, and both expressed support for the proposed artificial reef project. In addition, a presentation was made to the 'Ewa Neighborhood Board on June 8, 2006.

If you have any further questions concerning the project, please call Paul Murakawa at 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at 550-4483.

Sincerely,

Dan Polhemus
Administrator

cc: Sam Lemmo, OCCL
✓Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control
Harry Friebel, Army Corps of Engineers, Philadelphia

LINDA LINGLE
GOVERNOR OF HAWAII

#19

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. Box 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
EPO-7-058

April 16, 2007

Mr. Paul Murakawa
State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawaii 96813

Dear Mr. Murakawa:

SUBJECT: Draft Environmental Impact Statement for Kalaeloa Artificial Reef, Seafloor within State Waters off Kalaeloa, Ewa District, Oahu, Hawaii

Thank you for allowing us to review and comment on the subject documents. The documents were routed to the various branches of the Department of Health (DOH) Environmental Health Administration. We have the following Clean Water Branch and General comments.

Clean Water Branch

The construction of the proposed Kalaeloa Artificial Reef is to mitigate the aquatic environment lost due to the entrance channel dredging for the Kalaeloa Marine (formerly "Ewa Marina"). We support the "Alternative 1" proposal.

Based on the scope of the project, an individual application for a Section 401 Water Quality Certification is needed. The Division of Aquatic Resources of the Department of Land and Natural Resources shall be informed of this requirement and shall submit the application in a timely manner.

If you have any questions, please contact Mr. Edward Chen of the Engineering Section, Clean Water Branch, at 586-4309

General

We strongly recommend that you review all of the Standard Comments on our website: www.state.hi.us/health/environmental/env-planning/landuse/landuse.html. Any comments specifically applicable to this project should be adhered to.

If there are any questions about these comments please contact Jiacai Liu with the Environmental Planning Office at 586-4346.

Sincerely,

KELVIN H. SUNADA, MANAGER
Environmental Planning Office

c: EPO
CWB

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

May 7, 2007

Mr. Kelvin H. Sunada, Manager
Environmental Planning Office
Department of Health
State of Hawai'i
P.O. Box 3378
Honolulu, Hawai'i 96801-3378

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Mr. Sunada:

Thank you for your April 16, 2007 letter (your reference EPO-7-058) concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and routing the document to the various branches of the DOH Environmental Health Administration. To simplify your examination, we have reproduced the text of each branch's comments in *italics* before each response.

Clean Water Branch

Comment 1:

The construction of the proposed Kalaeloa Artificial Reef is to mitigate the aquatic environment lost due to the entrance channel dredging for the Kalaeloa Marine (formerly "Ewa Marina"). We support the "Alternative 1" proposal.
Based on the scope of the project, an individual application for a Section 401 Water Quality Certification is needed. The Division of Aquatic Resources of the Department of Land and Natural Resources shall be informed of this requirement and shall submit the application in a timely manner.

Response: Thank you for the notice concerning the need for a Section 401 Water Quality Certification for the proposed artificial reef. Paul Murakawa and Brian Kanenaka of our staff met with Mr. Edward Chen of the Clean Water Branch on May 3, 2007 to discuss the permit application process. We will continue to coordinate with Mr. Chen as things move forward and will submit the permit application in a timely manner.

General

Comment 2:

We strongly recommend that you review all of the Standard Comments on our website: www.state.hi.us/health/environmental/env-planning/landuse/landuse.html. Any comments specifically applicable to this project should be adhered to.

Response: We have reviewed all of the Standard Comments on your website and will adhere to those which are specifically applicable to this project.

Thank you again for your comments. If you have any further questions concerning the project, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

DAN A. POLHEMUS
Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 3RD FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8305 • Fax: (808) 523-4730 • Internet: www.honolulu.gov

#20

MUFI HANNEMANN
MAYOR

MELVIN N. KAKU
DIRECTOR

RICHARD F. TORRES
DEPUTY DIRECTOR

TP3/07-198734R

April 24, 2007

Mr. Paul Murakawa
State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawaii 96813

Dear Mr. Murakawa:

Subject: Kalaeloa Artificial Reef

Thank you for your letter dated March 6, 2007, requesting our review of and comments on the draft environmental impact statement for the subject project. We do not have any comments on the document.

Should you have any questions regarding this matter, please contact Ms. Faith Miyamoto of the Transportation Planning Division at 768-8350.

Sincerely,

MELVIN N. KAKU
Director

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATIONAND RESOURCESENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

April 26, 2007

Mr. Melvin N. Kaku, Director
Department of Transportation Services
City & County of Honolulu
650 South King Street, 3rd Floor
Honolulu, Hawai'i 96813

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Kaku:

Thank you for your April 24, 2007 letter (your reference TP3/07-198734R) concerning the State Division of Aquatic Resources' proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and preparing your letter.

We understand your Department has no comments to offer on the project at this time. Should you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus, Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc. ✓
Office of Environmental Quality Control

LINDA LINGLE
GOVERNOR OF HAWAII

#21

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR - LAND

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

May 1, 2007

Mr. Paul Murakama
State Division of Aquatic Resources
Department of Land and Natural Resources
1151 Punchbowl Street, Room 330
Honolulu, HI 96813

LOG NO: 2007.0910
DOC NO: 0704amj01
Archaeology

Dear Mr. Murakama:

SUBJECT: Chapter 6E-42 Historic Preservation Review –
Draft EIS Kalaeloa Artificial Reef
Offshore, 'Ewa District, Island of O'ahu
TMK: Not Applicable (State Waters)

Thank you for submitting the aforementioned document, which we received on March 8, 2007. We apologize for the short delay in responding. The proposed project for which you will be seeking a Conservation Use District Permit is the construction of an artificial reef on the seabed offshore Kalaeloa.

According to the Draft EIS (p. 3-19), "[t]he marine biological survey of the proposed site presented in Appendix C noted no evidence of shipwrecks or other human evidence that might be considered historically significant. In addition, high resolution (100 kHz) side-scan sonar conducted at the proposed site for the project by University of Hawai'i scientists…revealed only one feature (located at a depth of 100 feet…) that exhibits some significant vertical extent." We recommend that this feature be investigated by divers, and that the results be included in the Final EIS. Alternatively, if this object was physically investigated by divers, please include their observations in the Final EIS. Without additional investigation/clarification of what this feature is, we cannot issue a determination of effect for this project.

We look forward to reviewing the Final EIS.

Please contact me at (808) 692-8015 if you have any questions or concerns regarding this letter.

Aloha,

Melanie Chinen, Administrator
State Historic Preservation Division

amj:

LINDA LINGLE
GOVERNOR OF HAWAII

ALLAN A. SMITH
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
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STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

May 7, 2007

Ms. Melanie Chinen, Administrator
State Historic Preservation Division
Department of Land and Natural Resources
601 Kamokila Blvd, Room 555
Kapolei, Hawai'i 96707

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O'ahu, Hawai'i

Dear Ms. Chinen:

Thank you for your May 1, 2007, letter (your Log No: 2007.0910) concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing and commenting on the *Draft Environmental Impact Statement*. To simplify your review, we have reproduced the text of your comment in *italics* before our response.

Comment:

According to the Draft EIS (p. 3-19), "[t]he marine biological survey of the proposed site presented in Appendix C noted no evidence of shipwrecks or other human evidence that might be considered historically significant. In addition, high resolution (100 kHz) side-scan sonar conducted at the proposed site for the project by University of Hawai'i scientists... revealed only one feature (located at a depth of 100 feet...) that exhibits some significant vertical extent." We recommend that this feature be investigated by divers, and that the results be included in the Final EIS. Alternatively, if this object was physically investigated by divers, please include their observations in the Final EIS. Without additional investigation/clarification of what this feature is, we cannot issue a determination of effect for this project.

Response: As stated in the *DEIS*, DAR will conduct site-specific surveys prior to deploying each increment of artificial reef. This is to ensure that deployment occurs only on barren substrate and will not impact existing corals or underwater features that may be present. If and when artificial reef deployment is planned in the vicinity of the above-mentioned feature, divers will be deployed to the area to investigate it and other aspects of the bottom type and biota. In the event that possible historic or archaeological resources are encountered during any of the pre-deployment surveys, DAR will photograph and document them and will notify SHPD immediately.

If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

DAN A. POLHEMUS
Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control

#22

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

TAKE PRIDE IN AMERICA

MAY - 7 2007

In Reply Refer To:
12200-2007-FA-0051

Paul Murakawa
State of Hawaii, Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, HI 96813

Subject: Draft Environmental Impact Statement for the Kalaeloa Artificial Reef, Oahu, Hawaii

Dear Mr. Murakawa:

The U.S. Fish and Wildlife Service (Service) has reviewed the Draft Environmental Impact Statement (DEIS) for the Kalealoa Artificial Reef and we are providing the following comments for your consideration. The proposed project is sponsored by the Hawaii Department of Land and Natural Resources. A U.S. Clean Water Act permit from the U.S. Army Corps of Engineers will be required in order to construct the artificial reefs at this site. The proposed designation would establish a 224-acre area for the creation of multiple artificial reef structures on the southwest coastline of Oahu. The benthic marine habitat at the proposed artificial reef area has low coral cover (less than 5 percent) and fish communities are relatively diverse. Currently, the area has limited use due to its location and depth. However, the establishment of the artificial reef area and the opening of the Ocean Pointe Marina will increase recreational boat use as well as enhance recreational opportunities for fishing and diving in the area.

General Comments:

In general, the Service discourages placement of artificial material in the marine environment in areas that support coral growth. However, since the proposed project aims to create substrate for coral recruitment as well as habitat for reef fishes and marine invertebrates, we would support the project as long as it is designed to avoid or reduce impacts to existing marine resources to the greatest extent possible.

We recommend that DLNR confirm that the placement of the concrete structures and mooring buoys to construct the artificial reefs will be implemented in ways that cause minimal negative impact to the reef substrate and biota. We recommend that applicable standard Best Management Practices protective of fish and wildlife resources (enclosed) be implemented. We

also recommend that user conflicts that may arise from increased use of the area after the project is completed be addressed through State regulation of the underwater installation. Provided that these measures are incorporated into the project, we would agree that the proposed action should not result in significant adverse impacts to fish and wildlife resources at the site.

Specific Comments:

Section 2.2.2 (page 2-3) Full reef build-out: The current DEIS includes only the designation of the site and the construction of the first increment of the project. Impacts of subsequent increments to the site are not addressed and, therefore, should require a formal assessment when they are proposed in the future.

Section 3.7 (page 3-19) Enforcement: Recreational boat use and anchoring on the seafloor in the artificial reef area is expected to increase with the opening of the nearby Ocean Pointe Marina in 2009 and with the establishment and success of the artificial reefs. We recommend that DLNR place restrictions on use of the area, prohibit bottom anchoring at the site, and designate personnel to enforce these rules.

Section 3.13 (page 3-20) Mooring buoy and anchor installation: Impacts from mooring buoys and associated anchors are not mentioned. We recommend that an analysis of impacts anticipated to result from the estimated number of permanent mooring buoys to be placed at various locations within the site be included in the final analysis.

Anchor material and type for buoys: We recommend that the applicant use a permanent anchor system that can withstand even the largest swells expected at the Kalaeloa artificial reef. Manta Ray® anchors may have a lower impact on the marine environment than larger concrete blocks, which could damage coral reef habitat as they are dragged across the ocean floor. Use of concrete blocks to anchor the buoys in depths greater than 100 feet could be considered if only minimal impact to benthic substrate is anticipated.

Anchor placement: The DLNR should ensure that no corals or other benthic marine life in the area will be harmed during the placement of all proposed mooring buoys and anchors.

Maintenance: We recommend that a regularly scheduled buoy maintenance program be established in order to minimize the likelihood that an anchor line would break free and damage the marine environment as the free end whips around on the ocean floor.

Section 4.3.1 (page 4-5) Reef module manufacture: The concrete used in the manufacture of reef modules for the project should be clean enough to have low or no potential to adversely impact water quality.

Section 4.6.2 (page 4-8) Monitoring of artificial reefs: A monitoring program should be established that would include each artificial reef installation, tracking factors such as succession and settlement of organisms and reef fish diversity, density and biomass. Data collected will serve as biological support for the future installation of additional artificial reefs to the designated area.

The Service appreciates the opportunity to review the DEIS for the Kalealoa Artificial Reef project. We request that the foregoing comments be addressed in the final EIS. If you have questions regarding these comments, please contact Coral Reef Intern Nadiera C. Sukhraj at 808/792-9410.

Sincerely,

for Patrick Leonard
Field Supervisor

Enclosure

cc: Dan Polhemus, HDAR, Honolulu
Dennis Lau, CWB, Honolulu
Charles Morgan, PSI, Honolulu

US Fish and Wildlife Service
Recommended Standard Best Management Practices

The Fish and Wildlife Service recommends that the following measures be incorporated into projects to minimize the degradation of water quality and impacts to fish and wildlife resources:

a. Turbidity and siltation from project-related work shall be minimized and contained to within the vicinity of the site through the appropriate use of effective silt containment devices and the curtailment of work during adverse tidal and weather conditions;

b. dredging/filling in the marine environment shall be scheduled to avoid coral spawning and recruitment periods;

c. dredging and filling in the marine/aquatic environment shall be designed to avoid or minimize the loss special aquatic site habitat (coral reefs, wetlands etc.) and the unavoidable loss of such habitat shall be compensated for;

d. all project-related materials and equipment (dredges, barges, backhoes etc) to be placed in the water shall be cleaned of pollutants prior to use;

e. no project-related materials (fill, revetment rock, pipe etc.) should be stockpiled in the water (intertidal zones, reef flats, stream channels, wetlands etc.);

f. all debris removed from the marine/aquatic environment shall be disposed of at an approved upland or ocean dumping site;

g. no contamination (trash or debris disposal, alien species introductions etc.) of adjacent marine/aquatic environments (reef flats, channels, open ocean, stream channels, wetlands etc.) shall result from project-related activities;

h. fueling of project-related vehicles and equipment should take place away from the water and a contingency plan to control petroleum products accidentally spilled during the project shall be developed. Absorbent pads and containment booms shall be stored on-site, if appropriate, to facilitate the clean-up of accidental petroleum releases;

i. any under-layer fills used in the project shall be protected from erosion with stones (or core-loc units) as soon after placement as practicable; and

j. any soil exposed near water as part of the project shall be protected from erosion (with plastic sheeting, filter fabric etc.) after exposure and stabilized as soon as practicable (with vegetation matting, hydroseeding etc.).

The Fish and Wildlife Service believes that incorporation of these measures into projects will greatly minimize the potential for project-related adverse impacts to fish and wildlife resources.

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

ALLAN A. SMITH
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR

PETER T. YOUNG
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

May 17, 2007

Mr. Patrick Leonard, Field Supervisor
United States Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawai'i 96850

Subject: Draft Environmental Impact Statement: Kalaeloa Artificial Reef, 'Ewa District, O`ahu, Hawai'i

Dear Mr. Leonard:

Thank you for your May 7, 2007 letter (your reference 12200-2007-FA-0051) concerning the State Division of Aquatic Resources' (DAR's) proposed Kalaeloa Artificial Reef project. We appreciate the time you and your staff spent reviewing the *Draft Environmental Impact Statement* and providing written comments. Item-by-item responses to your comments are provided below. To simplify your examination, we have reproduced the text of your comments in *italics* before each response.

General Comments

In general, the Service discourages placement of artificial material in the marine environment in areas that support coral growth. However, since the proposed project aims to create substrate for coral recruitment as well as habitat for reef fishes and marine invertebrates, we would support the project as long as it is designed to avoid or reduce impacts to existing marine resources to the greatest extent possible.

We recommend that DLNR confirm that the placement of the concrete structures and mooring buoys to construct the artificial reefs will be implemented in ways that cause minimal negative impact to the reef substrate and biota. We recommend that applicable standard Best Management Practices protective of fish and wildlife resources (enclosed) be implemented. We also recommend that user conflicts that may arise from increased use of the area after the project is completed be addressed through State regulation of the underwater installation. Provided that these measures are incorporated into the project, we would agree that the proposed action should not result in significant adverse impacts to fish and wildlife resources at the site.

Response:

The impact analysis presented in the *Draft EIS* confirms that the placement of the concrete structures and mooring buoys will cause minimal negative impact to the reef substrate and biota. DAR will also implement Best Management Practices when constructing this artificial reef and may minimize the user conflicts through State regulations.

Specific Comments

Comment 1:

Section 2.2.2 (page 2-3) Full reef build-out: The current DEIS includes only the designation of the site and the construction of the first increment of the project. Impacts of subsequent increments to the site are not addressed and, therefore, should require a formal assessment when they are proposed in the future.

Response:

The impact analysis included in Chapter 4 of the *Draft EIS* does evaluate the impacts of the preliminary design for full buildout of the reef. However, since buildout will occur over a period of 10-20 years and the proposed materials and design may change subject to advances in technology and research, DAR will obtain the appropriate approvals for subsequent reef increments from the Department of the Army, State Department of Health and other government agencies.

Comment 2:

Section 3.7 (page 3-19) Enforcement: Recreational boat use and anchoring on the seafloor in the artificial reef area is expected to increase with the opening of the nearby Ocean Pointe Marina in 2009 and with the establishment and success of the artificial reefs. We recommend that DLNR place restrictions on use of the area, prohibit bottom anchoring at the site, and designate personnel to enforce these rules.

Response:

The main objective of DAR's artificial reef program is to increase fishing opportunities for recreational fishermen. However, if the new reef becomes too popular and user conflicts become a problem, DAR/DLNR can place restrictions on use of the area. DAR also has an agreement with the Navy that DAR will install mooring balls and that anchoring will be prohibited. It should be noted that the Division of Conservation and Resource Enforcement (DOCARE) within DLNR handles the enforcement arm of DAR's regulations and only DLNR's chairman is able to designate personnel from DOCARE to enforce these rules.

Comment 3:

Section 313 (page 3-20) Mooring buoy and anchor installation: Impacts from mooring buoys and associated anchors are not mentioned. We recommend that an analysis of impacts anticipated to result from the estimated number of permanent mooring buoys to be placed at various locations within the site be included in the final analysis.

Response:

DAR plans to install subsurface buoys attached directly to concrete modules weighing in excess of 5,000 pounds each. Pre-construction surveys will be conducted to ensure that these modules will be deployed only on seafloor that is devoid of coral and benthic marine life. Deployment will occur using the same methodology as planned for the Z-blocks comprising the reef. Consequently, DAR anticipates minimal impacts from installation of the mooring buoys and associated anchors. The FEIS has been updated to include this information.

Comment 4:

Anchor material and type for buoys: We recommend that the applicant use a permanent anchor system that can withstand even the largest swells expected at the Kalaeloa artificial reef Manta Ray® anchors may have a lower impact on the marine environment than larger concrete blocks, which could damage coral reef habitat as they are dragged across the ocean floor. Use of concrete blocks to anchor the buoys in depths greater than 100 feet could be considered if only minimal impact to benthic substrate is anticipated.

Response:

Please see response to comment 3.

Comment 5:

Anchor placement: The DLNR should ensure that no corals or other benthic marine life in the area will be harmed during the placement of all proposed mooring buoys and anchors.

Response:

Please see response to comment 3.

Comment 6:

Maintenance: We recommend that a regularly scheduled buoy maintenance program be established in order to minimize the likelihood that an anchor line would break free and damage the marine environment as the free end whips around on the ocean floor.

Response:

The mooring buoys will be inspected and maintained as needed during the periodic monitoring of the reef's marine life.

Comment 7:

Section 4.3.1 (page 4-5) Reef module manufacture: The concrete used in the manufacture of reef modules for the project should be clean enough to have low or no potential to adversely impact water quality.

Response:

The concrete used to manufacture the reef modules is donated from extra amounts left over from completed pours. It is very clean and will have little to no impact on water quality. The reef modules are cured for a minimum of four months before deployed, however most modules are over a year old before being deployed.

Comment 8:

Section 4.6.2 (page 4-8) Monitoring of artificial reefs: A monitoring program should be established that would include each artificial reef installation, tracking factors such as succession and settlement of organisms and reef fish diversity, density and biomass. Data collected will serve as biological support for the future installation of additional artificial reefs to the designated area.

Response:

DAR currently has a monitoring program in place for its artificial reefs. DAR surveys its artificial reefs periodically to obtain information on fish abundance and diversity. These surveys date back to when the artificial reef program was established. DAR has plans to monitor the proposed Kalaeloa artificial reef in

the same manner as previous artificial reef locations (initially more frequent surveys may be conducted as part of a proposed project to document colonization of the new artificial reef).

Thank you again for your comments. If you have any further questions, please call Paul Murakawa at (808) 587-5404, or our environmental consultant, Dr. Charles Morgan of Planning Solutions, Inc. at (808) 550-4483.

Sincerely,

Dan Polhemus
Administrator

cc: Sam Lemmo, OCCL
Dr. Charles Morgan, Planning Solutions, Inc.
Office of Environmental Quality Control