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REF:BOR:ME/vmk

June 10, 1999

MEMORANDUM

TO: Genevieve Salmonson, Director
Office of Environmental Quality Control

FROM: Timothy E. Johns
Chairperson

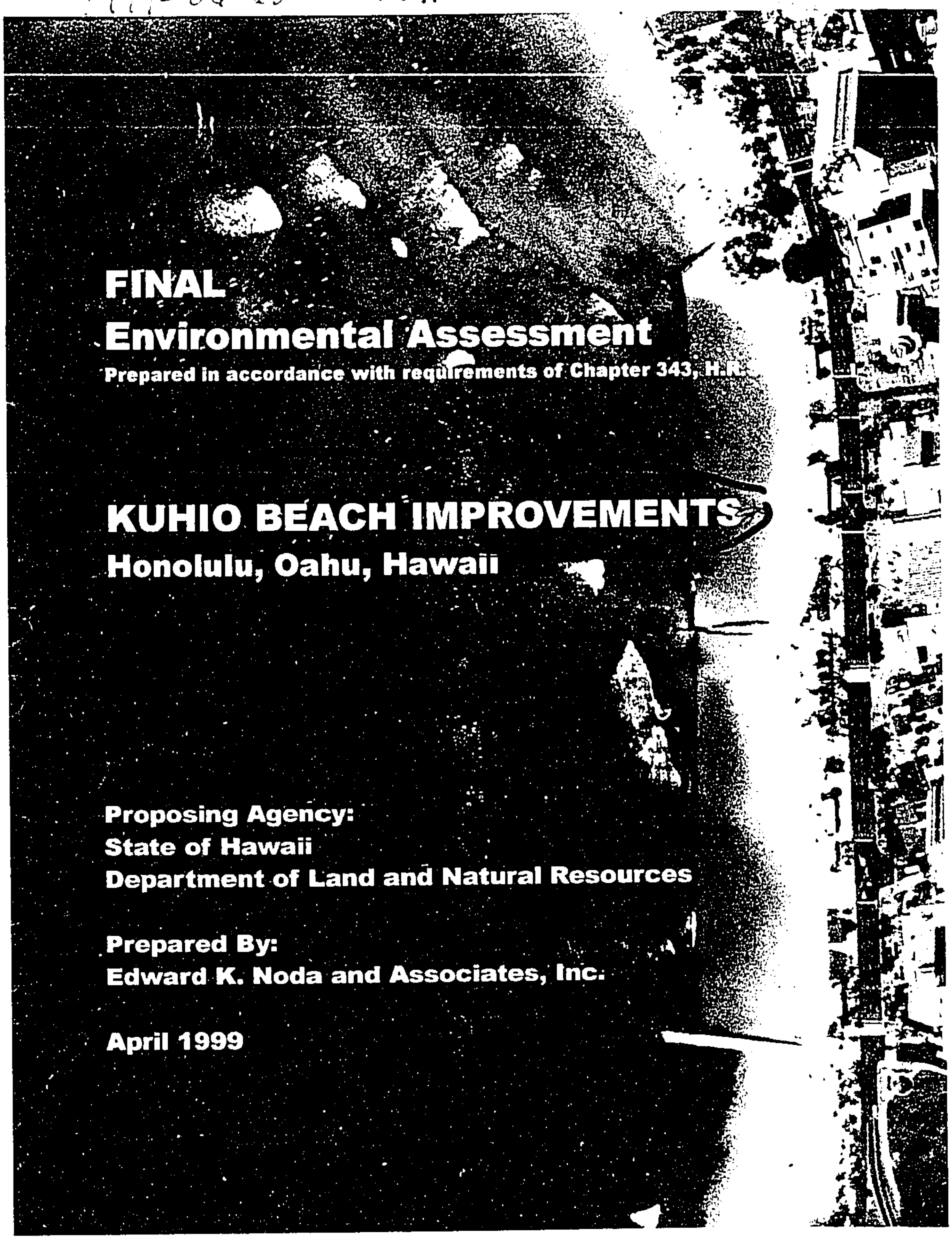
SUBJECT: FINDING OF NO SIGNIFICANT IMPACT (FONSI) FOR KUHIO BEACH IMPROVEMENTS, TMK: (1) 2-6-01, WAIKIKI, OAHU, HAWAII

Having reviewed the comments received on the draft environmental assessment during the 30-day public comment period which began on February 8, 1999, the Department of Land and Natural Resources has determined that this project will have no significant environmental effect and with this letter, issues a finding of no significant impact (FONSI). We request that you publish notice of this determination in the June 23, 1999, issue of the OEQC Environmental Notice.

We have enclosed a completed OEQC Publication Form and four (4) copies of the final EA. Should you have any questions, please call Manuel Emiliano of our Boating and Ocean Recreation Division at 587-0122, or our Consultant, Elaine Tamaye, of Edward K. Noda Associates, at 591-8553.

Enclosures: Final EA (four copies)
OEQC Publication Form

c: Edward K. Noda Associates (E. Tamaye)
Andrew Monden, DLNR-LD-Engr Br
Eric Yuasa, DLNR-LD-Engr Br
Hiram Young, DLNR-LD-Engr Br
Steve Thompson, BOR-O
David Parsons, BOR-SP



FINAL

Environmental Assessment

Prepared in accordance with requirements of Chapter 343, H.R.S.

KUHIO BEACH IMPROVEMENTS

Honolulu, Oahu, Hawaii

Proposing Agency:
State of Hawaii
Department of Land and Natural Resources

Prepared By:
Edward K. Noda and Associates, Inc.

April 1999

Kūhiō Beach Improvements

Waikiki Beach Improvement Project
Honolulu, Oahu, Hawaii
TMK: 2-6-01:19

FINAL ENVIRONMENTAL ASSESSMENT

Proposing Agency: STATE OF HAWAII
Department of Land and Natural Resources
Division of Boating and Ocean Recreation
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

Responsible Official:________________ Date: JUN - 7 1999

Prepared by: Edward K. Noda and Associates, Inc.
615 Piikoi Street, Suite 300
Honolulu, Hawaii 96814

April 1999

This document is prepared pursuant to Chapter 343, H.R.S. and the Administrative Rules, Title 11, Chapter 200, of the Hawaii Department of Health.

Kūhiō Beach Improvements: Summary Sheet

Project: The project involves reconstruction of the offshore crib wall system and restoration and improvement of the beach. Three sections of the crib wall will be reconstructed as breakwater segments using basalt stones in a rubble mound construction, similar to the wall segments that currently exist at the Ewa end of Kūhiō Beach. There will be gaps between the breakwater segments between 200 and 250 feet wide. The dry beach will be replenished from an existing area of about one (1) acre to a new beach area of about 2.5 acres.

The rubble mound construction of the breakwater segments will reduce wave overtopping and wave reflection because of the energy-absorbing nature of the rock slope – these features will contribute to a more stable beach in the future. The structures will not extend significantly seaward of the existing offshore walls, and will not impact the offshore surf sites.

The restored and improved beach will have a top-of-beach elevation of +6 feet MLLW, which is the approximate elevation of the existing dry beach area at the Ewa end near the banyan tree. The goal of the project is to maintain a dry beach width along the entire Kūhiō Beach shoreline. Sand from within the crib-wall cells will be reconfigured to restore the beach and additional sand will be pumped from nearby offshore locations.

The project will be constructed in phases over a six month period so that portions of Kūhiō Beach will usually be open and available for recreational use. Coordination has been underway with the City and if possible, work will be coincidentally with the City's Kūhiō Beach Park improvements. Overall, the project will have a beneficial impact to Waikiki's shoreline by providing additional beach area and a more inviting ocean interface for beach-goers or sight-seers.

Location	Honolulu, O'ahu, Hawai'i, City and County of Honolulu,:
Tax Map Key	2-6-01:19
Project Site	8 Acres total area; about 2.5 acres beach area & 5.5 acres water area
State Land Use District & Zoning	Conservation Land Use District; No County Zoning
Ownership	State of Hawaii
Approving Agency	Department of Land and Natural Resources, State of Hawaii, 1151 Punchbowl Street, Honolulu, Hawai'i 96813
Proposing Agency	Department of Land & Natural Resources, Division of Boating & Ocean Recreation, 333 Queen Street, Suite 300, Honolulu, Hawai'i 96813
Consultant	Edward K. Noda and Assoc., Ms. Elaine Tamaye, 615 Piikoi St., Suite 300; Honolulu, Hawai'i 96814; Telephone: (808) 591-8553 ext. 204
Associated Consultant	Eugene P. Dashiell, AICP, Environmental Planning, 1314 South King St., Suite 951; Honolulu, Hawai'i 96814; Telephone: (808) 593-8330; E-mail, **dashiell@lava.net**; URL, **www.lava.net/environmental-planning**
Required Permits and Approvals	U. S. Dept. of the Army Permit; Conservation District Use Permit (State Dept. of Land & Natural Resources); Section 401 Water Quality Certification (State Dept. of Health); Coastal Zone Consistency Declaration (State Dept. Business, Economic Development & Tourism)

Contents

Page

References

Exhibits

All Follow Page 33

Appendices

A Kūhiō Beach Physical Model Test, Phase 2

B Numerical Modeling Analysis of Kūhiō Beach Improvements

C Baseline Surveys of Nearshore Water Quality and Coral Reef Communities at Waikiki, Oahu, Hawaii

D Kuhio Beach Park Expansion & Kalakaua Avenue Promenade, Final Environmental Assessment

E Comments and Responses Regarding the Draft Environmental Assessment

1 Description of the Proposed Action

1.1 **Technical characteristics.** This section describes the location and purpose of the project and how it would be accomplished.

1.1.1 **Project background.** The State of Hawaii, Department of Land and Natural Resources, proposes to construct improvements to Kūhiō Beach, located along the central portion of Waikiki Beach. The proposed improvements involve restoration and widening of the beach area located within the offshore crib wall system, and reconstruction of the offshore walls to make it safer and to improve the stability of the beach.

The proposed Kūhiō Beach improvements are part of the overall Waikiki Beach Improvement Project, which was a study effort initiated in the early 1990s by the State of Hawaii, Department of Transportation. The Waikiki Beach Improvement Project was a major study effort to evaluate the problems of maintaining and improving Waikiki Beach, from Fort DeRussy to the Waikiki Aquarium. In order to design appropriate beach improvement plans, a detailed program of oceanographic, coastal engineering, and offshore sand source studies was undertaken together with environmental and economic feasibility evaluations. As a result of the technical studies conducted and input provided by various governmental, civic, special interest groups and the general public, a range of improvement options were developed for specific sectors of Waikiki Beach. These options included plans for beach nourishment, alternative structural measures for stabilizing new beach areas and improving the stability of certain existing beach areas, potential sources of sand for beach nourishment, and construction options for beach nourishment. The major recommended beach improvements were between the Fort DeRussy groin and the Royal Hawaiian groin (directly fronting the Outrigger Reef, Halekulani, Sheraton and Royal Hawaiian Hotels). However, because of the problem in resolving the "littoral rights" issue relating to ownership of certain beach areas fronting the hotels, focus was placed on the Kuhio Beach sector. The proposed improvements to the Kūhiō Beach sector of greater Waikiki Beach is the culmination of these prior study efforts and more recent studies conducted to verify the expected performance of the reconstructed offshore walls in stabilizing the improved beach area.

1.1.2 **Location and purpose of the project.** The Kūhiō Beach project site is located along the central portion of Waikiki Beach, extending from the Kapahulu Storm Drain northward for about 1,500 feet (Exhibit 1). The project limits are defined by the offshore crib wall system, consisting of low rock and concrete walls surrounding the beach area seaward of the existing seawalls that protect Kalakaua Avenue (Exhibit 2).

The present configuration of the offshore crib wall system poses several problems, which will be remedied by the proposed improvements. The three primary objectives of the project are:

(1) Improve the stability of the beach. Starting in the late 1930s, the offshore crib wall system was begun to create a beach where virtually no dry beach area existed because of the construction of Kalakaua Avenue and its retaining seawall. The present crib wall system was completed by the early 1950s, but it has not been entirely effective in protecting the beach from erosion. The beach has required periodic re-shaping and re-nourishment, the last sand nourishment

being done in late 1991. Improvements need to protect the beach from continuing erosion.

(2) Remove the public safety hazards. Because the crib walls are low, wave overtopping creates a hazard to people who ignore the posted warnings and walk on the slippery wall. The gaps between the walls are too few and too narrow, resulting in strong seaward-flowing currents through the openings when waves overtop the wall. This current scours deep holes in the sand bottom near the openings, and are dangerous to unsuspecting bathers. Improvements need to be properly designed to remove these hazards and prevent other potential hazards.

(3) Improve water quality within the basins. The existing water quality within the basins is poor, particularly in the Diamond Head basin. The narrow openings that were intended to allow flushing of the water in the basins are not adequate, and instead have caused safety problems. Improvements need to provide sufficient circulation and flushing of waters within the basins.

1.1.3 **Description of the project**. The proposed project involves reconstruction of the offshore crib wall system and restoration and improvement of the beach area. Exhibit 3 depicts the plan of improvement, and Exhibit 4 shows a photographic rendering of the proposed project. Three sections of the wall will be reconstructed as breakwater segments using basalt stones in a rubble mound construction, similar to the wall segments that currently exist at the Ewa end of Kūhiō Beach. Existing wall sections between the reconstructed breakwater segments will be removed to elevation -2 feet MLLW, which is the approximate depth of the seaward fronting reef. These gaps between the breakwater segments will be between 200 and 250 feet wide. The area of dry beach will more than double, from an existing area of a little over 1 acre to a new beach area of about 2.5 acres.

The rubble mound construction of the breakwater segments will reduce wave overtopping and wave reflection because of the energy-absorbing nature of the rock slope. Exhibit 5 shows typical sections for the breakwater segments. The crest elevation of the breakwater segments is +5 feet MLLW, which is only about 2 feet higher than much of the existing crib wall system. The armor stones are 1,000-1,600 pound stones, sized to remain stable under storm wave attack. The breakwater segments will sustain some wave overtopping during high surf, but wave energy transmission over the top of the structure will be much less than currently occurs. By raising the crest elevation and reducing wave overtopping, much wider dry beach areas can be stabilized in the lee of the breakwater segments. Wave energy entering the wide gaps between the breakwater segments will form a diffraction pattern behind the breakwater heads, helping to stabilize crescent-shaped beaches in each basin. The waves entering the wide gaps will also help to maintain the beach slope. At present, sand migrates off the dry beach area into the water area under constant foot traffic, and there is insufficient swell wave energy to transport sand back onto the beach slope. The consistency of the wave pattern through the breakwater gaps will help to maintain the stable beach configuration.

The restored and improved beach will have a top-of-beach elevation of +6 feet MLLW, which is the approximate elevation of the existing dry beach area at the Ewa end near the banyan tree. The goal of the project is to maintain a dry beach width along the entire Kūhiō Beach shoreline. The average beach slope will be constructed initially at 1V:10H, but the beach slope will be expected to vary in response to the seasonal wave types. The existing sand contained within the crib wall system will be used to re-shape the beach slope and additional sand will be placed to achieve the final beach configuration. The toe of the finished beach will be at elevation -4 feet MLLW, which is the existing dredged depth of the reef within the confines of the existing crib wall system.

The breakwater segments will be constructed along the existing alignment of the crib walls. The footprint will necessarily be wider than the existing walls because of the increased height and side slopes. However, the structures will not extend significantly seaward of the existing offshore walls, and will not impact the offshore surf sites as demonstrated in the Exhibit 4 photographic rendering.

Extensive coastal engineering analysis has been performed to date to confirm the conceptual design and performance of the proposed improvements. A 15-month offshore wave measurement program provided comprehensive data on the seasonal wave characteristics. Wave refraction analysis was performed to evaluate the near-shore wave transformation effects and littoral processes. Aerial photographic analysis also confirmed the historical beach and shoreline changes and the wave approach patterns at the shoreline. Physical model testing of the proposed plan was conducted at a scale of 1:40 (model to prototype) to evaluate the overall effectiveness of the recommended plan compared to existing conditions, with respect to improving water quality and circulation within the basins, improving beach stability, and minimizing impacts to offshore surf sites. A second physical model study was conducted at a scale of 1:20 to evaluate the structural stability of the breakwater design, the wave runup and overtopping characteristics of the breakwater, and the planform behavior of the beach protected by the segmented breakwater system. Numerical modeling analysis was also performed to obtain more detailed data on the design performance of the beach. Technical reports of the latter two most recent study efforts are appended to this Environmental Assessment.

1.1.4 **How the project will be accomplished.** The construction activities will involve beach restoration and enhancement, demolition of the existing offshore crib wall system, and construction of the breakwater segments. Each of these activities is described below.

Beach restoration and enhancement: The proposed project will more than double the dry beach area. The existing sand contained within the crib wall enclosure will be graded to restore the beach, using a crawler shovel to excavate the sand from the water areas and replace it on the beach slope. Additional sand will be added to the beach to achieve the final beach configuration. Although the total quantity of additional sand required will depend on the results of confirmation surveys to determine the existing sand quantity within the basins, it is presently estimated that approximately 10,000-20,000 cubic yards of additional sand may be required to achieve the desired beach configuration. The sand sources are both land-based and offshore. Large pockets of sand are located directly offshore Kūhiō Beach, within about 2,000 feet from shore. The shallow sand deposits are suitable for beach nourishment. The sand is relatively coarse because the deposits are constantly worked by swell wave energy and hence the sand grains are well sorted. In light of the high friction factor of the material and the pumping distance involved, the most practical method would be to use a 10" to 12" portable dredge and PVC pipe to transport the sand to shore. Production will be low as the sand layer is only 2-3 feet thick and will result in the dredge having to move over a wide area. At an estimated production rate of about 500 cubic yards per day, it will take about 20 working days to pump 10,000 cubic yards of sand. Land-based sources of sand are typically from inland excavation sites in former dunes. However, most of these inland sources on Oahu are located on the north shore, and trucking costs may be high. Land-based sand sources also generally have a higher percentage of fine silts, and are less desirable for beach nourishment purposes unless the sand is pre-washed or pre-screened. Crushed limestone sand is not a recommended source of sand for beach nourishment, except for use as a base course under the widened beach berm, say beneath the upper 4 feet or so of dry sand thickness.

Demolition of existing crib walls: The existing offshore walls will be demolished and removed using a crane and loader. The quantity of materials to be removed is estimated to be about 300 cubic yards of concrete rubble and about 500 cubic yards of rock material. Some of the rock material may be reused in the new breakwater construction.

Construction of breakwater segments: This is a standard operation with small armor stones and will be performed with a crane and loader. The quantity of rock required for this phase of the work should only result in about 5 truck loads of rock to be delivered to the site per day and should not overload the local traffic conditions. An estimated 2,400± cubic yards of rock will be required for each of the breakwater segments. Total duration of construction is approximately 6 months.

Schedule: Phasing of the construction will be performed to the extent possible in order to minimize the area of beach that will be closed due to the construction activities. Because all work will be conducted seaward of the existing seawalls, only the beach and water areas within the existing crib wall system will be closed to the public during construction. Public access along the sidewalk promenade and Kalakaua Avenue would not be impacted.

It may be possible to perform some of the beach restoration work in conjunction with the City and County of Honolulu's planned Kalakaua Avenue Promenade and Kūhiō Beach Park Expansion project. The landside improvements proposed by the City are described in their Final Environmental Assessment for the project, which is appended to this EA. Construction funding for the City's project is currently available, but construction funds are not yet available for the State's breakwater and beach improvements. However, design funds already appropriated for the beach improvements may possibly be used to do a demonstration sand pumping effort, using the sand deposits offshore Kūhiō Beach. Sand would be pumped into the Diamond Head basin, which is an ideal containment for the discharged slurry. Sand would then be moved and distributed between the two basins using a loader/backhoe. Although only a limited quantity of sand could be delivered to the beach under this demonstration project, and the offshore crib walls would not be reconstructed until a later date (perhaps a year or two later), any beach restoration effort performed in conjunction with the City's construction work would minimize the construction impacts associated with the State's Kūhiō Beach improvements.

1.2. **Socio-economic characteristics.** This section discusses the impacts of the proposed project on the community in terms of both social and economic effects.

1.2.1 **Economic impacts on the community at large.** This project will have a beneficial economic impact on the community at large because it will reduce the overall costs to the State of maintaining sand at Kūhiō Beach by providing a more stable beach system so that sand which is placed along Kūhiō Beach will stay in place for a longer period of time than has happened with sand replenishment actions in the past. No adverse economic impacts are projected.

The project will add to the available inventory of beach area which is consistent with the objectives of economic revitalization.

1.2.2 **Provision of income for the county or state and creation of employment opportunities in areas with high unemployment rates.** The project provides benefits through jobs related to its implementation. This is beneficial at this time of economic recession in Hawaii.

1.2.3 **Targeted segment of the population.** No specific segment of the population is targeted because this project has general public benefit.

1.2.4 **Population density.** The project has no effect on population density.

1.2.5 **Recreational facilities.** The project benefits beach-goers by improving the quality and quantity of beach at the public Kūhiō Beach Park. Water quality within the crib wall (which at times is not the best), will be improved because of improved circulation. There will be some reduction of hazards to swimmers and waders because the replacement of the "slippery wall" with the sloped rock segmented breakwaters will remove the narrow openings in the slippery wall which were originally constructed to provide circulation into the protected water area. These narrow openings increase the velocity of ocean water passing through the gaps causing the scouring of holes in the sand bottom. Swimmers or waders can step in these holes and find themselves in unexpectedly deep water. Small children can also be caught in the gaps. The "slippery wall" itself is a hazard because people walk out on it and can easily slip due to the texture of the worn smooth concrete covered with algae and water. However it is not clear that the proposed rock structure will significantly improve this situation which can only be remedied if people can be kept off of the offshore structures entirely.

Access to assist disabled or other challenged persons is proposed to be constructed over the existing center groin in the project. The conceptual design provides for a wheel chair ramp, extending along the top of the groin and into the water near the offshore breakwater. The ramp access into the water may include rails if necessary. A ramp into the beach will also be included in this access.

One potential effect of the proposed project is that surfers or body surfers may be attracted to the beaches which will be protected by the detached breakwater because they will be easily able to swim or paddle right through the large gaps directly into the ocean. Some additional mixing (an increase over existing mixing) of surfers and bathers or beach-goers may occur. Such mixing would seem to be similar in interaction to that which occurs in other locations along Waikiki's beaches, and in crowded beach parks such as Ala Moana where surfers are constantly crossing beaches and paddling through swimming lanes to the outer reefs and surf.

Surfing and surf sites in the vicinity of the project will not be adversely affected because the proposed project follows the alignment of the existing crib walls. During meetings held with a technical advisory group, the public, and including surfing interests, concerns were expressed that the project not adversely impact surfing. To meet this requirement, the project design maintains the alignment of the existing crib wall in order to cause no major intrusions into open water areas. The proposed revetted rock wall functions as a wave absorber which significantly reduces wave reflection off the front of the wall, and also off the backside so that conditions in the confined water area will also be more calm, and scouring of the bottom will be reduced.

Concern was expressed at a meeting of the Waikiki Neighborhood Board (December 15, 1998) that the sand replenishment project, although it will increase the beach area, will also reduce the water area behind the protective breakwater. The concern expressed was that this impact could be somewhat adverse in that it may lessen the opportunities for young or frail persons to enjoy an ocean bathing experience in a relative calm condition. It should be noted that this concern is based on present-day observations of the beach and water areas at Kūhiō Beach where extensive loss of sand has occurred. For example, the beach area just prior to sand replenishment in 1991 was estimated to be about 2.25 acres, but in 1998 that area (even after sand replenishment) has decreased to about 1 acre. The proposed project would replenish sand to create a stabilized beach area of about 2.5 acres, very similar to conditions in 1991. The surface water area will be reduced from present conditions because the overall area behind the crib wall and/or the proposed detached breakwater will remain the same (about 7.8 acres). At present (1998) the water surface area is approximately 6.7 acres. If sand were simply replenished, as has been done in the past, the water surface area would be reduced to less than 5.6 acres which is similar in water surface area to the conditions just prior to the sand replenishment of 1991.

Water surface areas are not directly comparable between the existing conditions and the proposed project condition because the proposed project breakwater will create large open areas which extend the protected water into the open ocean conditions. This mixing area will be relatively calm except during high wave conditions. It may be that if there is some loss of the most protected areas that this will be offset by improved water circulation and water quality.

Surfers will not lose surf sites and may benefit from slightly improved opportunities for access to surf sites from the shore because the removal of the crib walls will permit surfers to paddle directly from the beaches to the surf via the openings in the breakwater.

1.2.6 **Child care provisions.** There are no child care provisions in relation to the proposed project.

1.2.7 **Relocations of residences.** No relocation of residences would occur.

1.2.8 **Costs of the proposed project and economic analysis.** The estimated total cost of construction of the proposed project is $2.0 million, assuming that the construction is performed as a single project and assuming the sand will be obtained from the sand pockets on the reef located directly offshore Kūhiō Beach. The table below summarizes the major cost items.

If the sand source is land based, and assuming hauling distance from the north shore of Oahu, the sand fill cost is estimated at $1,061,000 (unit cost of $53.06 per cubic yard). The total project cost would be $2.4 million.

If the project is undertaken as multiple construction packages because of funding considerations and/or construction phasing, the costs will be higher because of multiple mobilization (mob)/demobilization (demob) costs. For example, it may be possible to do some of the beach restoration work using funds already appropriated for design. However, the unit cost of the sand fill will be much higher because of the smaller quantity of sand to be dredged in relation to the fixed costs for mob/demob. Assuming that approximately $400,000 may be available for the demonstration sand mining effort, only about 8,000 cubic yards of sand can be pumped and spread (unit cost of $50.25 per cubic yard).

Project Cost Estimate

Project Component	Quantity	Unit Cost	Total Cost
Mobilization (General Contractor)	Lump sum	-	$19,000
Sand fill (includes mob./demob. of dredge)	20,000 CY	$36.35	$727,000
Demolition of offshore walls	800 CY	$142.22	$114,000
Breakwater segments (1,000 LF)	12,000 ton	$67.62	$811,000
Wheelchair ramp (at middle groin)	Lump sum	-	$67,000
Site restoration/miscellaneous work	Lump sum	-	$32,000
Total Construction Cost (TCC)			**$1,770,000**
Engineering & Inspection (E&I, 15%)			$266,000
Total Project Cost (TCC + E&I)			**$2,036,000**

1.3 **Environmental characteristics.** This section discusses the potential effects of the proposed project on the physical environment.

1.3.1 **Aesthetics and viewplanes.** The project will result in a widened beach area. There will be little visual impact because the replacement breakwater is only slightly higher (about two feet) than the existing offshore walls, and the replacement breakwater will have less lineal feet and larger open areas which will leave a clear and unobstructed seaward view from many locations on the shore. Exhibit 6 shows where analysis was performed to assess the impact on seaward viewplanes, and Exhibits 7 through 10 show existing views compared to simulated views with the proposed project, from the four locations along the Kūhiō Beach shoreline.

1.3.2 **Air pollution.** There would be some effects during construction and these would be mitigated per county and state rules. There would be no long term effects because the proposed project includes no air pollution sources and would not generate significant differences in traffic from the existing conditions.

1.3.3 **Traffic congestion.** There will be little effect on traffic except during periods when construction materials are delivered to the site. Such traffic will consist of heavy trucks and trailers. They will operate during normal working hours and will follow existing regulations regarding road clean-up (if necessary) resulting from this traffic. The construction of the breakwater is anticipated to generate approximately five truck loads a day for a duration of about 6 months. The proposed route for the truck loads is via Kapahulu Avenue. This is not expected to significantly affect traffic flow within the study area.

1.3.4 **Noise levels.** There will be some increase in noise levels during construction of the project. This will occur during normal working hours. Contractor's equipment is required to meet Department of Health noise regulations.

1.3.5. **Effects on water quality and the marine environment.** There may be some temporary minor adverse effects during construction. Perhaps the most obvious possible effect of the breakwater construction and beach replenishment would be to release small particulate materials into the water column. This could cause increases in turbidity and/or total filterable solids. As described in the report of the biological surveys, however, the distributions and abundances of benthic communities in the Waikiki area are controlled by the presence of suspended and deposited sand. The temporary increase in turbidity that may accompany the crib wall removal and breakwater construction is likely to have little impact on attached organisms.

Poorly-washed sands could release significant quantities of nutrients (nitrate, ammonium, phosphate, silicate, total nitrogen, or total phosphorus). These nutrients could stimulate the growth of macroalgae and/or phytoplankton. Size distribution analyses of sand samples indicate that the existing sand deposits are well sorted and probably undergo constant movement. Such sorting and movement would result in interstitial waters of the sand deposits containing nutrient levels similar to overlying waters. The lack of significant organic material deposition and breakdown in the sand deposits would limit the amount of in situ nutrient generation.

Potential impacts of the proposed crib wall modifications include direct impacts due to the placement of material in areas not presently covered by walls; indirect impacts due to construction activities; and impacts due to alterations in patterns of sand movement.

The proposed alterations to the existing crib walls will entail placement of large boulders or other similar materials on and in front of the wall. The direct impacts of this activity on marine organisms will be minimal, and potentially beneficial rather than negative. The bottom immediately in front of the crib wall is composed of well scoured consolidated reef limestone, areas of coarse limestone rubble, and scattered patches of medium to coarse grained sand. Recent surveys observed only rare coral growth, but often large patches of macroalgae. Few fish were seen. The placement of boulders or other similar material in this area would thus not directly impact any significant biotic community. In fact, the sloping face of the new construction, combined with the irregular nature of the material and the expected spaces between boulders, may provide an increase in habitat for both corals and shallow reef fishes.

Indirect impacts of the placement of building materials for the modified crib walls are expected to be insignificant. Some loose material may cling to the boulders as they are put in place and may wash off under the action of waves, but the amount of this material is likely to be small. The loose material washed off the boulders would constitute only a small fraction of the loose material, primarily fine sand, which is already found in abundance at the site, and would add little to the existing impacts of that material. If the boulders utilized are especially dirt-covered, they could be cleaned by high-pressure water rinsing before being used. Such cleaning would be accomplished offsite.

The impacts of the proposed crib wall modifications on the nearshore benthic communities will not be significant, and may have some positive aspects. The crib wall modifications are designed to minimize the loss of sand from the beach to the nearshore region. Surveys of the biological communities of the area suggest that the movement of sand, either naturally generated on the reef or eroded from the beaches, most affects the distribution and abundance of benthic organisms in the area. Thus, the decrease in sand supplied from the beach could, over a long period, result in an increase in habitat for benthic organisms such as corals. However, the natural processes of sand generation on the reef and movement on and off shore may limit the extent to which such an increase in habitat can occur.

The nearshore marine environments off Waikiki are characterized by sand channels and flat limestone platforms. Benthos occupying the regions of solid substrate are subjected to the scouring action of wave-driven sand. As a result, the richest biotic assemblages occur in the areas where vertical structural relief affords protection from the continually shifting sands. Assessment of the marine communities does not indicate that there currently are impacts from activities on land.

It is probable that at least some of the sand found in the nearshore areas originated on Waikiki beaches during previous beach replenishment projects. It does not appear, however, that there is a quantitative data set describing the biotic structure of the region prior to the initiation of sand replenishment. Without such "baseline" data it is not possible to quantitatively assess the degree of biological change that has already taken place since sand replenishment began at Waikiki.

With regard to future replenishment, it would appear that this activity would not be likely to cause substantial changes relative to the current condition of the reefs. The data from the present assessment reveal that in areas presently subjected to sand scour, biotic composition is severely limited. Thus, it is unlikely that such composition would change even if the proposed sand replenishment results in incrementally more sand movement from the beach through the nearshore region. Similarly, the areas off Waikiki that presently serve as suitable habitats for benthos are so because of vertical relief that mitigates much of the scouring action of sand. Incremental increases in sand movement, or small decreases in sand volume, are not likely to introduce changes that will alter the characteristics of the area in terms of vertical relief.

The replenishment of the Kūhiō beaches with sand pumped from offshore deposits is not expected to result in any obnoxious odors resulting from decaying organic material contained in the sand deposits. Analyses of samples from the deposits (EKNA data) showed little if any material in sizes smaller than 0.125 mm, where fine organic material would be expected to be found. In addition, few if any infaunal organisms were observed in these samples. The well sorted nature of the sand results in little organic material being incorporated into the deposits, and the lack of organic detritus in the sand limits the numbers of infaunal organisms that can be supported.

In summary, it appears that the dominant environmental factor shaping the nearshore benthic and reef fish communities off Waikiki is the movement of sand, much of which originated in large part from prior beach replenishment projects. The proposed sand replenishment is not likely to qualitatively alter these conditions, and hence will probably result in no identifiable changes to biotic structure.

1.3.6 **Other environmental effects.** The site is located in a coastal flood hazard area with base flood elevations of 8 and 9 feet above mean sea level. The restored beach and reconstructed offshore walls will be at lower elevations, and will not significantly affect the base flood elevations. There are no other environmental effects.

2 Description of the Affected Environment

2.1 **Location.** The proposed project is located at Kūhiō Beach Park in Waikiki. Honolulu, Oahu. Tax Map Key: 2-6-01:19.

2.2 **Land ownership and tenancy.** The land is owned by the State of Hawaii and managed (via life guard and cleaning services) by the City and County of Honolulu.

2.3 **County Zoning, State Land Use District.** The proposed project is in a State Conservation District and subject to review and approval under the Conservation District Use Application process by the State Department of Land and Natural Resources, Land Division, Planning Branch.

2.4 **Special Management Area, Coastal Zone Management Consistency.** The proposed project is seaward of the boundary of the SMA (Special Management Area) and is not subject to regulatory authority of the City and County of Honolulu. The project will be subject to review and approval by the Hawaii Coastal Zone Management (CZM) Program for consistency with CZM objectives as part of the federal requirements which will be imposed by the U.S. Army Corps of Engineers for issuance of their permit.

2.5 **Land, beach and water use.** The proposed project site consists of a sand beach, protected nearshore water, and protective concrete and rock offshore cribwalls. Use at the site is by beachgoers. Counts of beach-goers at Kūhiō Beach were made on two different dates in 1990. On a very crowded July 4th (Sunday) holiday when outrigger canoe races were being held also, the estimated number of persons on the beach and wading totaled 2,597 with a density of about 2.5 persons per 100 square feet of dry beach. In comparison, on a weekday (September 6th) the estimated total number of beach-goers was 768 with a density of about 0.75 persons per 100 square feet of dry beach. People interviewed during these beach counts stated that on the average they tended to stay at the beach about two hours. These field counts are independent of beach-goers counts made by City lifeguards who make three estimates daily using a sector-estimating technique similar to that used by the contractors in preparation for this environmental assessment. The lifeguards' counts are somewhat higher[1] because they include all people in the water (surfers, swimmers and paddlers) whereas the independent counts were only of beach-users and persons wading. It is worth noting that the field counts show the number of beach-goers on the fourth of July to be nearly four times the number of beach-goers on the weekday. Most of the beach-goers on the weekday appeared to be generally visitors and not residents. This finding implies that residents make intensive and heavy use of Waikiki's Beaches, at least on selective occasions (for example, canoe races on a fourth of July), see Edward K. Noda and

[1]Lifeguard count data for 1989, aggregated and summarized by month and for the entire study area, was obtained from the City for this investigation. The data was aggregated by month, and for the entire beach area between the Moana Hotel and Queens Surf. For the month of July (1989), Lifeguard data totaled an instantaneous average count of about 14,000 daily compared to the field count (July 4, 1990) of 10,400. Again, the lifeguard estimates include people in the water, not only people on the beach whereas the field count included only people on the beach. For the month of September (1989) the Lifeguard data totaled an instantaneous average count of about 9,800 daily compared to the field count (September 6, 1990) of 3,800.

Associates, December 1991b, for the complete study, prepared by Eugene P. Dashiell, AICP, Planning Services).

Observations and counts of persons using Kūhiō Beach and the water area enclosed by the crib walls were made on December 20, 1998. In general, the lowest number of people using the beach and water area was observed in the Diamond Head basin adjacent to the Kapahulu Storm Drain/groin (0.5 persons per 100 square feet of beach) and a slightly higher frequency of use was observed in the Ewa basin near the curved steps and the banyan tree (0.6 persons per 100 square feet). A higher density of use was observed at Kūhiō Beach outside the crib walled area, fronting the Duke Kahanamoku Statue and areas towards Fort DeRussy (1.0 persons per 100 square feet). This implies that the beach area protected by the crib walls is used less than the areas of the beach exposed to the open ocean. In terms of water use in the area protected by the crib wall, the least use occurred nearest the Kapahulu Avenue Storm Drain (about 0.1 persons per 100 square feet) and the water area near the curved stairs was used slightly more intensively (about 0.2 persons per 100 square feet). The water is shallow, less that two to four feet in the areas behind the crib wall, and most persons using the water area appeared to be children.

The proposed project will have some effect on patterns of beach and water use. It is likely that more people will begin to use Kūhiō Beach itself after the beach sand has been restored and there is a larger area to use. Because there will be a reduction in enclosed water areas from the present condition, there may be some slight reduced opportunity for bathing in the areas now protected by the crib walls.

To summarize, the impact of the proposed project will be increased beach area and increased water access. There will also be a protected water area in the lee of the segmented breakwaters structures.

2.6 **Land and related water use plans.** Following is a discussion of land and water use plans which are related to the proposed plan.

2.6.1 **City and County of Honolulu.**

a) **Kūhiō Beach Park Expansion & Kalakaua Avenue Promenade.** This plan is described in an environmental assessment (included as Appendix D, City and County of Honolulu, August 1998). In their plan, the City would close the seaward-most lane of Kalakaua Avenue and make improvements to the beach park which adjoins the sand beach, the present proposed project. The herein proposed Kūhiō Beach Improvement project would enhance and improve the City's Kūhiō Beach Park Expansion & Kalakaua Avenue Promenade by providing a continuous and more stable beach seaward of the City's project.

b) **Waikiki Master Plan.** This plan (City and County of Honolulu, May 15, 1992) describes a long-range set of objectives to improve Waikiki. The plan includes components such as a Waikiki Beachwalk (page 43) to include access to the beaches for the disabled and where people could walk out on the beach via a "pier lanai" to look back at views of Waikiki. The proposed Kūhiō Beach Improvement project includes two components to assist in achieving these goals: access for disabled and access on a groin extending from the shore into the ocean so that people could go out on it and look back.

c) **Primary Urban Center (PUC) Development Plan.** This plan (January 1999) as described in the Policy Evaluation Report, provides guidance on growth, protection of resources, maintenance of communities, housing and community development, viability of military and transportation centers, visitor industry activities, and regional transportation issues. Specifically, the proposed project assists the City in meeting the economic objectives of the PUC Development Plan by making a significant segment of the public beach at Waikiki more attractive and of higher quality than at present., the PUC plan states:

> Economic Activity: Tourism is supported, particularly in Waikiki (Obj. B), through a number of policies:
>
> *a. Provide for the long-term viability of Waikiki as Oahu's primary resort area by giving the area priority in visitor industry related public expenditures (Policy 1).*
>
> *b. Provide for a high quality and safe environment for visitors and residents in Waikiki (Policy 2).* [2]

2.6.2 **State of Hawaii.** State plans for this location are described in "Waikiki: Hawaii's Premier Visitor Attraction" (Waikiki Working Planning Group, March 1998). The Kūhiō Beach Improvement project is included as one of the components in the overall support which the State is providing to the Waikiki District in order to enhance it as a visitor destination area, and as a place where residents can enjoy the natural environment. The proposed Kūhiō Beach Improvement project contributes to these goals to benefit the recreational experiences of both visitors and residents.

The Waikiki Working Planning Group has been superseded by another group established by the Legislature through Senate Concurrent Resolution 191, CD1, called the Joint Waikiki Task Force. This Task Force is responsible for coordinating governmental and private activities in the Waikiki area and developing recommendations to the 2000 Hawaii State Legislature. The proposed project is supported by the Joint Waikiki Task Force.

A key state objective is to: "Address the problem of saturation of the capacity of beach parks and nearshore waters." (State Recreation Functional Plan, December 1990, Page 63.) The proposed project addresses the problem of saturation by increasing the public beach area from about 1 acre to 2.5 acres.

2.6.3 **Federal.** There are no federal plans for the area.

2.7 **Flora.** None. The site consists of beach sand.

2.8 **Coastal Setting and Beach Stability.** Kūhiō Beach, and the greater part of Waikiki Beach, is man-made. Existing shoreline structures effectively "compartmentalize" the beach segments along the Waikiki shoreline. Some structures have performed well in stabilizing certain beach areas, such as the groin between the Sheraton Waikiki and

[2] Department of Planning and Permitting, City and County of Honolulu, *Primary Urban Center Development Plan*. January 1999.

Royal Hawaiian Hotels. Other structures, such as the crib wall system at Kūhiō Beach, have been only marginally successful. Analysis of historical aerial photographs from 1952 to 1990 indicated that, for the most part, there was a net increase in total beach area for the entire Waikiki shoreline, due largely to artificial beach nourishment and improvement projects (Edward K. Noda and Associates, 1991). Major additions to the recreational beach area were the artificial beach creation fronting the Hilton Hawaiian Village and Fort DeRussy. The Hilton Lagoon was created by filling around an existing water area, effectively landlocking the lagoon. Sand has been periodically placed on Waikiki Beach to restore and maintain the dry beach areas. Siltation and infilling of nearshore reef areas from sand eroded off the beaches may have caused detrimental impacts to the reef life and surfing sites.

Nearshore wave patterns in the Kūhiō Beach sector of Waikiki are relatively consistent because of the bathymetry contours. Wave refraction effects cause both sea and swell waves to approach nearly perpendicular to bathymetry contours, which is from the southwest direction for Kūhiō Beach (Edward K. Noda and Associates, 1992). Wave approach is more south-southwesterly fronting the adjacent beach to the north, and more from the west-southwesterly direction fronting the adjacent beach to the south. Aerial photographs were also analyzed to determine the wave approach patterns across the surf zone. Exhibit 11 shows a composite of all wave fronts that could be discerned from aerial photographs dating from 1952. Note that the wave fronts approach Kūhiō Beach not parallel to the shoreline, but at an angle to the crib walls. This is the reason that it has been difficult to stabilize the beach in this sector. The adjacent beaches on the northwest and southeast sides of Kūhiō Beach are oriented nearly parallel with the wave fronts, which is the reason for the relatively greater stability of these beach areas compared to Kūhiō Beach.

Waves and wave-generated currents are the primary forces that move sediment along the coast. Sediment transport in the littoral zone occurs as longshore transport or cross-shore (onshore-offshore) transport. In most cases, both types of transport will occur because of the seasonal and storm wave characteristics. Longshore transport occurs because waves approach at an angle to the beach, moving sediment in the direction of wave breaking. For Kūhiō Beach, this results in sand transport towards the northerly direction. Cross-shore transport is the movement of sediment perpendicular to the beach. Low, long period swell waves can rebuild beaches by transporting sediment shoreward. High, steep waves can erode the beach and deposit the beach material offshore. Although Kūhiō Beach is protected by the offshore crib wall system, the walls are low and much wave overtopping energy can still reach the beach. The nearly continuous walls also result in superelevation of the water level within the basin during periods of wave overtopping, which causes wave erosion at higher elevations on the beach and which also results in strong seaward-flowing currents through the narrow gaps in the wall. The proposed reconstruction of the offshore walls and the new restored beach will mitigate the existing problems of beach stability. The breakwater segments will be high enough to prevent longshore transport of beach sediments beyond the confines of these structures. Cross-shore transport will still occur, but the wide gaps will allow swell waves to rebuild the beach, similar to the adjacent beaches on either side of the project site.

The possible removal of between 10,000 and 20,000 cubic yards of sand from the pockets on the nearshore reef directly fronting Kūhiō Beach will not alter or impact the littoral processes at the site or adjacent beaches. It is estimated that about 140,000 cubic yards of sand suitable for beach nourishment are available in vast sand patches on the nearshore reef between the Halekulani Channel and the Waikiki Aquarium (Exhibits 12 and 13). This does not include the sand resource in the Halekulani Channel, which is estimated to contain about 500,000 cubic yards of sand. Directly offshore Kūhiō Beach within about 2,000 feet from shore is an estimated 40,000+ cubic yards of sand. Much of the sand that has settled in depressions on the reef came from erosion of the beaches that were artificially nourished. The U.S. Army Corps of Engineers' 1963 report on the Cooperative Waikiki Beach Erosion Control Study suggests that about 157,000 cubic yards of sand artificially placed on the shoreline from Kuhio Beach to the Natatorium had eroded between 1951 and 1960. This sand has smothered the nearshore reef area and causes scouring of the reef because of the high wave energy environment. Recycling of this sand back to the beach will help to restore the reef habitat as well as prevent the introduction of additional "offsite" sand into the aquatic system. The sand that has settled into the pockets on the reef cannot easily be transported back to the beaches naturally because of the irregular reef bottom.

2.9. **Benthic and Fish Communities.** A marine biological survey conducted on 3 August 1990 (OI Consultants, Inc., 1990; Appendix D) examined benthic and fish communities in the nearshore Waikiki area. In general, the marine environment offshore of Waikiki can be characterized into two major zones. A nearshore zone, extending from the shoreline to approximately the 25-foot depth contour, is characterized by expansive sand plains. Owing to the nearly constant movement of the sand by waves, few attached or epibenthic organisms occupy this biotope. Between the sandy areas in the nearshore zone are numerous limestone (calcium carbonate) projections that could be described as "finger knolls". These structures are elongated ridges, generally oriented parallel to the shoreline, that rise several feet off the sandy bottom. The sides of the knolls are generally gently sloping rather than vertical. As a result of their elevation above the sand flats and the solid substratum they provide, the surfaces of the finger knolls serve as preferred settling sites for attached benthos.

The second major zone, occurring in water depths from approximately 25 feet to the limits of the qualitative survey (approximately 80 feet), can be described as a "hardpan" bottom. This region consists of an extremely flat, calcium carbonate surface covered by a veneer of sandy sediment and rubble fragments. Vertical relief in this zone is restricted to shallow indentations and channels lined with sand. Colonization by attached benthos is uniformly low over the hardpan surface, and is generally restricted to small corals and benthic algae. In the few locations having structural relief, solid substratum that extended above the surrounding reef surface was colonized by comparatively dense aggregations of attached benthos and fish.

The predominant macrobenthic (bottom-dwelling) fauna throughout the reef zones off Waikiki are reef-building corals, sea urchins, and encrusting sponges. Other benthic taxa were also observed, but were substantially less abundant. Nine species of "stony" corals and one "soft coral" were encountered on transects, and the number of coral species at a singled sampling station ranged from two to six. Two species of corals (*Pavona varians* and *Cyphastrea ocellina*) were observed in the study area but did not occur on any transects. The dominant coral species at all of the Waikiki stations were *Porites lobata* and *Pocillopora meandrina*. *P. lobata* accounted for about 49% of the coral coverage measured on transects and *P. meandrina* accounted for about 45%. Thus, the eight remaining species totaled accounted for only about 6% of coral cover.

Coral community structure was related to depth zones and north-south location. With respect to coral cover, several patterns are evident. Overall coral cover is higher at the northwest end of Waikiki than at the southeast end. In the northern areas offshore the Hilton Hawaiian and Halekulani Hotels, cover is highest at the middle stations (20 and 40 feet in depth), and lowest at the deep (60 foot) stations. In the southern area offshore the Moana Hotel to the Waikiki Aquarium, there are no such relationships, and coral cover is comparatively low (less than 15%) at all areas. The number and diversity of coral species do not show the same spatial trends as do coral coverage. The highest species number (6) and the highest diversity (1.25), however, were observed near the Hilton Hawaiian Pier channel.

The higher coral coverage and diversity along the northwest transects apparently relates to the greater area of solid substratum available in these areas. The finger knolls that predominate in the northwest area are not as abundant in the southeast area. Coral colonization was clearly greater on these structures, owing to the protection offered from sand scour. In areas with less vertical relief, coral colonization and growth appears to be severely restricted. Coral cover was uniformly low at all of the 60-foot stations, and the sea bottom consisted of carbonate hardpan covered with fine sediment.

Thus, it appears that the major factor controlling coral community structure at Waikiki is the degree of protection from shifting sand. In areas of high sand cover (low relief) corals are very limited; in areas where vertical relief provides settling surfaces above the level of sand movement, coral communities are moderately well-established.

It is evident from survey results that reef fish community structure off Waikiki is largely a function of topographical relief of the bottom. Areas with little structural relief in the vertical dimension were poor habitats for reef fish. In such areas, few fish were noted and most of these were species such as triggerfishes (humuhumu, Balistidae) which inhabit barren areas and take shelter in small crevices in the bottom. In contrast, areas with low rock ledges or finger knolls harbored substantial numbers of fish consisting of a variety of species. The fish in such areas can be grouped into four general categories: juveniles, planktivores, herbivores, and rubble-dwelling fish.

Juvenile fish belonged mostly to the family Acanthuridae (surgeon fish), with representatives from the families Labridae (wrasses), Mullidae (goat fish) and Chaetodontidae (butterfly fish). The predominant planktivorous fish were the blackfin chromis (*Chromis vanderbilti*) and the milletseed butterflyfish (lau-wiliwili, *Chaetodon milliaris*). The primary herbivore was the brown surgeonfish (ma'i'i'i, *Acanthurus nigrofuscus*). Other common herbivores were goldring surgeonfish (kole, *Ctenochaetus strigosus*), convict tangs (manini, *A. triostegus*) and small unicornfish (kala, *Naso unicornis*). The primary rubble dwelling fish were the saddle wrasse (hinalea lau-wili, *Thalasoma duperrey*) and manybar goatfish (moano, *Parupeneus multifasciatus*).

A few species of "food fish" (those preferred by commercial and/or recreational fishermen) were observed during the survey. A school of approximately 2,000 juvenile blue-lined snapper (taape, *Lutjanus kasmira*) were observed at one site. Several grand-eyed porgeys (mu, *Monotaxis grandoculis*) were also observed. Rocky ledges and large coral heads sheltered occasional squirrelfish (u'u, *Myripristes berndti*). Other food fish included parrotfish (uhu, *Scarus* spp.), and goatfish (moana kea and malu, *Parupaneus cyclostomus* and *P. bifasciatus*). Overall, however, such fish were quite rare, tended to be small, and avoided divers. In general, the entire survey area appeared to be subjected to substantial fishing pressure which has noticeably impacted the abundance, size and behavior of sought-after species.

A biological and sediment infaunal survey was conducted of the sand deposits offshore Kuhio Beach on 11 February 1999 (Oceanic Institute, letter report dated 3

March 1999; Appendix D). The purpose was to assess the importance of these sand deposits as a functional habitat for marine invertebrates and fish. The survey revealed that the sand deposits were barren in terms of infaunal organisms. Also, no large benthic invertebrates or bottom-feeding fish were observed in the sand habitats. The sand habitat does not appear to support sufficient biological resources to serve as an important feeding area for large invertebrates or fish. While the sand habitat may be used as resting areas by certain species of fish, the removal of some portion of the sand is not expected to impact this use of the habitat.

2.10 **Water Quality.** A water quality survey conducted on 3 August 1990 (OI Consultants, Inc., 1990; Appendix D) identified several general trends in water quality within the Waikiki study area. Levels of many water quality parameters (e.g., temperature, pigments, and nutrients) were generally higher at the shallower stations. However, lower levels were observed near shore along transect C, where channels cut through the offshore reefs and deeper water lies closer to the beach.

Water quality near shore along transect D in the vicinity of the project site appears to be affected by a source of nutrient-rich fresh water, perhaps the Kapahulu storm drain. The salinity and temperature data also suggest that the nearshore waters between the Royal Hawaiian Hotel and Kapahulu Avenue are more actively mixed with water from offshore, perhaps due to the presence of the deep channels described above. Chave et al. (1973) observed a net seaward current flow near Kapahulu and near the Natatorium during low-wave conditions. During large waves, they observed a strong seaward flow originating nearshore between the Royal Hawaiian Hotel and Kūhiō Beach.

Surface water quality in nearshore samples along the northeastern transects (A and B) appeared to be strongly influenced by a water mass having lower salinity and elevated concentrations of nutrients, pigments, and suspended materials. The most likely source of this water is the Ala Wai Canal and Harbor. However, other sources cannot be ruled out.

In general, the deeper, offshore samples had low levels of TFS, turbidity, nutrients, and pigments, probably reflecting a greater influence of oceanic water. However, anomalously high levels of some parameters (e.g. turbidity, nitrate, silicate) were observed in mid-depth and bottom samples at some offshore stations, especially along transects D and E. Presumably, these anomalies result from mixing of offshore and nearshore waters, perhaps transported from the Diamond Head area. However, the overall trends in water quality from the mid-depth and bottom samples are complex and difficult to assess.

The State Department of Health has reported high bacterial counts in the water area enclosed by the crib walls (Honolulu Advertiser, June 7, 1993)[3]. A study by the University of Hawai'i's Water Resources Research Center (March 1994) which explored this issue in depth reported that the levels of Fecal coliform bacteria within the two basins enclosed by the crib walls at Kūhiō Beach consistently exceeded state water quality standards for recreational swimming areas. ("Impact of Kapahulu Storm Drain

[3]Environmental elements and storm drain runoff, not human sewage are apparently the cause of high bacteria counts measured at Kuhio Beach. According to Dr. Bruce Anderson (then Deputy Director of the state Department of Health), "Birds in the Waikiki area seem the likely suspect since there is no evidence of a sewage spill." (Quoted in an article by Lorna W.S. Lim, Honolulu Advertiser, June 7, 1993)

System on Water Quality at Kuhio Beach: A Multi-Phasic Study", UH-WRRC, March 1994, Page 1-12, Table 1). However, the UH team concluded that there was little if any health risk based on their epidemiological investigation which queried 2,556 Kūhiō Beach subjects and which found that there was little evidence of illness due to swimming at Kūhiō Beach according to responses to questions.

2.11 **Historical, archeological and cultural sites.** At this location, there are no historic sites within the boundaries of the proposed projects. There is one historic site adjacent to the proposed project, within the boundaries of the City's Kūhiō Beach Park. This site is known as the Wizard Stones. The State Department of Land and Natural Resources, Historic Preservation Division, has concurred that this site will not be affected by the project, and has issued a determination of "no effect" on historic sites.

This area of Waikiki is rich in history as discussed in "The View from Diamond Head: Royal Residence to Urban Resort" (Hibbard and Franzen, 1986). Prior to construction of the crib wall in the 1950's, there was little if any sand beach adjacent to Kalakaua Avenue in the vicinity of the project location. Rather, the surf washed directly against retaining walls adjacent to the sidewalk. Construction of the crib walls permitted creation of a beach in this area. However, the design of the crib walls was such that forceful wave overtopping continued to occur under high surf conditions which provided enough energy to stir up beach sand and to wash it away. During high surf conditions some sand would be transported within the crib walls and other sand would actually be conveyed outside the crib walls onto adjacent reef flats, an adverse impact of the existing condition of crib-walls and sand replenishment.

Kuhio Beach and surrounding land and ocean areas have a rich history. Surf breaks and the Kuhio Beach area may be viewed as cultural resources and traditional cultural properties in the sense that Hawaiians prior to western contact may have surfed the breaks and used the beach area for staging, both of surfing and of canoe launching. Prior to western contact and the development of Waikiki Kuhio Beach did not exist as it is at present. Rather, Kalākaua Avenue, sidewalks and structures were constructed on the beach and its backshore, and a variety of seawalls, groins and other hardened structures were built over the years. At present, the beach provides a staging area for use of the water and surf by beachgoers including surfers, and the placement of the statue of Duke Kahanamoku was intended to invite people to enjoy these activities at this location.

According to Kanahele (Kanahele, George S., 1995), Chief Kahekili led an invasion of Oahu from Maui numbering perhaps thousands of men and hundreds of canoes. The invaders landed at Waikiki between Diamond Head and the halekulani Hotel (Kanehele, p. 79).[4]

According to Clark (Clark, John R. K., 1977), the land (named Hamohamo) adjacent to Kuhio Beach Park originally was owned by Queen Lili'uokalani and Prince Kuhio's home was at Pualeilani, on the seashore of Hamohamo. "On July 22, 1918, the prince removed the high board fence arund his property and opened this section of beach to the public (Clark, p. 52)." Though the Park was already named Kuhio, when

[4]Kanahele, George S., *Waikiki 100 B.C. TO 1900 A.D. An Untold Story*, The Queen Emma Foundation, Honolulu, 1995.

the prince died in 1922, Pualeilani went to the City. The park was officially dedicated in 1940 and a plaque is still there today (Clark, p. 52)[5].

Hemmings (Hemmings, Fred, 1997) has written about the importance of Waikiki's surf sites while growing up and the role played of the surf both in history and in modern society. For example, he writes that the surf site known as "Tonggs" was named after a family who lived on the beach and that Rice Bowl, next to Tonggs, was: "..hottest tube in town. (Hemmings, p. 60.)".[6]

2.12 **Sensitive habitats or bodies of water adjacent to the proposed project.** Surveys of the marine habitat off Waikiki indicate that coral coverage and diversity are relatively low, particularly offshore Kūhiō Beach where the highest coral coverage was less than 12% at 20-foot depth along the transect. Coral coverage was 0% at the 10-foot depth and only about 2% at the 40-foot and 60-foot depths. The major factor controlling coral community structure is the degree of protection from shifting sand. In areas of high sand cover (low relief), corals are very limited. In areas where vertical relief provides settling surfaces above the level of sand movement, coral communities are moderately well-established.

Coral coverage offshore the Waikiki Aquarium was slightly higher, but still lower than offshore the Halekulani and Hilton Hawaiian Hotels. However, at the 10-foot depth, coral coverage offshore the Aquarium was almost 15%, which was the second highest coverage at this depth compared to the other transects. The beach sector fronting the Aquarium, between the Natatorium and the groin at Queen's Surf beach, has been artificially nourished in the past in attempts to maintain a dry beach along this sector. A 1958 aerial photo shows a fairly uniform dry beach extending along this entire shoreline reach. Prior to artificial nourishment, there was no dry beach along this reach north of the Natatorium. Progressive erosion has resulted in no dry beach fronting the Aquarium and only a small triangular fillet beach next to the Queen's Surf groin. There is a general perception that the shallow nearshore reef has "recovered" over the years as the beach within this reach diminished. A Marine Life Conservation District (MLCD) has been established by the Department of Land and Natural Resources in the waters offshore the Waikiki Aquarium. Exhibit 13 shows the MLCD boundaries, extending from the Kapahulu Storm Drain to the Natatorium, and offshore for a distance of 500 yards. Within the MLCD, prohibited activities include the taking, altering, or removing of any sand, coral, rock, or other geological features. Therefore, portions of the sand deposits located within the MLCD will not be used for the proposed beach replenishment.

Sand transport along this sector of the coastline is northward, towards Kūhiō Beach. Therefore any erosion of sand from the Kūhiō Beach project site will not impact the nearshore reef areas fronting the Aquarium.

The proposed dredging of sand from the shallow pockets in the reef offshore Kūhiō Beach will not detrimentally affect adjacent coral reef areas. The sand will be removed from the reef using a small hydraulic suction dredge, which will pump the sand slurry to shore through PVC pipe. Turbidity generated during the dredging activity will be very localized and minor compared to the area-wide turbidity naturally occurring during high swell activity. Because coral coverage on the reef is limited by the scouring

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[5]Clark, John R. K.., *The Beaches of O'ahu*, University of Hawaii Press, Honolulu, 1977.

[6]Hemmings, Fred, The Soul of Surfing is Hawaiian, Sports Enterprises, Inc., Maunawili, 1997.

action of the sand, there would be beneficial impacts due to the removal of sand from the nearshore reefs.

2.13 **Flooding and Tsunami.** According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM Panels 150001 0120C and 0125B, September 4, 1987), portions of the Kūhiō Beach shoreline seaward of Kalakaua Avenue are located within a coastal flood hazard zone designated Zone AE, with base flood elevation between 8 and 9 feet above mean sea level. The designated flood elevations apply landward of the shoreline. The proposed project will be constructed seaward of the shoreline, and the beach and reconstructed offshore walls will be at finish elevations much lower than the BFEs and Kalakaua Avenue. Therefore, there will be little, if any impact on the coastal flood hazard characteristics. However, extending the shoreline farther seaward by restoration of the dry beach area should mitigate potential storm wave overtopping impacts to the present shoreline areas landward of the existing beach.

3 Major Impacts and Alternatives Considered

3.1 **Positive significant impacts.** Positive and beneficial impacts of the proposed project, include a stable beach area which will reduce maintenance costs for sand replenishment in future years. If sand is obtained from nearshore sources, as proposed, there may be benefits to the reef communities if the sand is removed from the hard ocean bottom substrate. Persons familiar with the offshore areas to be mined for sand have suggested that over the years, sand washing away from previous restoration projects may have covered the reef and adversely affected biotic communities through a reduction of the hard substrate area. Reconstruction of the "slippery wall" will remove some hazards to swimmers which consist of deep holes or pockets near the "slippery wall", especially where the wall was constructed with narrow openings to permit circulation of ocean water. These narrow openings cause ocean waters to accelerate through the narrow gaps, and to scour the bottom, creating holes in the sand bottom which can deceive an unwary bather. Construction of the segmented breakwaters as proposed will provide large openings to the ocean so that circulation within the protected beach areas will be much improved.

3.2 **Negative significant impacts.** There are no negative significant impacts of the proposed project.

3.3 **Alternatives considered.** The following is a discussion of the alternatives which were considered during the formulation of the recommended Kūhiō Beach Improvement project.

3.3.1 **No-Action Alternative.** If no improvements are made to the offshore crib wall system and to the beach, the existing problems will continue. The beach will continue to have stability problems, which will require regrading and beach nourishment every 5-10 years or so, depending on how diligent the state is in keeping the beach maintained. The last renourishment was done in late 1991, and by early 1995 the beach was already misshapen and eroded to the point where the Diamond Head end had little dry beach width. At present there is no dry beach in front the Diamond Head trellised area. Water quality within the basins will continue to be a problem, and the slippery wall and the scour holes near the narrow gaps will continue to pose public safety hazards.

3.3.2 **Periodic Beach Nourishment.** Under this alternative, no work will be done on the existing offshore walls. Periodic beach grading and renourishment would be required to maintain a continuous dry beach along the entire Kūhiō Beach shoreline. Sand that is eroded from the beach and which escapes the crib wall enclosure will continue to impact the nearshore reefs. Water quality within the basins will continue to be a problem, and the slippery wall and the scour holes near the narrow gaps will continue to pose public safety hazards.

The City and County will necessarily have to ensure that the beach is maintained if they are to implement the Kalakaua Avenue Promenade and Kūhiō Beach Park expansion project. Their project involves removing sections of the seawall that presently protect the sidewalk and Kalakaua Avenue, and replacing the shoreline interface with landscaping improvements. This unprotected shoreline interface will sustain damage from overtopping waves and erosion if the dry beach area is not restored and maintained along the entire shore frontage where the existing seawalls are removed.

3.3.3 **Alternative Sand Sources and Construction Methods.** Sand sources are either land-based or offshore. At present, there is no large commercial source of clean, natural coarse beach sand suitable for major beach nourishment projects. Small quantities can be obtained from inland excavation sites in former dunes or old beach ridges. However, most of these inland sources on Oahu are located on the north shore, and trucking costs are high. Dune sand is typically fine-grained and less desirable than sand from old beach ridges. Land-based sand sources also must be screened and/or washed to remove dirt and silts. Crushed limestone sand is another land-based source, although the limestone may have originally been dredged from the ocean bottom. The limestone material is crushed and processed to yield specified grades of sand and aggregate. Processed limestone sand, while less expensive than other land-based sources, is not as desirable as natural sand for beach nourishment because of the angular grains, which tends to compact more than round grains and does not "give" underfoot as easily as natural sand with rounded grains. Processed limestone sand may also display cementitous characteristics over time as the angular grains abrade. However, these characteristics make processed limestone sand suitable for use as a base course under the widened beach berm, say beneath the upper 4 feet or so of dry sand thickness (below MHHW elevation).

Offshore submarine sources contain large quantities of sand. The most suitable offshore sources are the nearshore deposits, contained in pockets on the reef platform or in channels cut through the reef. The nearshore sand deposits are generally better sorted and coarser than deep offshore deposits because of the higher wave energy environment in shallower waters. The most cost-effective construction methodology is to dredge and pump sand from nearshore sand deposits directly to the beach area being restored. This is the methodology proposed for the subject Kūhiō Beach improvement. Because the nearshore deposits contain little silts, if any, no beneficiation will be required.

For deepwater deposits which contain a significant fraction of silts, beneficiation will be required. Beneficiation involves processing the sand to remove silt-sized particles, using techniques such as screening, settling ponds, hydrocyclone dewatering systems, or agitating the material in the deposit to suspend the silts before extraction of the sand. Depending on the technique used, beneficiation can either be accomplished at sea or on land. However, multiple handling of the material adds to the cost of the sand. Also, for locations such as in Waikiki, delivery of large quantities of sand by land (via trucking) can have significant traffic impacts. In a prior study conducted to assess the dredging methods and options for delivering large quantities of sand for the overall Waikiki Beach Improvement Project, the recommended scenario was sand extraction using a hydraulic mining system, piping the slurry to a barge, and pumping the sand to the beaches from the barge via pipeline with a hydrocyclone at the discharge end to remove fines and dewater the sand. Transfer of sand to the beach by pipeline has the most potential for turbidity impacts because of the high water content of the pumped slurry. The hydrocyclone at the discharge end of the pipeline can dewater the slurry, but the water must then be piped back to the ocean. Because restoration and widening of Kūhiō Beach involves a small quantity of sand compared to the overall Waikiki Beach project, and because the nearshore sand deposits directly offshore the crib walls contain suitable quantity and quality of sand, a small hydraulic dredge can be used to simultaneously extract and pump the sand directly to the beach.

3.3.4 **Alternative Structural Measures** Three general concepts were considered for improving the beach stability and enabling the provision of wider beach areas. Exhibit 14 schematically depicts the three concepts. Concept 1 is the proposed improvement plan, which involves the reconstruction of the offshore crib walls to simulate a segmented breakwater system. Concept 2 involves reconstruction of the south end of the crib wall similar to the proposed breakwater segment, and building a new groin at the north end. The crib walls would be removed completely and the new groin would stabilize the beach by allowing the beach to be oriented parallel with wave crests. Concept 3 involves removing the crib walls completely and extending the middle groin and north groin. Extending the groin structures a significant distance seaward of the existing crib wall alignment could potentially have detrimental impacts on the nearshore surf sites. During prior planning and coordination efforts, surfers were adamant that any new structures should not extend significantly seaward of the existing crib walls. Although the groins may not physically extend into the surf sites, they could potentially affect the wave breaking characteristics by altering the nearshore currents. Another shortcoming of the extended groin concept is the loss of the sheltered beach and waters that presently exist within the Kūhiō Beach basins. Because of the protection afforded by the offshore crib walls, the shallow calm waters are ideally suited for wading and for small children. Kūhiō Beach is the only area in Waikiki where such sheltered waters can be found. While extended groins can function to stabilize a wider beach, they would not provide the same type of shelter from wave action that a shore-parallel structure would provide. Concept 2 seeks to maintain this sheltering, but the groin on the north end would extend 200 feet or more seaward of the existing crib wall alignment.

4 Proposed Mitigation Measures

4.1 **Potential problems and appropriate mitigation including best management practices.** There are two potential problems related to the proposed project. Each is mitigated using best management practices as follows.

4.1.1 Potential Problem of Visual Intrusion into the Environment. If the breakwater was designed to prevent wave overtopping from hurricane waves, it's crest elevation would likely obscure the horizon from a viewing point on-shore. The proposed project addresses this issue by maintaining an elevation similar to the existing crib-wall, and it also provides larger gaps which further accommodate views. The restored beach may suffer wave inundation and erosion effects from extreme storm wave events, but no more so than adjacent beaches.

4.1.2 Water Quality Impacts During Construction. The short-term construction impacts, although not expected to be significant, can be avoided or minimized by implementing suitable mitigation measures. The construction contractor would be required to comply with the State of Hawaii Water Quality Standards. Applicable Best Management Practices include:

- Use of effective silt-containment devices to isolate the construction activity, to minimize the transport of potential pollutants, and to avoid the potential degradation of receiving water quality as well as the marine ecosystem. The existing cribwall enclosure will be maintained during the sand pumping activity to contain the turbidity.

- Periodic monitoring immediately outside the silt containment devices to verify that applicable state water quality criteria are not being exceeded as a result of construction.

- Work in the water will be curtailed during adverse sea conditions.

- Construction materials will be free of pollutants.

- Care will be exercised to insure that no contamination of the marine environment results from construction activities. Actions will be taken to avoid water quality impacts such as assuring that debris, petroleum products, or other deleterious materials are not allowed to fall, flow, leach or otherwise enter the water.

- Any materials from the demolition of the existing cribwalls that are not suitable for use in the new breakwater segments will be disposed of at an upland site.

4.2 **Mitigation or preservation plan prepared for the Department of Land and Natural Resources State Historic Preservation Division.** Because there are no historic properties at the proposed project site, a preservation plan is not applicable.

5 Determination and Justification

5.1 **Finding of No Significant Impact (FONSI).** The proposed Kūhiō Beach improvements will not have significant effect on the environment and therefore preparation of an environmental impact statement is not required. This document constitutes a Notice of Negative Declaration/Finding of No Significant Impact for the proposed project. This determination was based on review and analysis of the "Significance Criteria" in Section 11-200-12 of the Hawaii Administrative Rules, as documented below.

5.2 **Findings and reasons supporting the determination including justifying evidence.**

5.2.1 *No irrevocable commitment to loss or destruction of any natural or cultural resource would result.* There are no sites listed or eligible for listing in the National and/or State Registers of Historic Places within the project area. The area seaward of the existing seawalls protecting Kalakaua Avenue has been extensively altered by dredging, construction of the offshore walls and beach fill activities. No significant natural resources are present within the limits of proposed construction.

5.2.2 *The proposed project would not curtail the range of beneficial uses of the environment.* The proposed project will in fact enhance the beneficial use of the environment by mitigating existing water quality problems, beach stability problems, and public safety hazards. The project will also increase the recreational beach area within the present limits of the crib wall enclosure. The proposed reconstructed offshore walls will not impact the surf sites, and in fact will facilitate access to the surf sites and enhance seaward view planes. Access to the beach and enclosed water areas within the limits of the crib wall enclosure will be temporarily restricted during the period of construction for public safety. However, phasing of the construction will minimize the area of beach that will be closed. Public access along the sidewalk promenade and Kalakaua Avenue would not be affected.

5.2.3 *The proposed project would not conflict with the state's long-term environmental policies or goals and guidelines.* The state's environmental policies and guidelines as set forth in Chapter 344, Hawaii Revised Statutes, "State Environmental Policy", encompass two broad policies: conservation of natural resources, and enhancement of the quality of life. The proposed project will both conserve and enhance the natural beach resources, and enhance the recreational experience for both visitors and the local populace.

5.2.4 *The proposed project will improve the economic and social welfare of the community and the state.* Waikiki Beach is a world-class destination, but with increasing competition for the vacation travelers, the State must actively seek to maintain and revitalize this premier attraction for visitors. The proposed project will mitigate the existing problems at Kūhiō Beach and enhance the recreational beach area, thereby contributing to the economic and social welfare of the community and the state.

5.2.5 *The proposed project would not substantially affect public health.* The proposed improvements will not have substantial effects on public health. Impacts, if any, will be beneficial because of improvement to the water quality within the semi-enclosed basins.

5.2.6 *No substantial secondary impacts, such as population changes or effects on public facilities, are expected.* The project will not alter the present use of the recreational beach area. Enhancement of the recreational beach area will not cause population changes nor will there be any effects on existing public facilities.

5.2.7 *No substantial degradation of environmental quality is expected due to the proposed project.* Construction activities would have potential short-term impacts on ambient environmental quality, although these impacts are expected to be minor. In the long term, the completed project will improve the environmental quality by stabilizing and improving the beach area, reconstructing the offshore walls to mitigate the existing hazardous condition and improve the water quality within the basins, and improving view planes and access to the offshore surf sites.

5.2.8 *No cumulative effect on the environment or commitment to larger actions will be involved.* The Kuhio Beach portion of Waikiki Beach is man-made, and it is compartmentalized from the adjacent beach segments on either side. The proposed project will stabilize and improve the beach area within the limits of the existing offshore crib wall system bounded by the Kapahulu Storm Drain to the south, and therefore will mitigate the present erosion problems. The project will not detrimentally affect existing littoral processes in and adjacent to the Kuhio Beach area and will not affect adjacent beach areas because there are no new structures extending significantly seaward of the existing offshore walls. The behavior of the newly reconstructed beach is expected to be similar to the behavior of the adjacent beach areas.

5.2.9 *No rare, threatened or endangered species or their habitats are affected.* No impacts are anticipated on any candidate, proposed or listed endangered species or their habitats. There are no known threatened/endangered species or their habitats within the project limits.

5.2.10 *The proposed project will not detrimentally affect air or water quality or ambient noise levels.* Construction activities may cause short-term impacts to air, noise and water quality which will be mitigated to the extent practicable. In-water construction activities have the potential for generating localized and short-term turbidity impacts to the coastal waters, which can be minimized by implementing best management practices. In the long term, the proposed project will result in improvement to the water quality within the semi-enclosed basins.

5.2.11 *The proposed project will not detrimentally affect environmentally sensitive areas such as flood plains, tsunami zones, beaches, erosion-prone areas, geologically hazardous lands, estuaries, fresh waters or coastal waters.* The proposed project is the improvement of existing beach areas, and therefore is situated seaward of the existing shoreline. The project has been designed to take into consideration the site-specific characteristics of the coastal environment. The project will have no effect on the coastal flood hazard due to tsunamis because the crest elevation of the reconstructed offshore walls and beach would be lower than the existing elevation of the shoreline and seawalls adjacent to Kalakaua Avenue. The project will not cause adverse impacts to marine resources or coastal waters, and may result in beneficial impacts to coastal waters by mitigating the continued erosion of the beach and improving circulation and flushing of waters within the semi-enclosed basins.

5.2.12 *The proposed project will improve scenic vistas and view planes identified in county or state plans or studies.* The proposed improvements to Kūhiō Beach would not obstruct seaward views because the reconstructed offshore walls will be lower than the top-of-beach elevation. Certain view planes will be improved because sections of the offshore walls will be removed to provide the wide gaps between the breakwater segments. Widened sections of the beach will also enhance certain view planes and scenic vistas.

5.2.13 *There will be no requirement for substantial energy consumption.* Construction of the project will not require substantial energy consumption.

6 Identification of Agencies, Organizations and Individuals Consulted

The following narrative summarizes the coordination with key agencies and with the Neighborhood Board as of this date of writing.

6.1 State of Hawaii.

6.1.1 Department of Land and Natural Resources (DLNR). DLNR is the sponsor, proposing and approving agency for this project.

6.1.2 Department of Health. Coordination with the Office of Environmental Quality Control has occurred through use of their guidelines for preparation of this environmental assessment. A Water Quality Certification will be requested when a permit for construction is requested from the U.S. Army Corps of Engineers.

6.1.3 Department of Transportation (DOT). The Department was the original proponent of this project. Within the State administration, the project was reassigned from DOT to DLNR.

6.1.4. Department of Business, Economic Development and Tourism. The Department has included this project in its list of projects proposed by the State administration to benefit Waikiki. A Coastal Zone Consistency Declaration will be requested from the Department's Coastal Zone Management Program when a permit for construction is requested from the U.S. Army Corps of Engineers.

6.1.5 Commission on Persons with Disabilities. Discussion has been held with the Commission regarding the inclusion of access for the disabled in the proposed Kūhiō Beach Improvement project.

6.2 City and County of Honolulu.

6.2.1 Office of the Mayor. The mayor has been recently briefed about this project and its relationship to the City's proposed improvements to Kūhiō Beach Park.

6.2.2 City's Waikiki Task Force. The Task Force is chaired by the Managing Director and includes members of City Departments, businesses, hotels, landowners, interested groups and individuals who are concerned about the quality of Waikiki.

6.2.2 Department of Design and Construction. The Department is the proponent of the City's Kūhiō Beach Park and Kalakaua Avenue Promenade project. Several meetings have been held with representatives of the Department and their consultants who are preparing plans for the City's project in order to coordinate the State's proposed Kūhiō Beach Improvement project with the City's improvements.

6.2.3 Department of Parks and Recreation Services. The Department has been fully involved from the beginnings of this proposed project and they have attended coordination meetings with shoreside land owners and briefings at the physical model sessions held at Look Laboratory. City lifeguard services provided beach user data also. At a recent meeting before the Waikiki Neighborhood Board, a representative of the Department expressed concern that the proposed project would reduce the protected open water area for persons who prefer the protected area within the crib wall at Kūhiō Beach.

6.3 United States Government.

6.3.1 U.S. Army Corps of Engineers. A permit will be required from the U.S. Army Corps of Engineers for construction of the proposed project.

6.4 Community, Organizations and Individuals.

6.4.1 Waikiki Neighborhood Board. An informational presentation was made at the December 15, 1998 meeting of the Waikiki Neighborhood Board. The Board endorsed the project by unanimous vote.

6.4.2 Waikiki Resident's Association. An informational presentation was made at the January 25, 1999 meeting of the Waikiki Resident's Association.

6.5 **Public Involvement Prior to Preparation of the Environmental Assessment.** A comprehensive public involvement program was undertaken as part of the prior study effort related to all of Waikiki's beaches between Fort DeRussy to the Aquarium. The proposed Kuhio Beach Improvement project evolved from that overall effort. A key component of the initial investigation was the formation of the Waikiki Beach Advisory Committee, with representatives from branches of government, landowners (hotels) abutting the beach, recreational users/groups, and Waikiki business organizations. The role of the Advisory Committee was to provide information, opinions, advice, comments, and consensus on the goals, needs, and recommended improvements for Waikiki Beach. The Advisory Committee met monthly or as necessary to discuss findings from the technical study. During the conduct of the multi-year study, members were added to the Committee and representatives of organizations may have changed, but by-and-large, key organizations and individuals were dedicated in their participation on the Committee. The following organizations and individuals were represented on the Advisory Committee:

Waikiki Improvement Association (Christina Kemmer, Scotty Bowman)
Waikiki-Oahu Visitors Association (Tom Kiely)
Waikiki Neighborhood Board (Anita Benfatti, Wright Hiatt)
U.S. Army Corps of Engineers - Planning (John Pelowski, David Lau)
Department of Land and Natural Resources - State Parks (Ralston Nagata)
City & County Parks Department - Planning (Donald Griffin)
City & County Water Safety Division - Lifeguards (Ralph Goto)
City & County General Planning (Ben Lee, Gary Okino)
Waikiki Aquarium (Bruce Carlson)
Outrigger Hotels (Max Sword)

Sheraton Hotel (John Brogan)
Halekulani Hotel (Larry Chang)
The Ocean Recreation Council of Hawaii - TORCH (Terry O'Halloran)
Surfers - Save Our Surf (George Downing, John Kelly)
Rough Water Swimmers (James Anderson)
Hawaii Council of Dive Clubs (Frank Farm)
Senator Mary Jane McMurdo
Representative Duke Bainum
Councilman Andy Mirikitani

In October 1990, a public workshop was sponsored by DOT-Harbors to discuss the initiation and scope of the study for restoring Waikiki Beach. The meeting format included a presentation on the status of the study, a slide show on the history of Waikiki Beach and the present conditions and problems, and group discussions facilitated by the Advisory Committee members to obtain public input and generate discussions on key topics of concern. A public notice of the workshop was issued, and attendees were asked to participate in one of the three workshop groups on the topics of (1) business, concessions, property/littoral rights, (2) offshore recreation, and (3) beach and nearshore recreation.

In September 1991, a public information meeting was held by the State Department of Transportation - Harbors Division, to discuss the status of the studies and to present the alternative concept plans that were developed for the Waikiki Beach improvements. The meeting was chaired by the Director of Transportation, Ed Hirata, and included slide presentations by Dr. James Walker of Moffatt & Nichol Engineers and Elaine Tamaye of Edward K. Noda and Associates. Following the formal presentations, the meeting was opened to questions and comments from the public. A transcript of this public information meeting was prepared for the record.

6.6 **Consulted Parties During Preparation of the Environmental Assessment.** The following agencies and individuals were provided copies of the Draft Environmental Assessment for review and comment. Comment letters received (indicated by asterisk) and written responses are included in Appendix E.

<u>Federal Agencies:</u>
U.S. Fish and Wildlife Service
National Marine Fisheries Service
U.S. Army Corps of Engineers*
U.S. Environmental Protection Agency

<u>State Agencies:</u>
Office of the Governor
Office of the Lieutenant Governor
Department of the Attorney General
Department of Business, Economic Development and Tourism (DBEDT)
DBEDT Planning Office*
Dept. Of Land and Natural Resources, Historic Preservation Division*
Dept. Of Land and Natural Resources, Aquatic Resources Division*
Dept. Of Land and Natural Resources, State Parks Division

Dept. Of Land and Natural Resources, Land Management Division*
Department of Health*
Department of Transportation*
Department of Transportation, Harbors Division*
Office of Hawaiian Affairs
U.H. Environmental Center
U.H. Water Resources Research Center

City and County of Honolulu:
Office of the Mayor
Department of Parks and Recreation*
Department of Emergency Services - Ocean Safety and Lifeguards
Department of Design and Construction*
Department of Planning and Permitting*
Department of Transportation Services*
Department of Planning
Department of Environmental Services*

Elected Officials:
State Senator Carol Fukunaga
State Senator Les Ihara, Jr.
State Senator Brian Taniguchi
State Representative Galen Fox
State Representative Brian Yamane
State Representative Scott Saiki
State Representative Terry Nui Yoshinaga
State Representative Calvin Say
Councilmember Duke Bainum
Councilmember Andy Mirikitani
Councilmember Rene Mansho
Councilmember Steve Holmes
Councilmember John Henry Felix
Councilmember Jon Yoshimura
Councilmember Donna Mercado Kim
Councilmember Mufi Hannemann
Councilmember John DeSoto
Waikiki Neighborhood Board No. 9

Others:
Waikiki-Kapahulu Public Library
Waikiki Improvement Association
Office of Waikiki Development
Hawaii Hotel Association
Hawaii Visitors and Convention Bureau
Waikiki Resident's Association
Outrigger Hotels
Sheraton Hotels
Halekulani Hotel
Frank Farm (Hawaii Council of Dive Clubs)

Surfrider Foundation, Oahu Chapter
Waikiki Surfing Ohana (Jordan Jokiel)*
Rob Mullane, Hawaii Sea Grant Extension
Ginny Meade, Greater East Honolulu Community Alliance
Waikiki Aquarium
Waikiki Surf Club
George Downing
Lester H. Inouye & Assoc.
Gordon Leong
Bob Colopy
Kenneth Martyn
Scott Houdek*

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Kanahele, George S., *Waikiki 100 B.C. TO 1900 A.D. An Untold Story*, The Queen Emma Foundation, Honolulu, 1995.

University of Hawaii, Water Resources Research Center, "Impact of Kapahulu Storm Drain System on Water Quality at Kuhio Beach: A Multi-Phasic Study", March 1994.

Exhibits

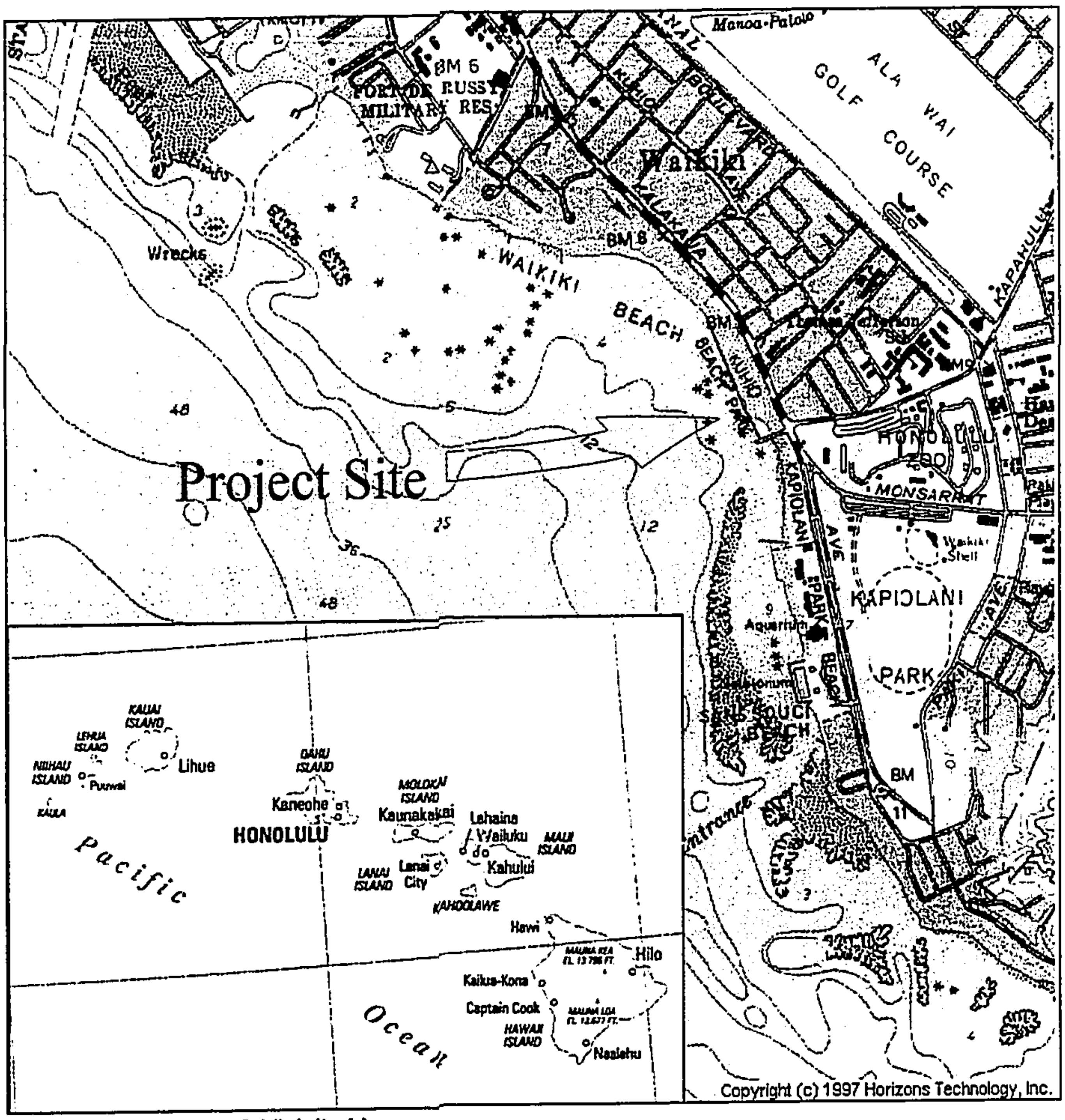
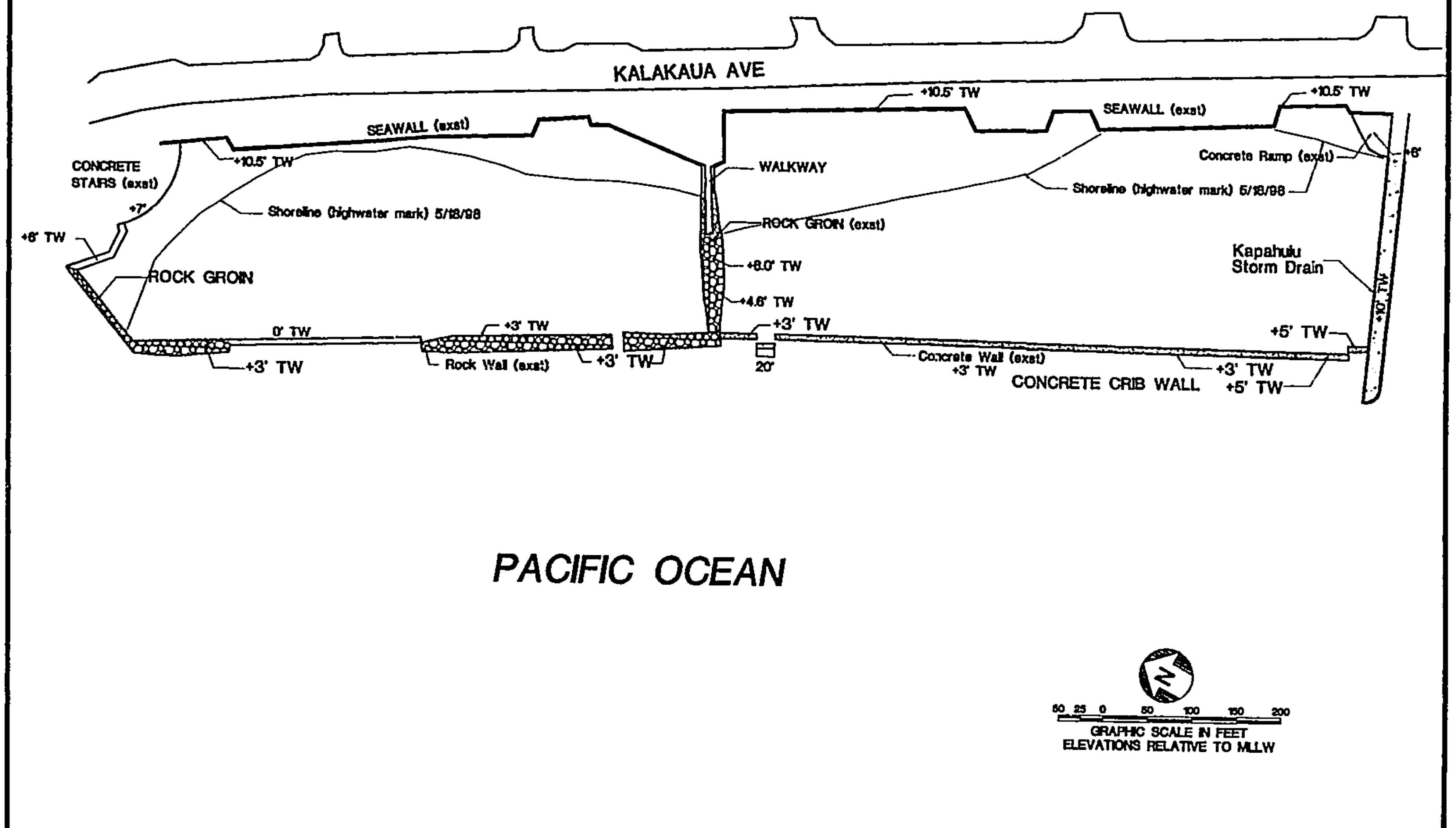
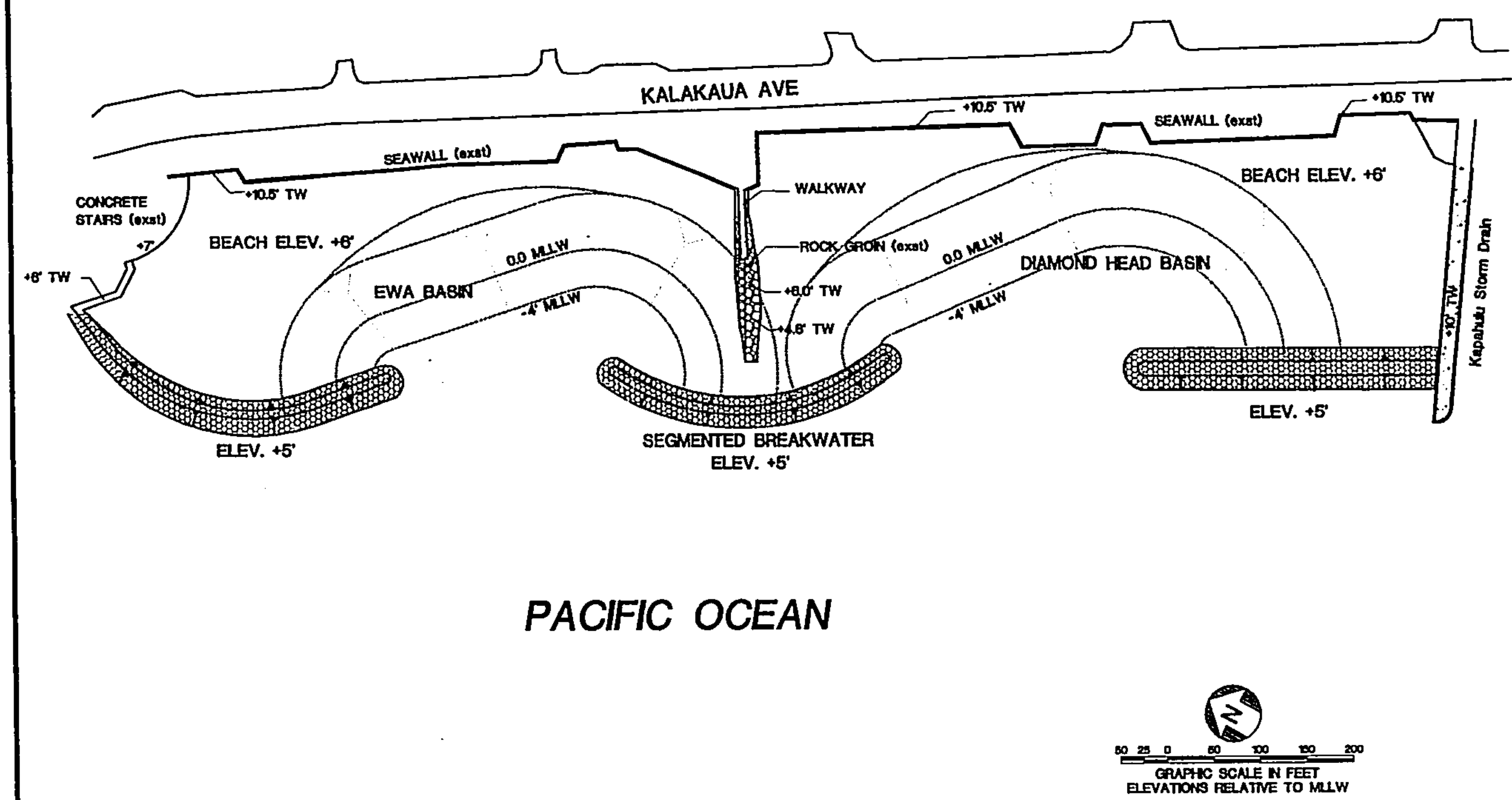


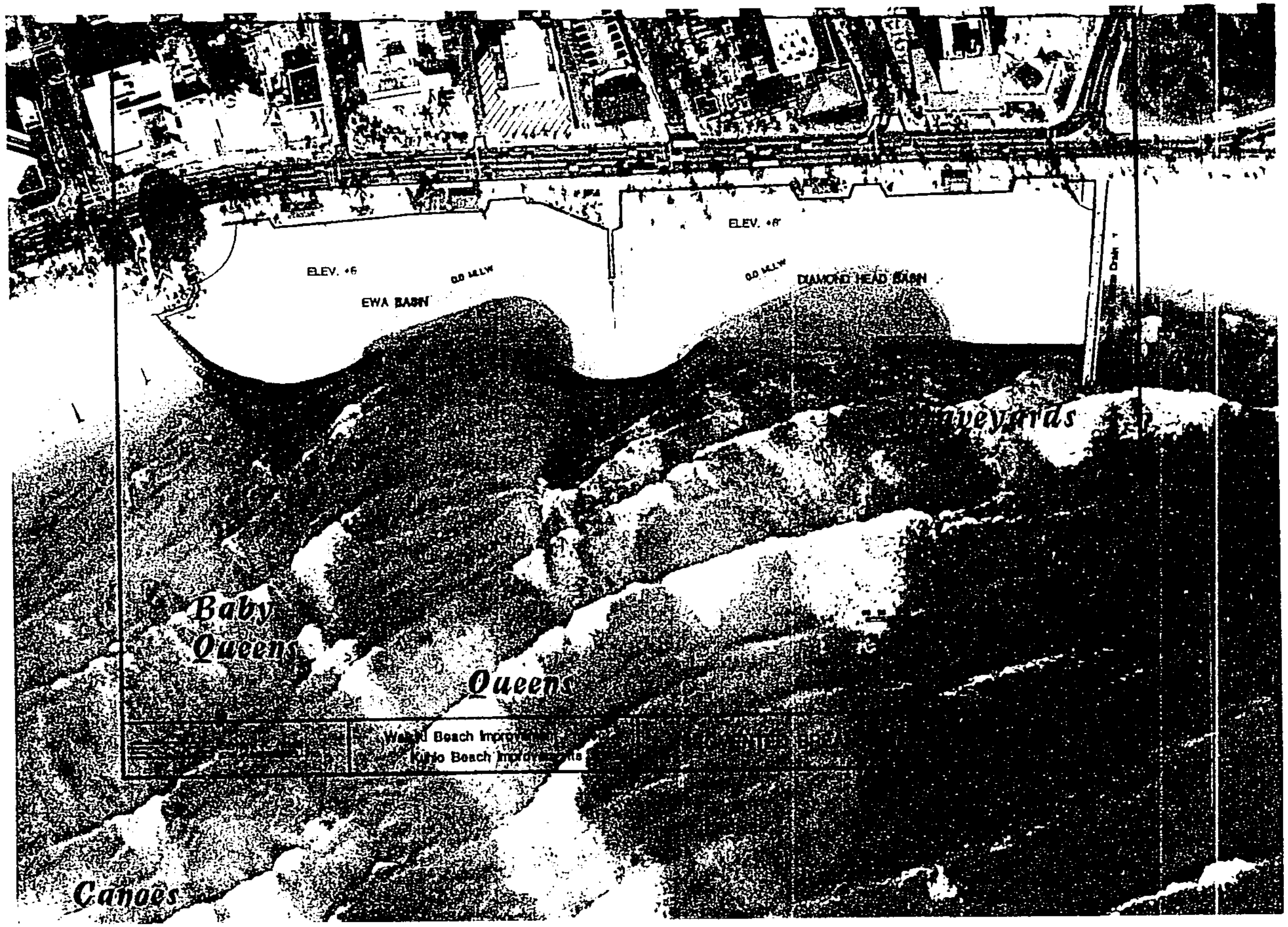
Exhibit 1. Location & Vicinity Map.



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	KUHIO BEACH PROJECT SITE - Existing Conditions	EXHIBIT 2



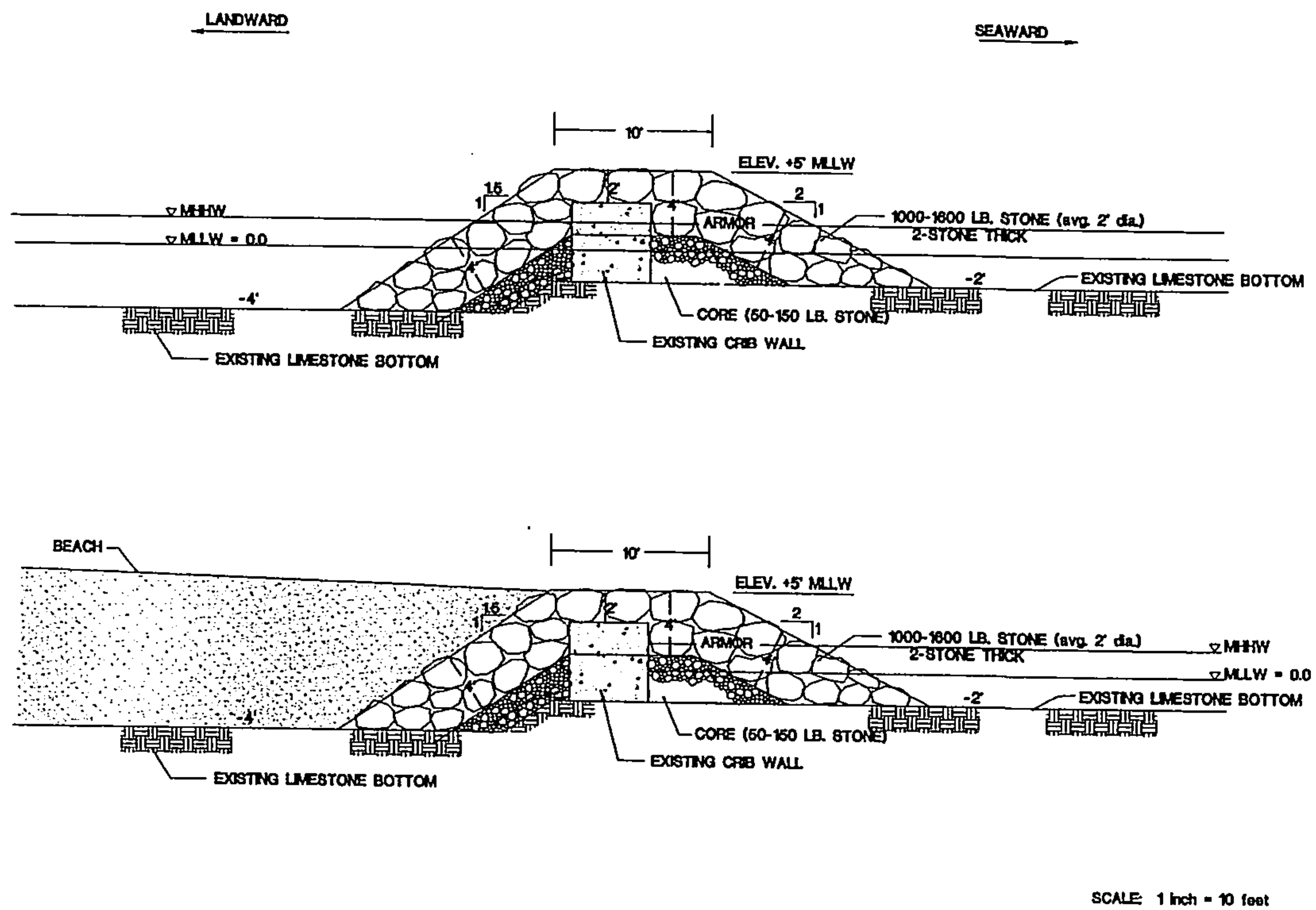
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	KUHIO BEACH - PROPOSED PLAN OF IMPROVEMENT	EXHIBIT 3



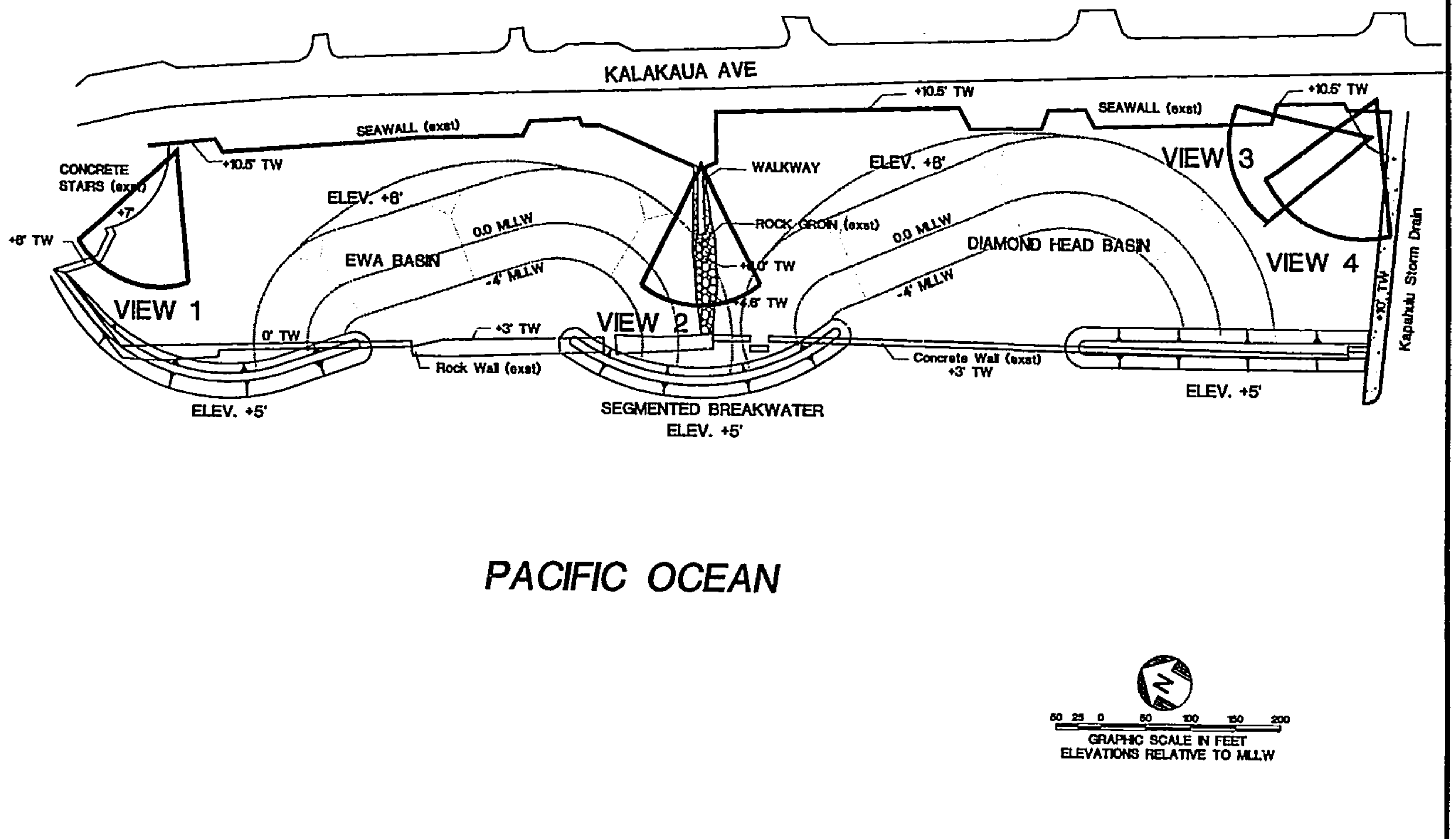
SIMULATED VIEW OF PROPOSED RESTORED BEACH WITH RECONSTRUCTED OFFSHORE WALLS
Reconstructed offshore walls are along the same alignment as existing walls, and will not affect the offshore surf sites.

Edward K. Noda and Associates, Inc. KUHIO BEACH IMPROVEMENTS. State of Hawaii, DLNR Aerial photo by Air Survey Hawaii, 12/1/82

EXHIBIT 4



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	BREAKWATER SEGMENTS - TYPICAL SECTIONS	EXHIBIT 5

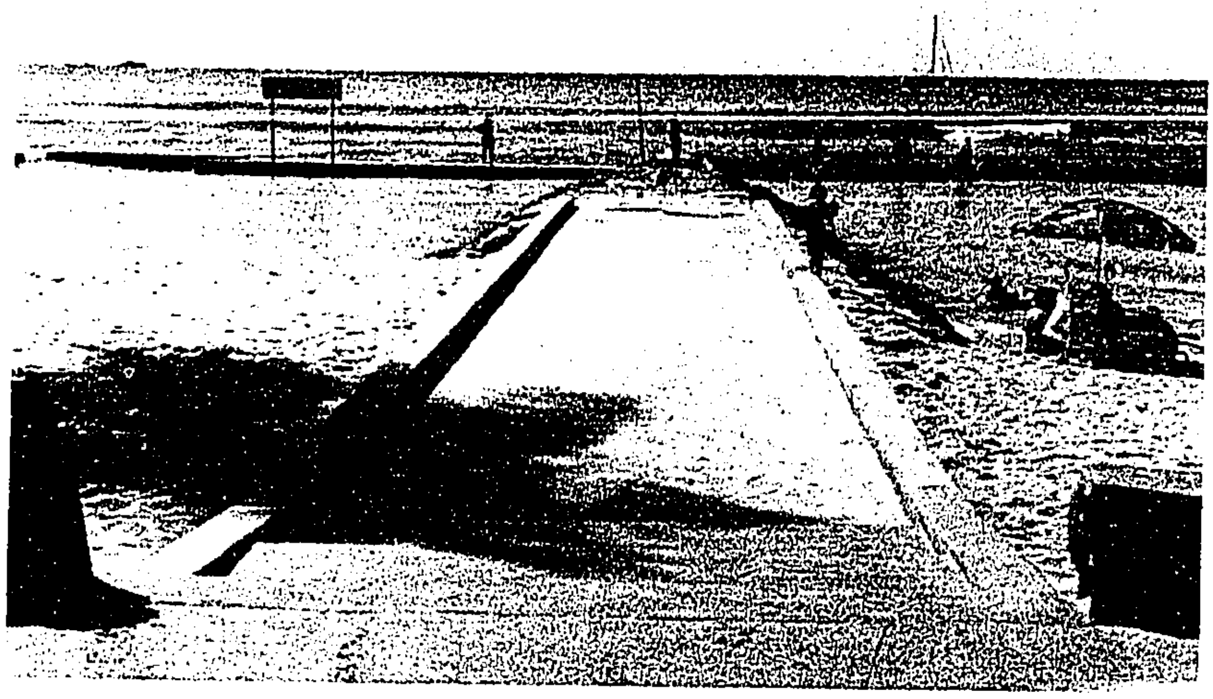


Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	PHOTO VIEWS OF KUHIO BEACH - EXISTING VS. PROPOSED	EXHIBIT 6

EXISTING VIEW OFFSHORE 11/12/98

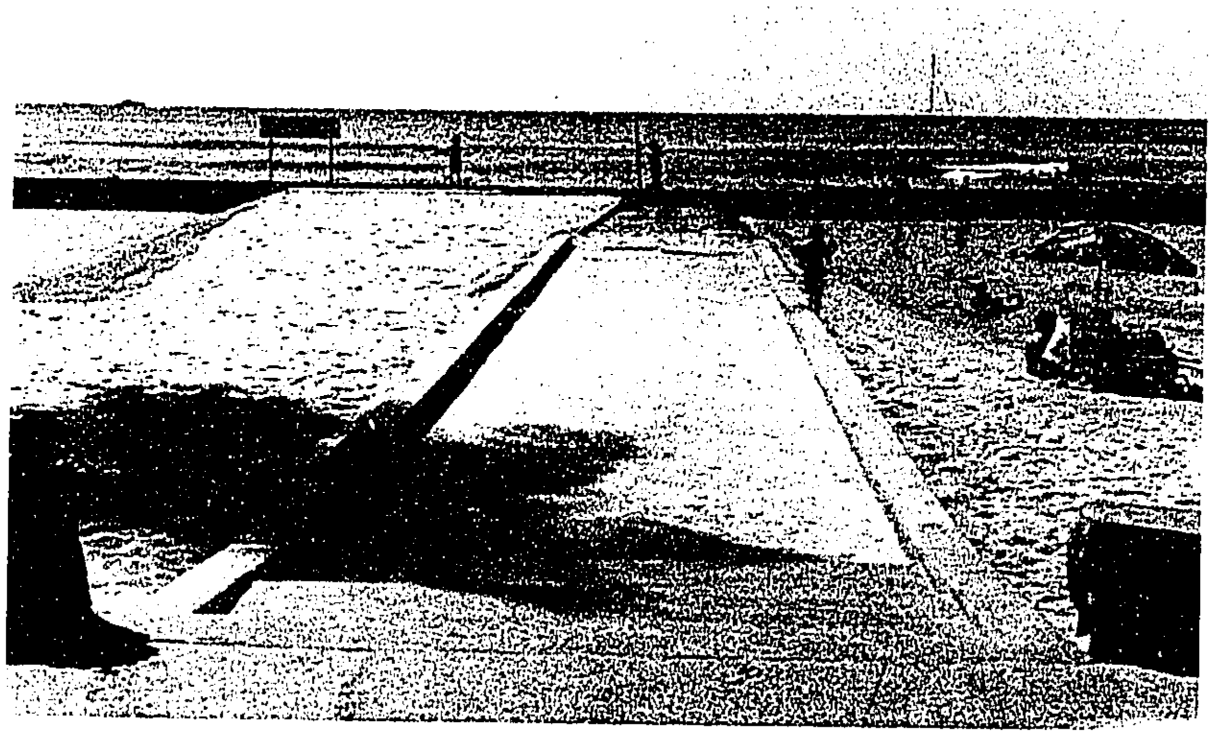
PROPOSED RESTORED BEACH WITH RECONSTRUCTED OFFSHORE WALLS (SIMULATED VIEW)
Offshore wall height raised 2 feet to protect new beach. Seaward views not obstructed. New beach elevation +6 feet MLLW to match existing.

VIEW #1 - VIEW OFFSHORE AT STEPS NEAR BANYAN TREE



EXISTING VIEW OFFSHORE

11/12/98



PROPOSED RESTORED BEACH WITH RECONSTRUCTED OFFSHORE WALLS (SIMULATED VIEW)
Offshore wall height raised 2 feet. Seaward views not obstructed.

VIEW #2 - VIEW OFFSHORE AT MIDDLE GROIN

EXISTING VIEW TOWARDS ROYAL HAWAIIAN HOTEL 11/12/98

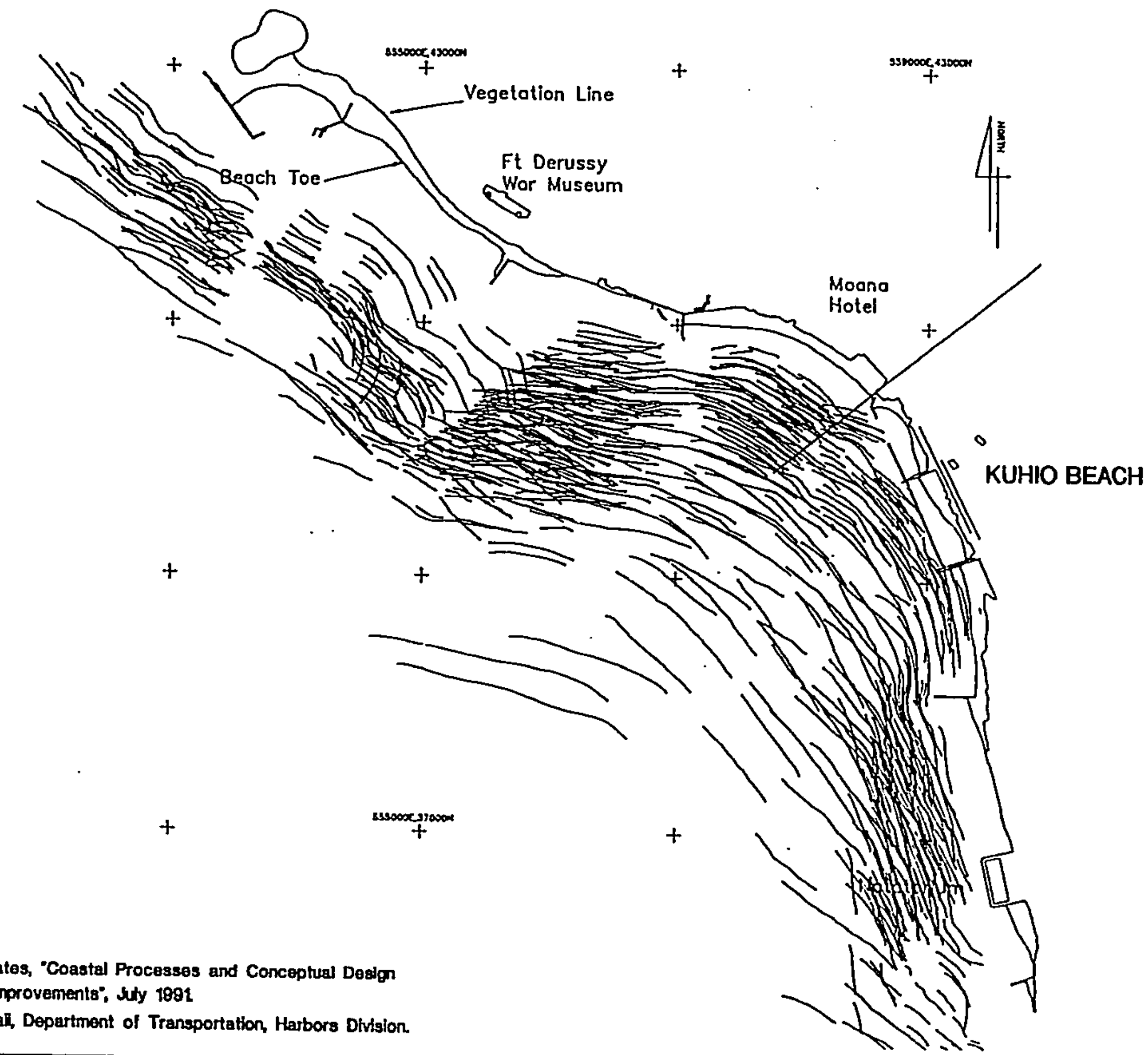
PROPOSED RESTORED BEACH WITH RECONSTRUCTED OFFSHORE WALLS (SIMULATED VIEW)
Offshore wall height raised 2 feet. Approx. 250-foot wide gap between raised wall sections provides unobstructed views of surf sites. Beach elevation raised to +6 feet MLLW along shoreline.

VIEW #3 - VIEW NORTHWARD FROM RAMP AT KAPAHULU STORM DRAIN

EXISTING VIEW OFFSHORE FROM SIDEWALK LEVEL 11/12/98
Offshore wall height is +5 feet MLLW next to Kapahulu Storm Drain, and +3 feet for rest of wall.

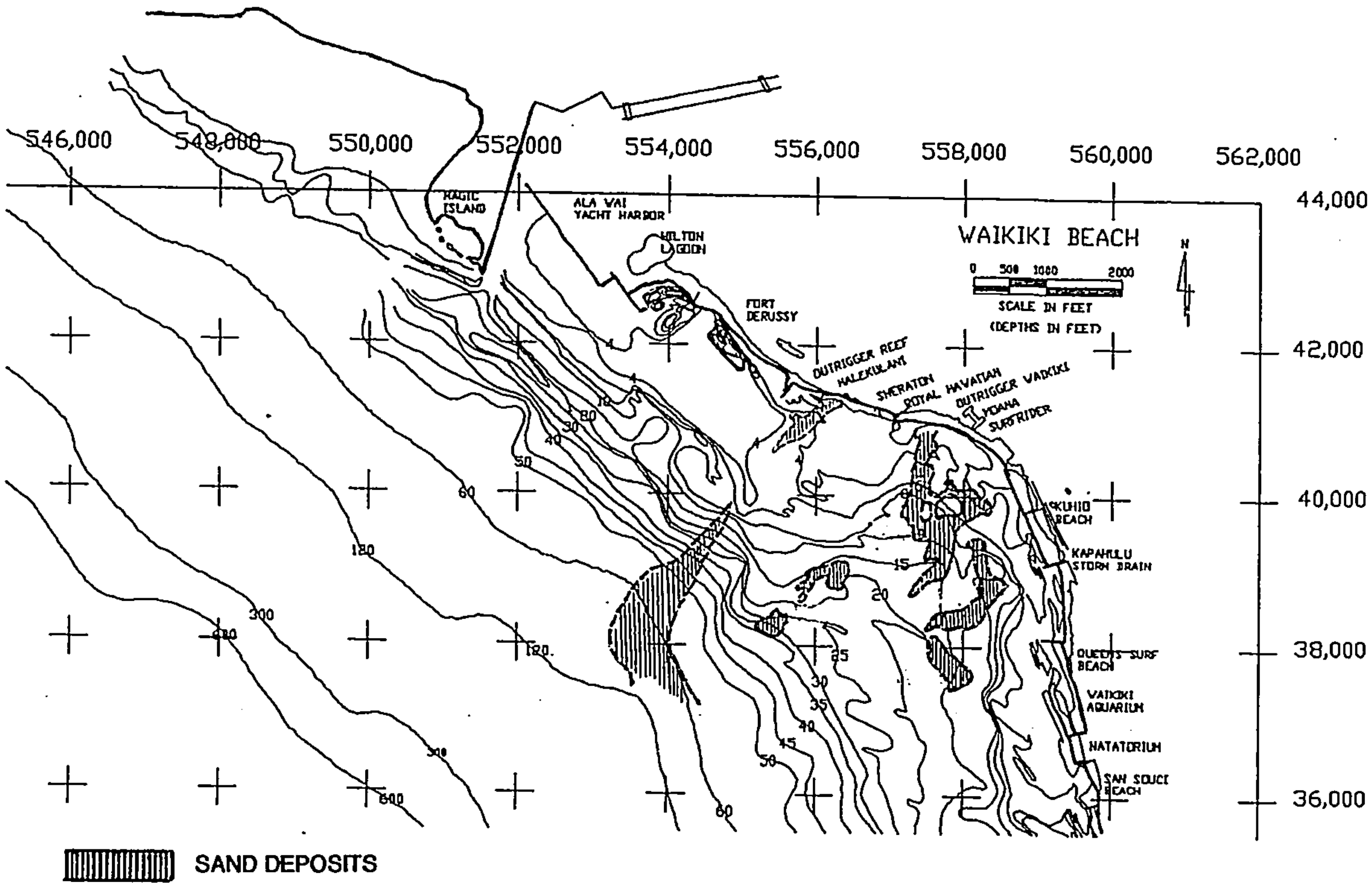
PROPOSED RESTORED BEACH WITH RECONSTRUCTED OFFSHORE WALLS (SIMULATED VIEW)
Offshore wall height +5 feet MLLW, same as existing section of wall next to Kapahulu Storm Drain. Approx. 250-foot wide gap between wall sections enhances seaward views.

VIEW #4 - VIEW OFFSHORE AT KAPAHULU STORM DRAIN



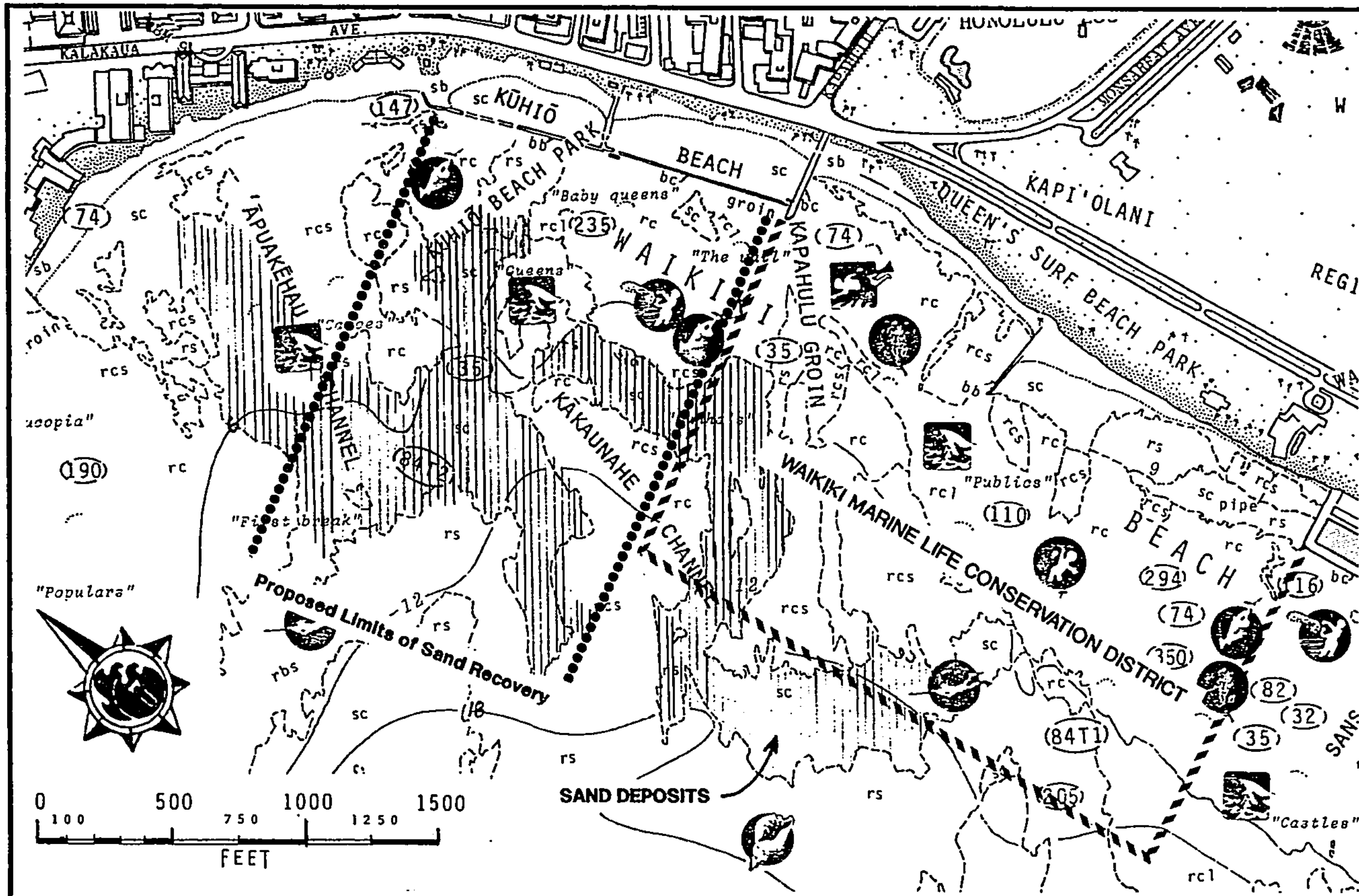
From Edward K. Noda and Associates, "Coastal Processes and Conceptual Design Considerations for Waikiki Beach Improvements", July 1991
Report prepared for State of Hawaii, Department of Transportation, Harbors Division.

Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	WAVE FRONT PATTERNS OFFSHORE WAIKIKI FROM AERIAL PHOTO ANALYSIS 1952-1990	EXHIBIT 11



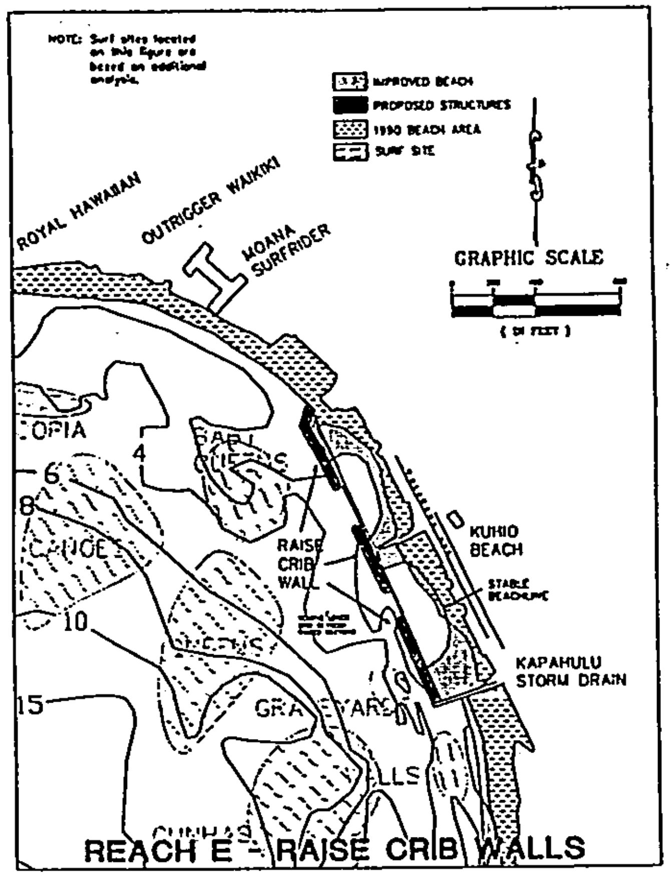
From Edward K. Noda and Associates, "Sand Source Investigations for Waikiki Beach Fill", June 1991, report prepared for State of Hawaii, Department of Transportation, Harbors Division.

Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SAND DEPOSITS ON NEARSHORE REEF AREAS OFFSHORE WAIKIKI	EXHIBIT 12

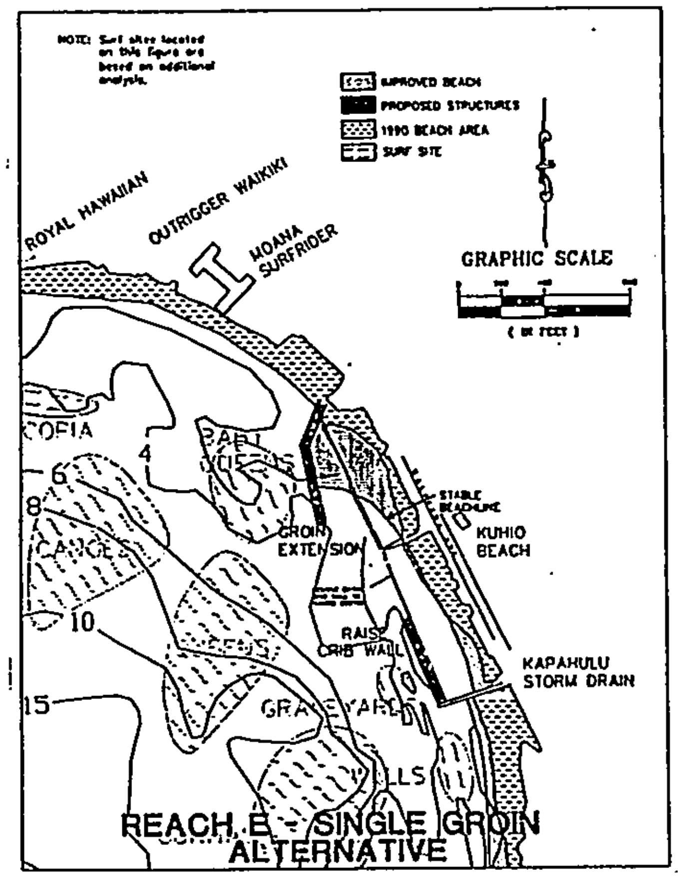


Map background from "Oahu Coastal Zone Atlas, Coral Reef Inventory of Oahu", produced by AECOS Inc. for the U.S. Army Corps of Engineers, 1981.

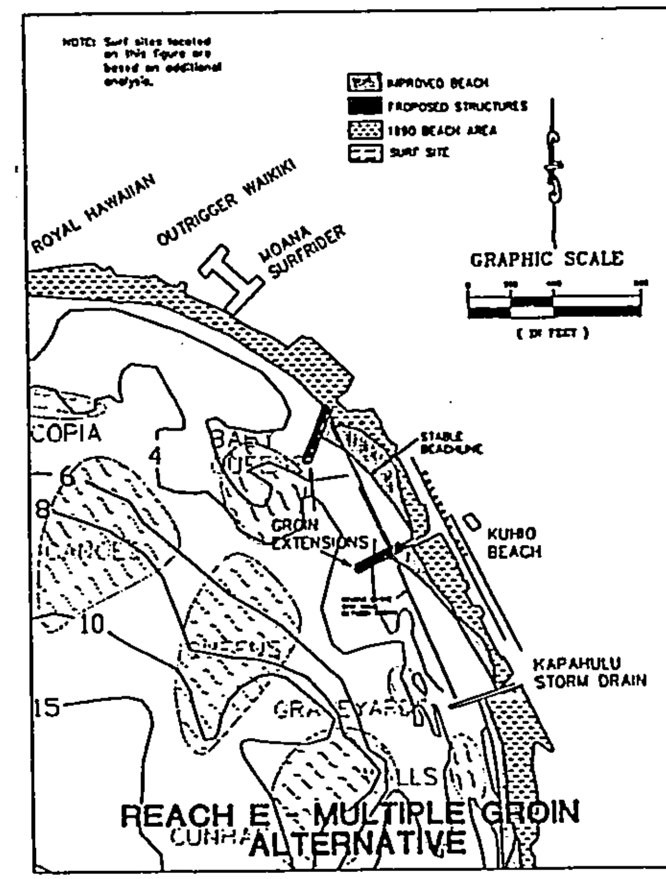
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SAND DEPOSITS PROPOSED FOR KUHIO BEACH NOURISHMENT	EXHIBIT 13



CONCEPT 1



CONCEPT 2



CONCEPT 3

From Edward K. Noda and Associates, Waikiki Beach Improvement Project, Alternatives and Economic Feasibility Evaluation", December 1991.

Report prepared for State of Hawaii, Department of transportation, Harbors Division.

Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	ALTERNATIVE STRUCTURAL MEASURES	EXHIBIT 14

Appendix A

Kūhiō Beach Physical Model Test, Phase 2

KUHIO BEACH PHYSICAL MODEL TEST, PHASE 2

WAIKIKI BEACH IMPROVEMENTS
HONOLULU, HAWAII
JOB H.C. 2269

Prepared For:

State of Hawaii
Department of Land and Natural Resources
Division of Boating and Ocean Recreation
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

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Honolulu, Hawaii 96814

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Escondido, California 92029

EKNA Project No.: 1201-25F

August 31, 1998

KUHIO BEACH PHYSICAL MODEL TEST, PHASE 2

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF TABLES

1.0 INTRODUCTION

1.1 Background

The Fifteenth State Legislature appropriated funds to the Department of Transportation, Harbors Division (DOT-Harbors), for the planning and restoration of the sand beach between the Waikiki Aquarium and Fort DeRussy. In order to design appropriate beach improvement plans, a detailed program of oceanographic, coastal engineering, and sand source studies was undertaken by Edward K. Noda and Associates, Inc. (EKNA) under contract with DOT-Harbors. Environmental and economic feasibility evaluations were also accomplished to identify conceptual alternative plans for beach improvements. An extensive public involvement program was an important component in this planning effort.

As a result of the technical studies conducted and input provided by various governmental, civic and special interest groups, a range of improvement options were developed. These options included plans for beach nourishment, and construction options for the beach nourishment. Total construction cost was estimated at $10 million (in 1992 dollars), of which over half the cost was devoted to beach improvements between the Fort DeRussy groin and the Royal Hawaiian groin (directly fronting the Outrigger Reef, Halekulani, Sheraton and Royal Hawaiian hotels).

However, because of the problem in resolving the littoral rights issue with the hotels, greater focus was placed on the Kuhio Beach sector, and additional technical studies were performed to advance the planning and preliminary engineering for this one sector. This effort included a physical model study of the proposed Kuhio Beach plan of improvements which was completed in 1993. The following report describes the second (Phase 2) physical model study that was undertaken in May 1998 to obtain more detailed data on the design performance of the recommended plan and alternative concepts.

1.2 Site Description

Kuhio Beach, which is part of the Waikiki Beach system, is located toward the southeastern end of Waikiki, as shown in Figure 1-1, and its limits extend between the Kapahulu storm drain on the south to a rubble groin on the north, a length of about 1,450 ft. A central rubble groin compartmentalizes Kuhio Beach into two approximately equal cellular beaches, north and south basins, as described in Figure 1-2. A series of concrete and rock "crib walls" fronts the beach on the seaward (makai) side and is located about 200 ft makai of the Kalakaua Avenue wave-protective seawall. The crib walls provide a wave protected swimming and beach area.

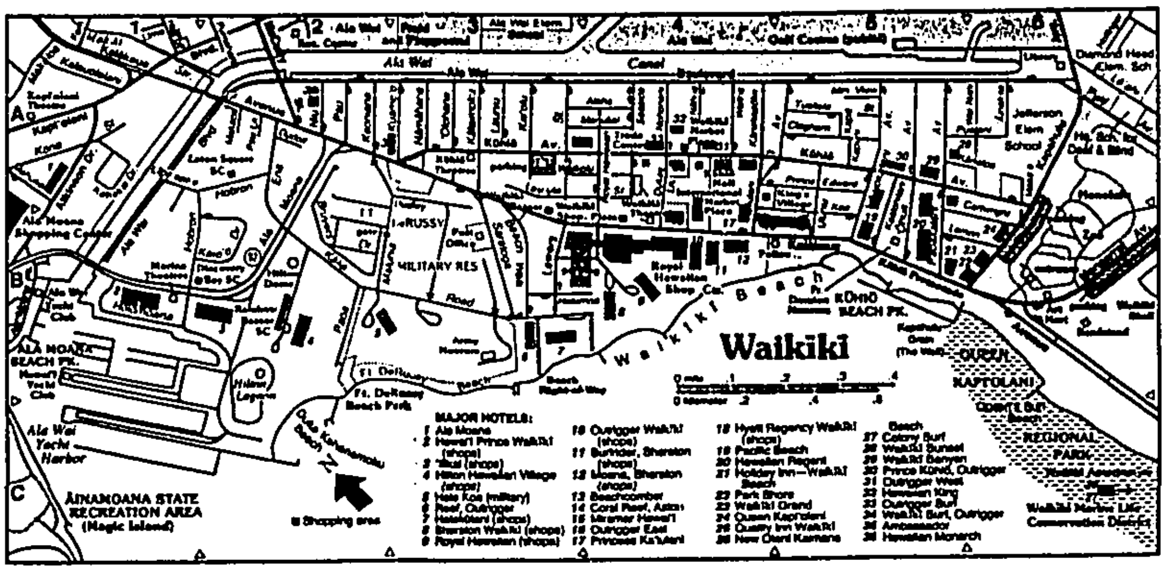
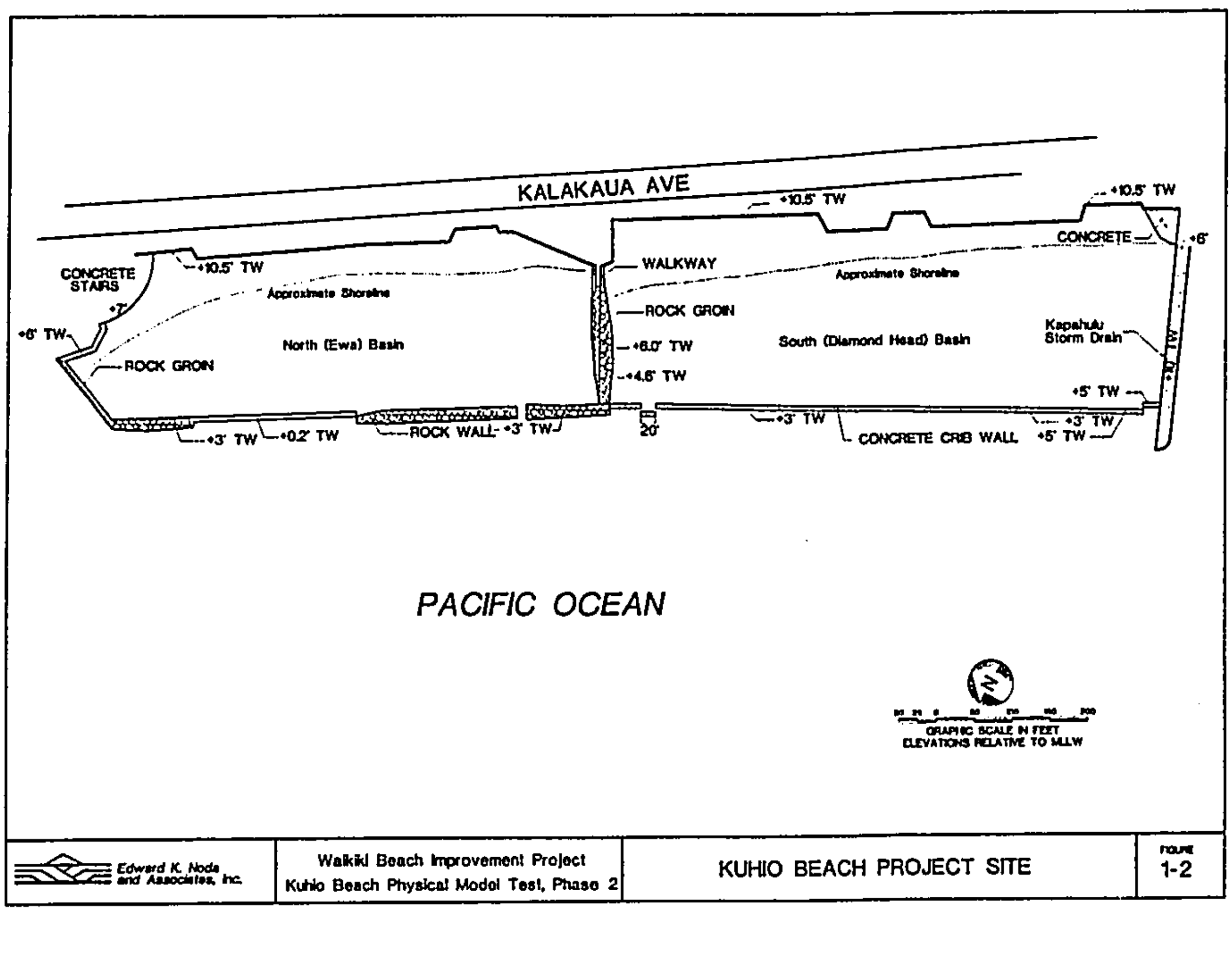


Figure 1-1: Waikiki Beach Vicinity Map



1.3 Purpose and Scope

The Waikiki beaches are largely man-made. In the late 1920's the Ala Wai Canal was dredged to capture and divert rainfall runoff from passing over and entering Waikiki Beach. The dredged material was used as fill to construct much of the land at Waikiki, which was previously low lying swamp lands. Sand has been periodically placed on the Waikiki beaches to increase its width and provide more attractive beaches. Groins, seawalls and other structures such as the Crib Walls at Kuhio Beach have been constructed over the years to stabilize the beaches.

The Kuhio Beach crib wall system has evolved over the years to its present configuration, but continues to exhibit problems with efficient functioning of this beach stabilization system, requiring periodic beach nourishment and maintenance of the beach areas contained within the cellular beaches. The crib wall system is the primary focus of concern. The orientation of the crib walls relative to the dominant in-coming waves, the low-height crib walls which allow wave over-topping, the vertical solid structure which causes wave reflections, and strong seaward return currents through the narrow gaps between crib walls, all contribute to creating an irregular and unstable beach.

With the combined orientation of the crib walls and its low crest height, wave overtopping frequently occurs and the transmitted waves arrive at an angle to the beach. Longshore currents induced by the waves arriving at an angle to the beach, move sand towards the north or towards the Ewa direction. Thus, sand is slowly lost from the beach basins by transport over the Ewa end groins.

Waves overtopping the low height crib walls adds water to the beach basins which raises the water level relative to the ocean water level. The only opportunity for return flows are the narrow gaps between the crib wall segments, which generate strong return flows and produces deep scour holes in the sand bottom. This is another mechanism for the loss of sand from the beach basins. The unexpected depth and strong currents at these gap scour holes present a danger to unsuspecting waders and have been implicated in several drowning accidents.

The crib wall system restricts the free circulation of flushing water. The wave-protected Kuhio Beach is heavily used by beach-goers, resulting in pollutants being transferred to the poorly flushed basin waters. In addition, the Kapahulu storm drain discharges rainfall runoff waters just seaward of the south basin or Diamond Head basin, where gaps in the crib wall system allows the rainfall runoff discharges to enter the basin waters. It is known that the Kapahulu storm drain discharges include high concentrations of bacteria. These factors as well as others contributes to the generally poor water quality in the enclosed basin waters.

Edward K. Noda and Associates, Inc. [EKNA] (1991) developed conceptual design alternatives to improve Kuhio Beach as part of an overall study for Waikiki Beach Improvements. Based on the conceptual design alternatives, a physical model study was carried out using a semi-movable bed model of Kuhio Beach (Moffatt & Nichol, Engineers, 1993). This model study was

performed at the J.K.K. Look Laboratory of Oceanographic Engineering, University of Hawaii at an undistorted model scale of 1:40 (model:prototype). The purpose of the physical model study was to evaluate the overall effectiveness of the recommended plan of improvement compared to the existing conditions, with respect to improving the water quality and circulation within the basins, improving beach stability, and minimizing impacts to offshore surf sites. This Phase 1 physical model study demonstrated that the proposed improvements to Kuhio Beach could both improve water quality within the basins as well as promote a more stable beach configuration. However, the scale of this model was too small to obtain relevant information on the design stability of the breakwater, wave runup and overtopping characteristics of the breakwater, and the effects of wave transmission on the stability of the beach.

The present Phase 2 Kuhio Beach Model study was designed to obtain more detailed data on the design performance of alternative breakwater concepts. To provide the largest model scale for the Phase 2 study, it was decided to model only the south or Diamond Head basin at a scale of 1:20. The results from this model test effort would be applicable to the design of the north or Ewa Basin breakwater configuration. The following were the objectives of this three-dimensional (3-D) model study:

1. <u>To verify the structural stability of the proposed breakwater design</u>, which is a rubblemound structure intended to convey a natural look reminiscent of Hawaiian rock walls. The existing crib wall structure is proposed to be removed and a new breakwater structure constructed at the approximate same location. The stability of the rubblemound breakwater was tested by running design-equivalent waves in the model.

2. <u>To evaluate the degree of wave overtopping of the breakwater</u>, with the goal of minimizing the height of the breakwater, but at the same time, maintaining a calm shallow wading area and protected beach. The breakwater design concept envisioned the top of the breakwater at elevation 7 feet above mean lower low water (MLLW) in order to prevent wave overtopping. While this non-overtopping breakwater structure would maximize protection, it would also obstruct some of the seaward view plane. A lower breakwater height was tested in the model to evaluate whether overtopping could be allowed and still result in a stable beach planform and safe swimming area.

3. <u>To evaluate the planform behavior of the beach protected by the segmented breakwater system</u>, with the objective of maximizing the stable beach area. The segmented breakwater concept is designed with wide enough gaps between the breakwater segments to prevent strong return-flow currents and to provide water flushing and maintenance of good water quality in the basins. Waves passing through the breakwater openings would create wave diffraction zones in the lee of the breakwater segments, which determine the planform shape of the beach. The crescent-shaped beach was tested in the model to evaluate the maximum stable beach area.

4. <u>To assess other concepts</u>, such as extended groins, to evaluate the effectiveness in stabilizing comparable beach areas. Previously identified conceptual design alternatives for Kuhio Beach improvements involved various configurations of groin extensions. The segmented breakwater concept was identified as the preferred alternative because the structures would not extend substantially seaward of the present crib walls, whereas any groin alternative would extend significantly seaward of the present walls and potentially impact the surf sites. However, a groin alternative was modeled to assess the viability of this alternative in stabilizing the beach.

The model testing scope of work also included producing a video documentary describing the model objectives, test procedures and test results. The intent of the video is to provide a short summary presentation that can be used for public information purposes.

1.4 Test Configurations

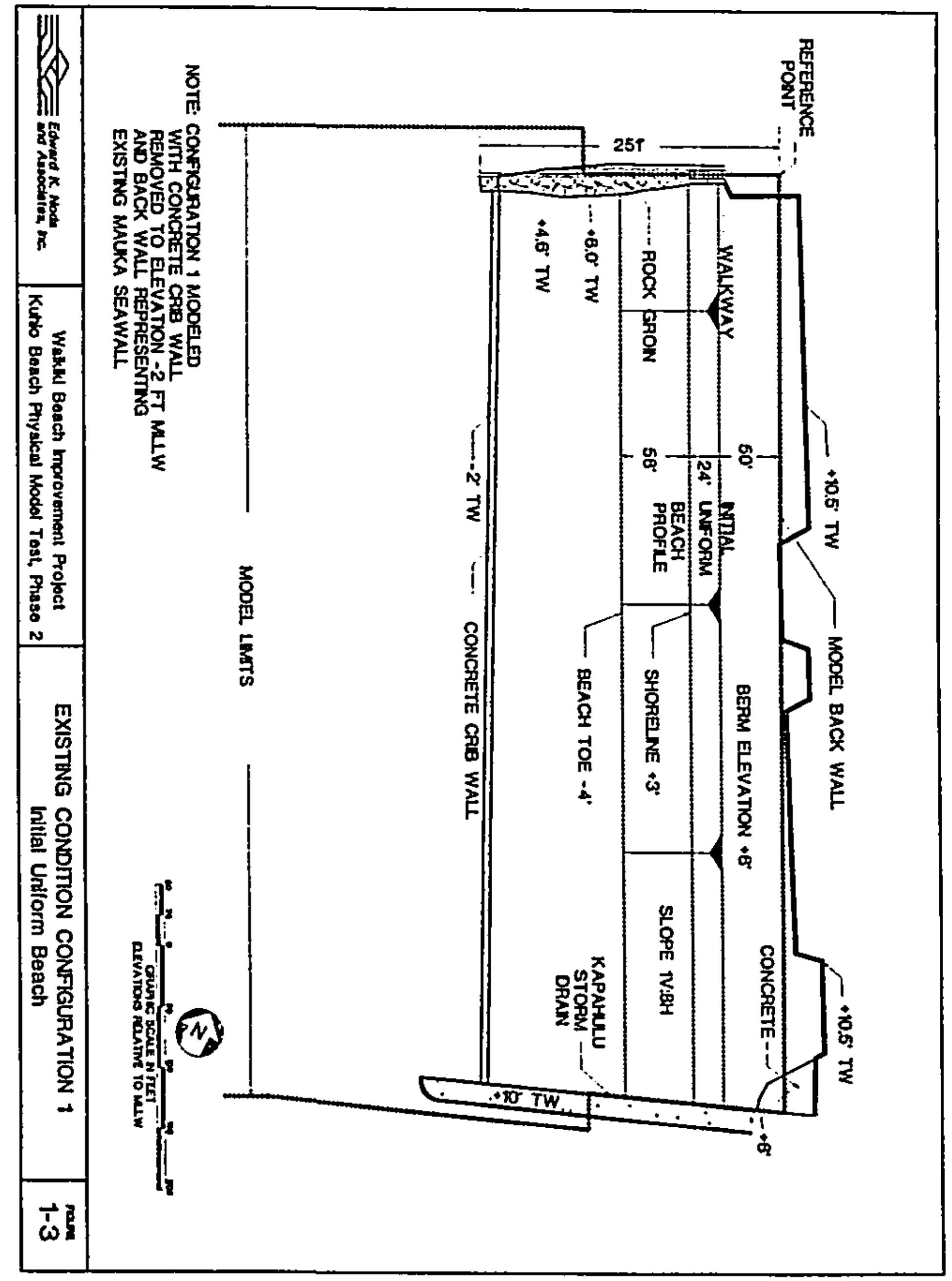
Three configurations were tested consisting of the existing condition and two alternative improvement concepts.

Configuration 1: Existing Condition Without Crib Wall Structures

Configuration 1 represents the existing condition but with the removal of the crib walls down to elevation -2 ft MLLW which is the approximate depth of the reef at the seaward edge of the walls. The initial beach profile was represented by a uniform beach consisting of a 50 ft wide flat berm at elevation +6.0 ft MLLW and a beach face with a slope of 1V:8H extending seaward from elevation +6.0 to -4.0 ft MLLW. Figure 1-3 describes this existing condition configuration and the initial uniform beach planform for the section of Kuhio Beach that was actually represented in the model basin. The objective of this test was to quantify the evolution of the beach planform changes when no wave protection is provided.

Configuration 2: Groin Extension

Configuration 2 represents a new 350 ft groin that is build over the existing center basin-dividing groin and will extend 150 ft beyond the end of the existing groin. In addition, the crib walls have been removed down to elevation -2.0 ft MLLW. The groin crest elevation for the entire 350 ft groin was +7 ft MLLW to prevent sand overtopping and by passing. Two different initial beach planform shapes were tested for this configuration. First, the initial beach shape consisted of a "maximum fillet" beach, which featured a straight fillet on the groin (north) end of the beach extending about one-third the basin length and continuing with the uniform beach profile to the Kapahulu Storm Drain wall on the south end. Second, an "equilibrium" beach was tested which was determined by the approximate equilibrium shape obtained after conducting the test with the "maximum fillet" beach. This equilibrium beach planform shape was similar to the previous "maximum fillet" beach but at a less severe fillet angle. For the "maximum fillet" beach profile, the berm elevation was +6 ft MLLW and the straight uniform beach had a slope of 1V:8H, while



Waikiki Beach Improvement Project
Kuhio Beach Physical Model Test, Phase 2

EXISTING CONDITION CONFIGURATION 1
Initial Uniform Beach

FIGURE 1-3

the "maximum fillet" section had a beach slope of 1V:5.8H. For the "equilibrium" beach in the area of the fillet, the beach slope was set to a more gradual 1V:10H, while the remaining the uniform beach slope was 1V:8H.

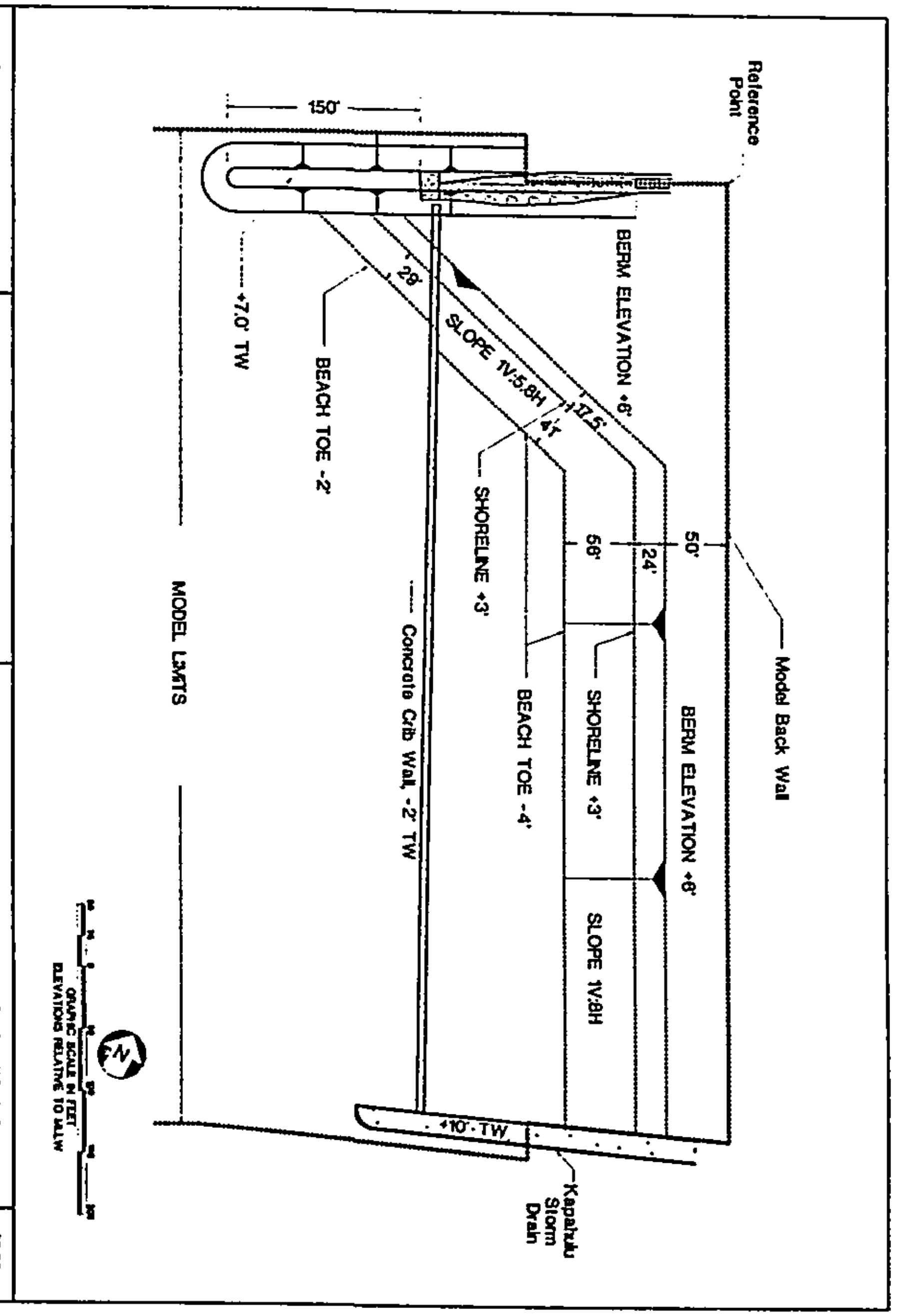
Figures 1-4 and 1-5 show the Configuration 2 with the "maximum fillet" beach and the "equilibrium beach", respectively. The objective of this configuration test was to evaluate the effectiveness of a groin extension in stabilizing the beach planform shape. In addition, the structural stability of the rubblemound groin extension design was evaluated under the design wave event conditions.

Configuration 3: Segmented Breakwater

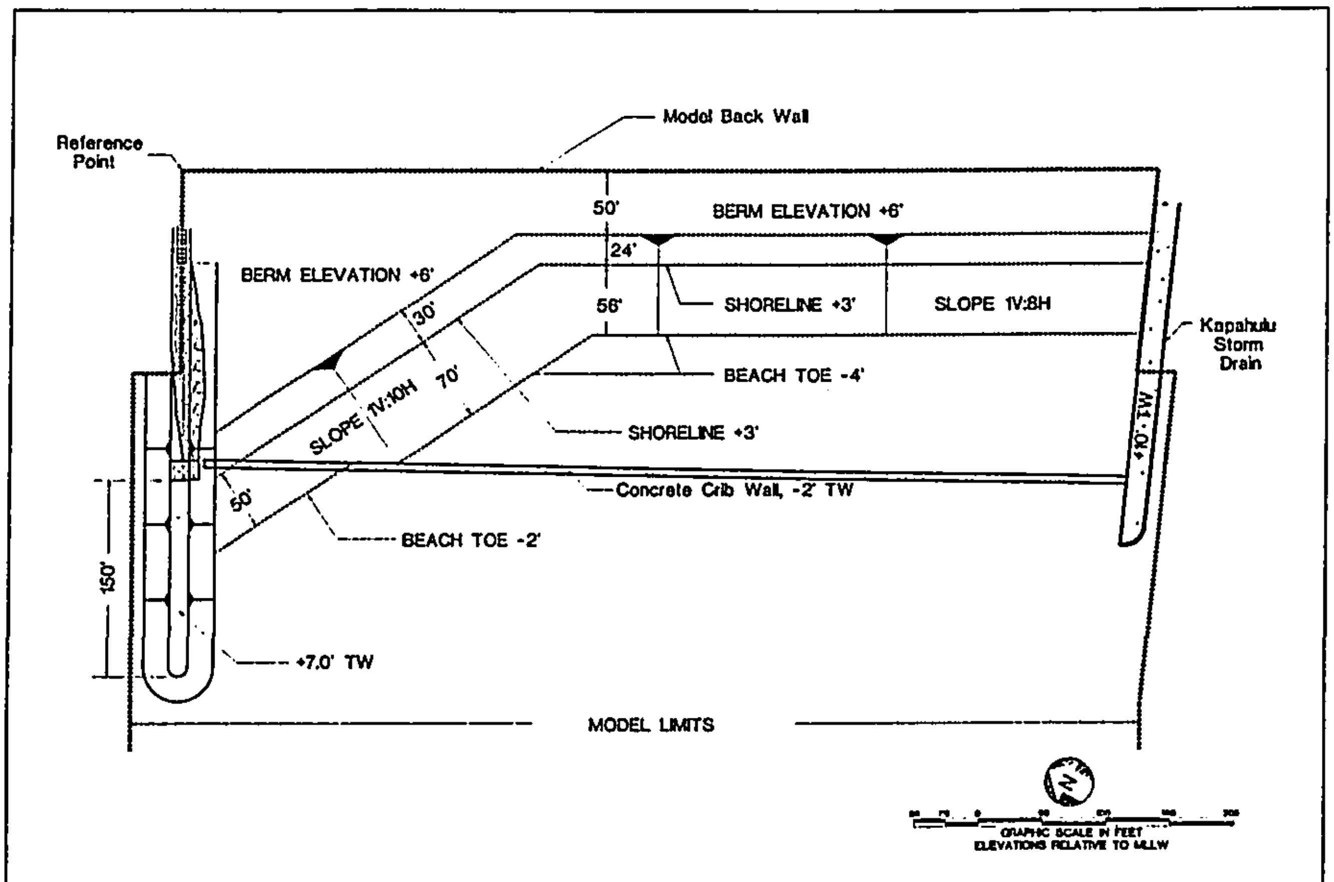
Configuration 3 represents the segmented rubblemound breakwater concept which is considered the most favorable design alternative and is shown in Figure 1-6 (Moffatt and Nichol Engineers, 1993). The original design concept shows the south breakwater segment to be curved to reduce wave reflections. However, during the Groin Extension, Configuration 2 tests, it was noted that a strong rip current formed along the Kapahulu storm drain basin wall. In addition, as the curved breakwater meets the Kapahulu storm drain wall, the wave height will probably increase as the "V" notch is approached, which could present a safety problem for surfers and boogie boarders. Thus, the design was modified to a straight section for the south breakwater segment as shown in Figure 1-7, which represents the Configuration 3, Segmented Breakwater plan that was tested.

The southern breakwater segment extends from the Kapahulu storm drain northward about 340 ft in a straight alignment over the existing crib wall footprint. The northern rubblemound breakwater section, with a length of about 160 ft, represents a half segment of the proposed curved middle breakwater design segment centered on the basin-dividing existing groin. The large gap between the breakwater segments is about 270 ft wide and is designed for free-flow water exchange to improve water quality and to prevent strong return flows in order to minimize the development of deep scour holes. The crib wall has been removed down to elevation -2.0 ft MLLW. The large gap or opening is not centered, but has been shifted towards the north direction in recognition of the direction of dominant wave attack and the need to provide as much berm width as possible for erosion protection. The incident waves will pass through the breakwater opening and create wave diffraction zones behind each breakwater segment, thereby determining the circular planform shape of the shoreline and the resulting dry beach area. Thus, one of the objectives of the Configuration 3 tests was to evaluate the planform shape of the beach with a goal of maximizing the stable beach area within each of the Kuhio Beach basins. The initial beach was crescent shaped, with a berm elevation of +6 ft MLLW and a beach slope of 1V:8H.

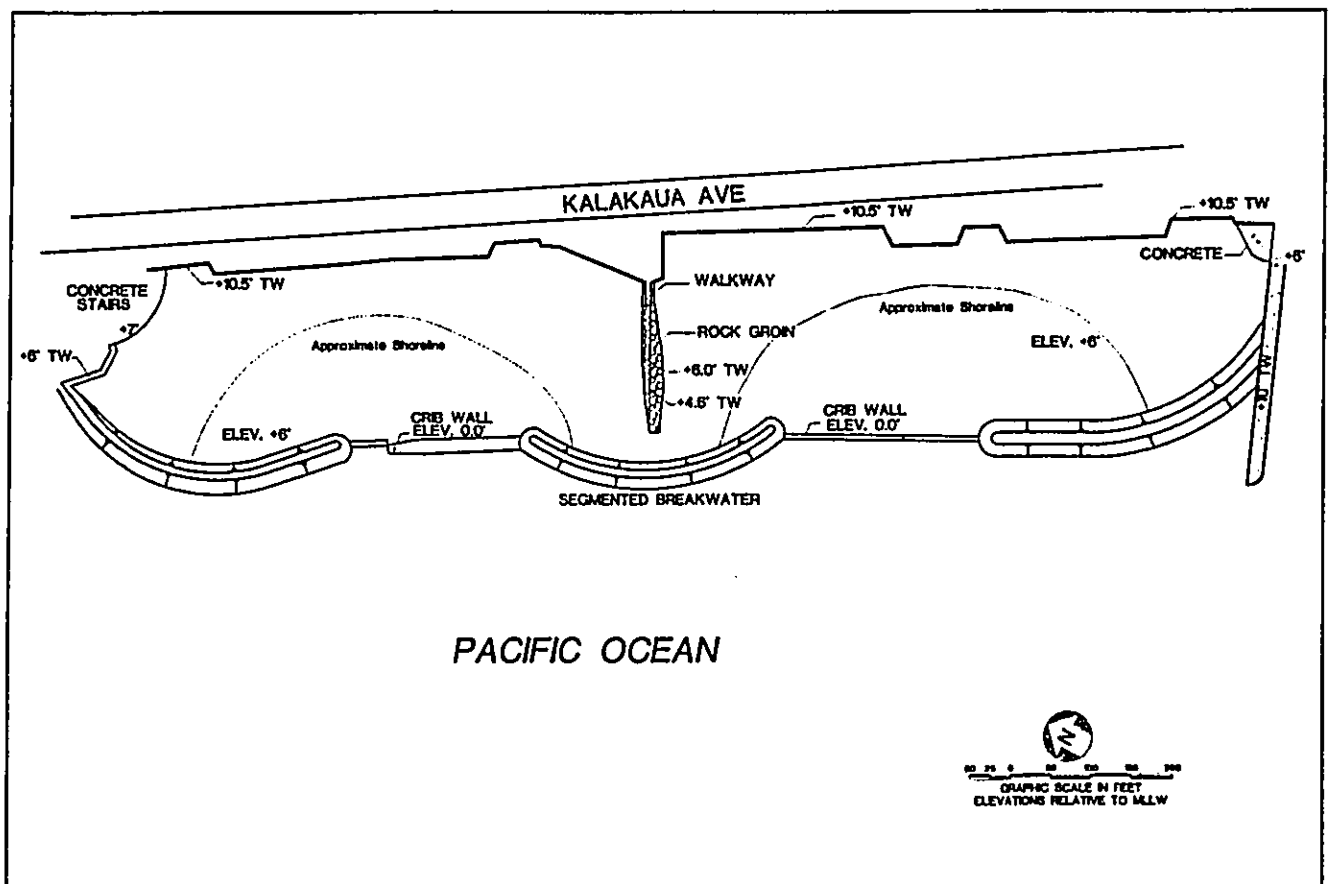
The breakwater crest elevation was +5 ft MLLW, which is only 2 ft higher that the existing crib wall and still lower than the beach berm elevation of +6 ft MLLW. This breakwater elevation was expected to be overtopped, but was considered the lowest practicable height in order to provide a stable beach and safe swimming area.



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project, Kuhio Beach Physical Model Test, Phase 2 | GROIN EXTENSION CONFIGURATION 2 Initial Maximum Fillet Beach | FIGURE 1-4

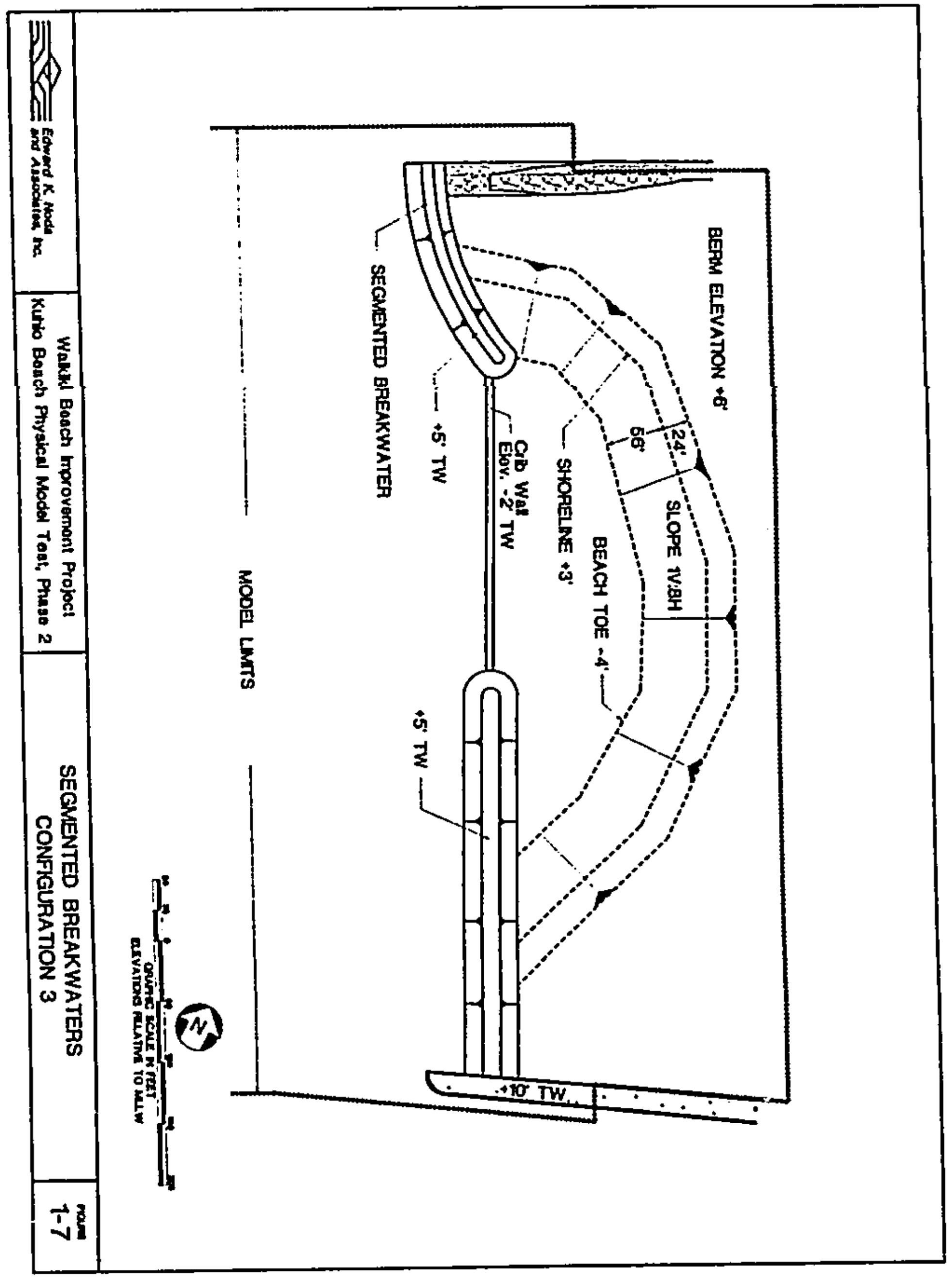


Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project
Kuhio Beach Physical Model Test, Phase 2 | GROIN EXTENSION CONFIGURATION 2
Initial Equilibrium Beach | FIGURE 1-5



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project
Kuhio Beach Physical Model Test, Phase 2 | SEGMENTED BREAKWATER CONCEPT | FIGURE 1-6

Additional objectives of the Configuration 3 tests were to evaluate the structural stability of the rubblemound breakwater design under attack by equivalent model design waves, and to assess the degree of wave overtopping of the breakwater segments.



2.0 MODEL DESCRIPTION

2.1 Test Facility

The Phase 2 Kuhio Beach 3-D physical model tests were performed at the Scripps Institution of Oceanography's (SIO) Hydraulics Laboratory located at the University of California at San Diego, LaJolla, California. The model basin is 52 ft wide x 45 ft long x 2 ft deep and has an electro-hydraulic servo, plunger type wave generator with a wave front of approximately 53 ft that is capable of producing both monochromatic (single wave period) and random waves. The basin is equipped with wave absorbers.

Figure 2-1 describes a layout of the entire model basin at the SIO Hydraulics Laboratory. The offshore bathymetry contours in ft MLLW, the orientation of the wave maker relative to the modeled area, and the modeled area for each configuration are shown in Figure 2-1.

2.2 Model Scale and Configurations

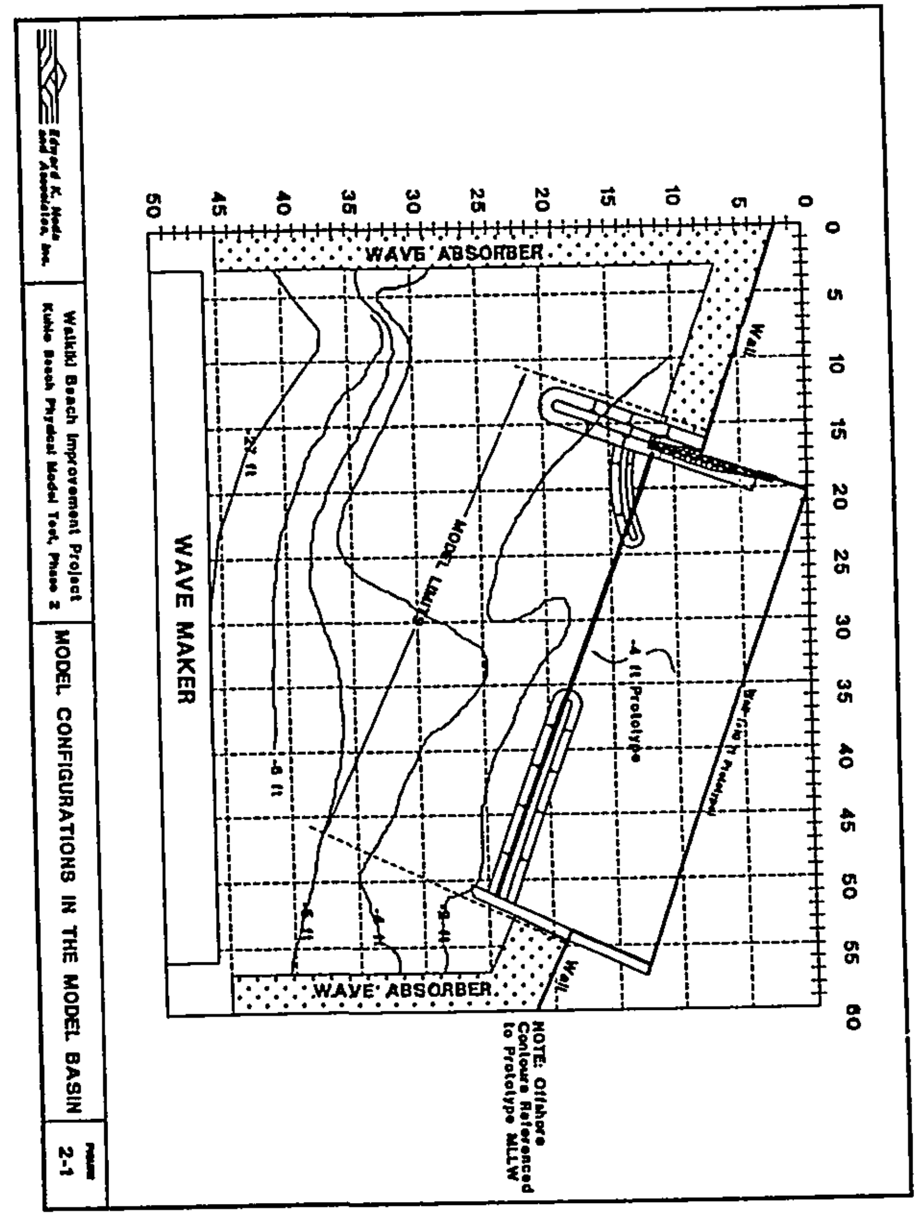
For the Phase 2 Kuhio Beach model tests, only the South Basin of Kuhio Beach was modeled, from the middle groin to the Kapahulu storm drain. The model was constructed as a semi-movable bed model where the basin's beach was modeled as a "movable bed" and the offshore reef area as a "fixed bed" from the crib wall alignment to approximately the -6 ft MLLW depth contour. The simultaneous testing of beach evolution and breakwater stability and overtopping required a geometrically undistorted model. The model was designed following Froude scaling at a model to prototype scale of 1:20.

Dimensions for model sizing and construction, including layout, structures, bathymetry, elevations, etc. were taken from the following documents:

a. Topographic survey dated 4/25/90, which shows a plan view of the Kuhio Beach North and South basins.
b. Drawing labeled "Conceptual Typical Sections for Structural Beach Stabilization Measures", Figure 3-1, from Edward K. Noda and Associates, Inc. (1991) report "Waikiki Beach Improvement Project, Alternatives and Economic Feasibility Evaluation".
c. Model bathymetry, Figure 2-1, from Moffatt & Nichol, Engineers (1993) report "Kuhio Beach Hydraulic Model Investigation".

Three configurations were tested as generally described in Section 1.3. In all configurations the existing crib wall was removed to elevation - 2.0 ft MLLW and the water depth within the basin was -4 ft MLLW. Breakwaters, groins and seawalls were modeled as impermeable structures.

Configuration 1: "Existing Condition": Prior to each test, an initial uniform beach was built as described in Section 1-3 and Figure 1-3. Figure 2-2 shows a photographic view of the initial uniform beach in Configuration 1 in the model basin prior to wave attack.



Waikiki Beach Improvement Project, Kuhio Beach Physical Model Test, Phase 2 — MODEL CONFIGURATIONS IN THE MODEL BASIN — FIGURE 2-1

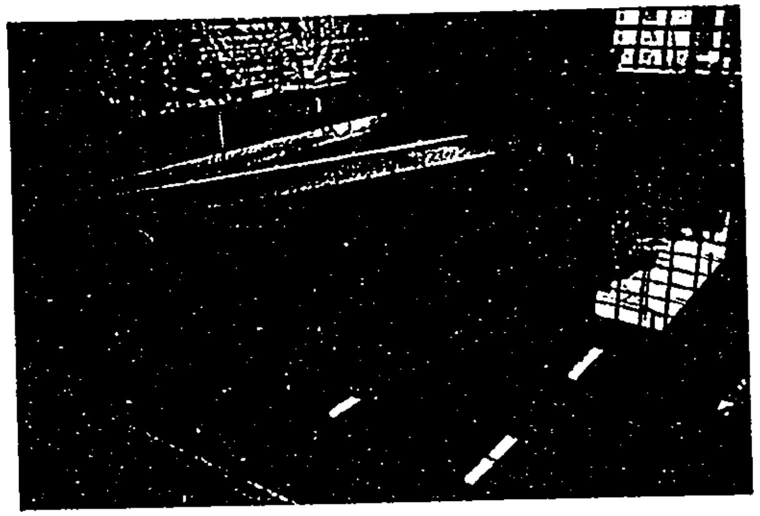
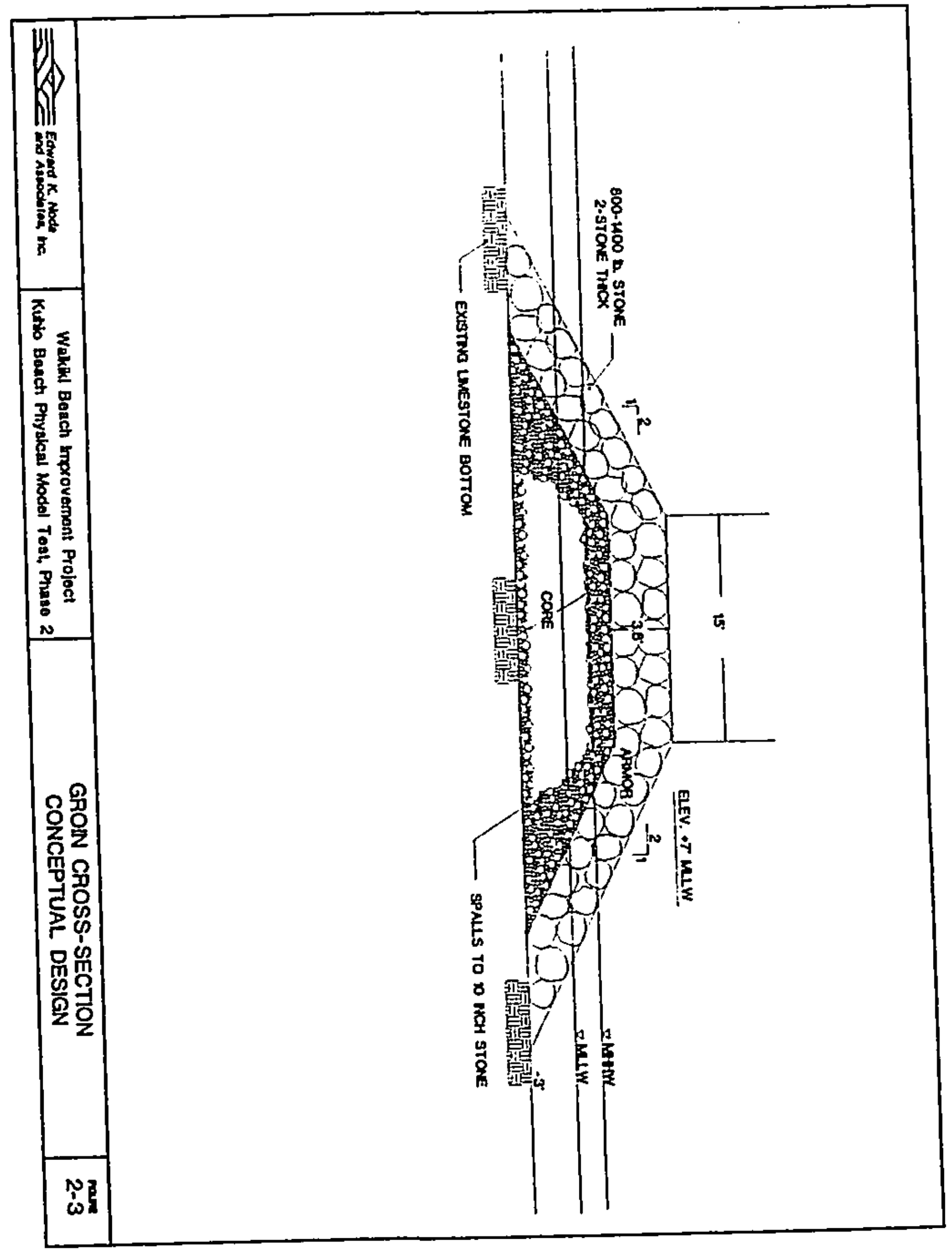
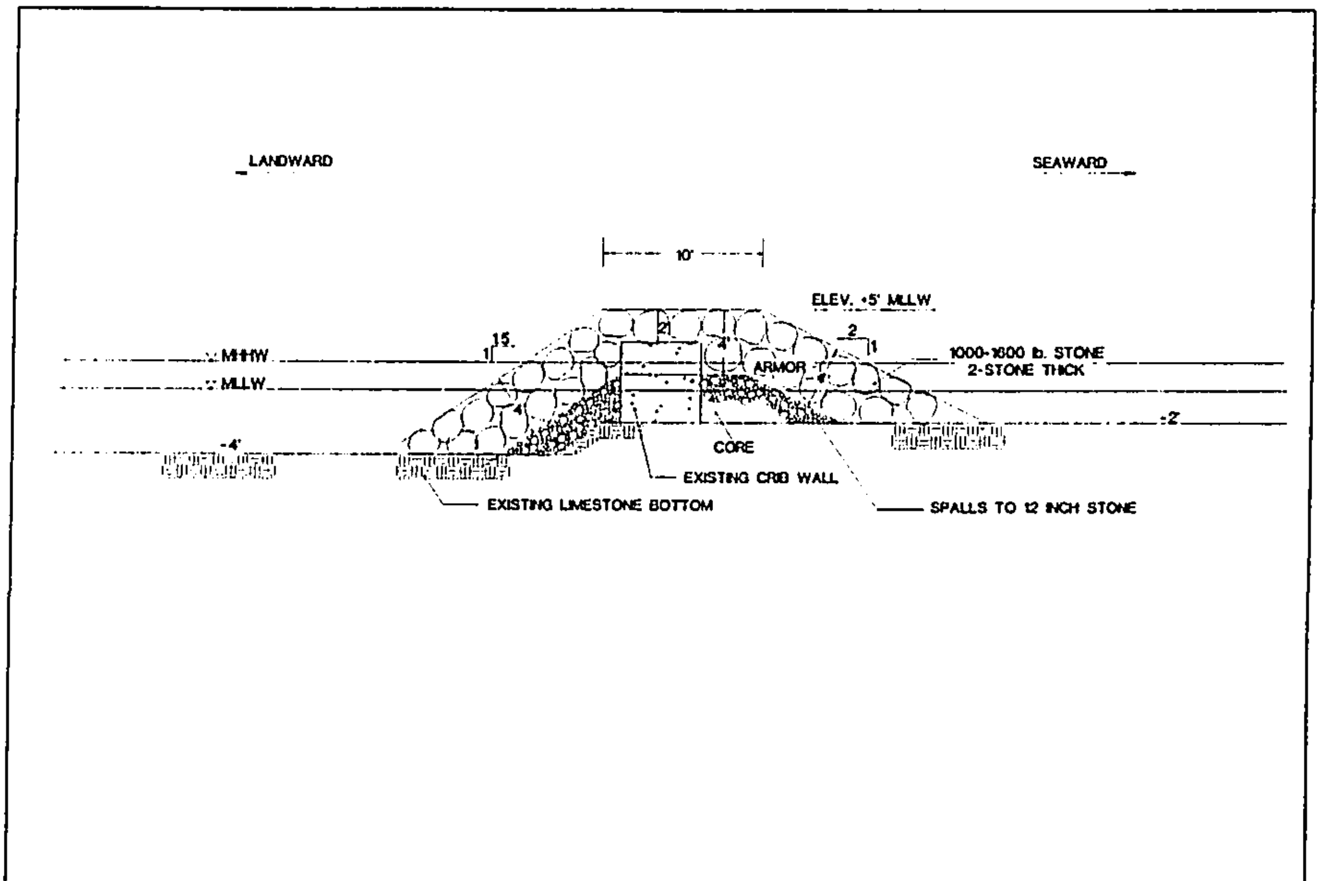


Figure 2-2: Configuration 1 with the initial uniform beach prior to a test run

Configuration 2: "Groin Extension": A groin, constructed over the existing groin location that divides the North and South basins, was built with a crest elevation of +7 ft MLLW and total groin length of 350 ft (150 ft extension beyond the existing crib wall alignment). The groin cross-section design is shown in Figure 2-3 (Edward K. Noda and Associates, Inc., 1991b). Three-quarter inch plywood was constructed along the centerline of the groin and 3/8 inch size rocks were used for the core material. The armor rock size was 1-1/2 inch stones, as described in the following section. Figure 2-4 shows a photograph of Configuration 2 with the "maximum fillet" initial beach planform and Figure 2-5 shows a photograph of Configuration 2 with the "equilibrium" initial beach planform.

Configuration 3: "Segmented Breakwaters": The segmented breakwater layout is shown in Figure 1-7. The breakwater cross-section is described in Figure 2-6 (adapted from Edward K. Noda and Associates, Inc., 1991b). The breakwater crests had an elevation of +5 ft MLLW. The initial beach shape for this segmented breakwater configuration featured a crescent "bay" shaped beach. In order to facilitate construction of the initial beach planform, it was approximated by 6 straight sections of uniform beach, each with a slope of 1V:8H. The beach had a flat berm elevation of +6 ft MLLW. Figure 2-7 shows a photograph of Configuration 3 and the initial crescent beach prior to wave attack.





Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Physical Model Test, Phase 2	BREAKWATER CROSS-SECTION CONCEPTUAL DESIGN	FIGURE 2-6

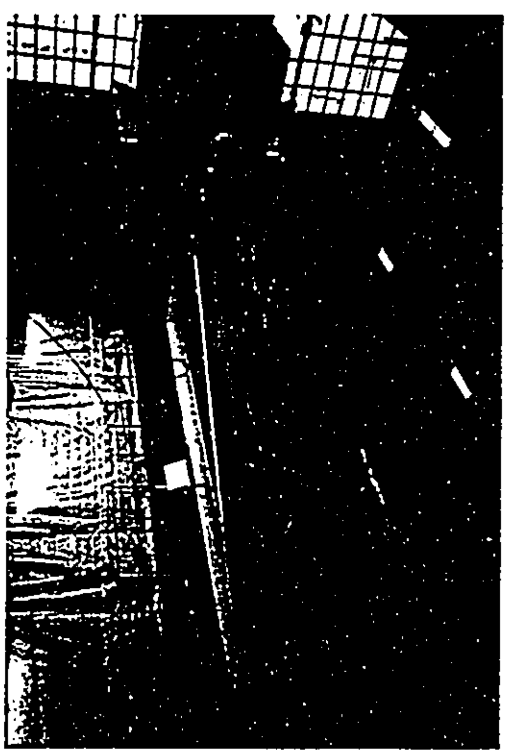


Figure 2-4: Configuration 2 with the "maximum fillet" initial beach profile.

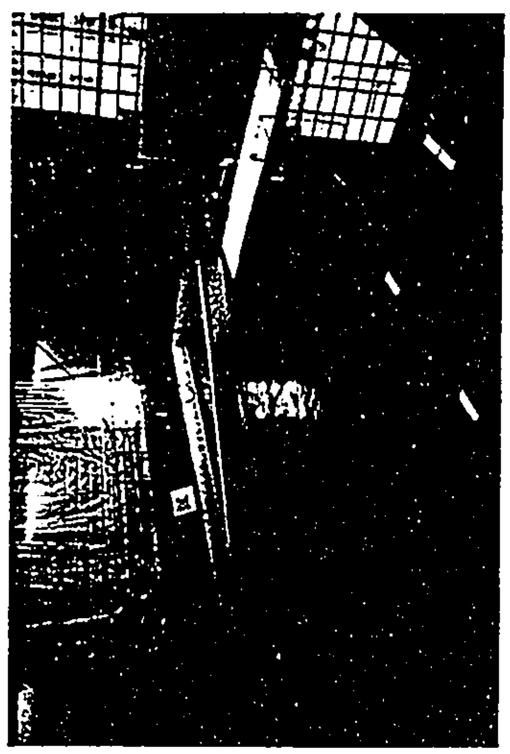


Figure 2-5: Configuration 2 with the "equilibrium" initial beach profile.

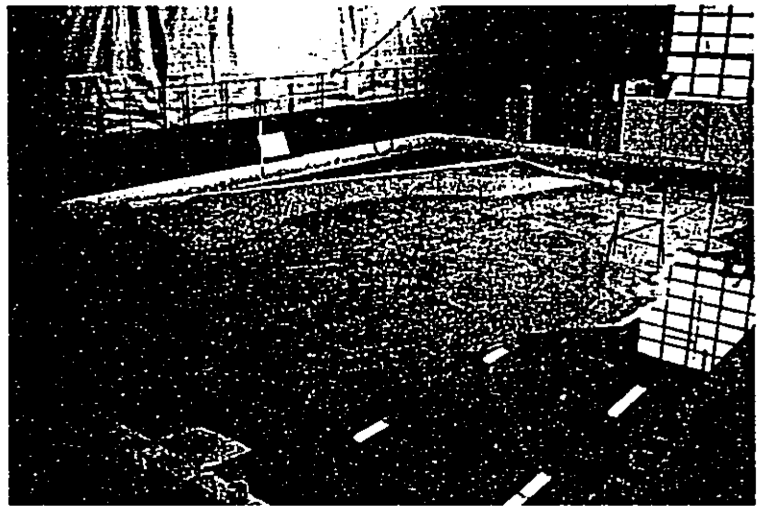


Figure 2-7: Configuration 3, Segmented Breakwaters, with the initial beach prior to the test run.

Model Beach and Breakwater Material

The model beach material was sand and the model grain size was determined based on Dalrymple's profile parameter. According to Dalrymple (1992), beach similarity requires the Dalrymple parameter to be the same between model and prototype. Assuming that the model is scaled according to Froude scaling law and the same type of sediment and fluid is used in the model and in the prototype, the nominal grain diameter for the model d_m is given by:

$$d_m = d_p / \lambda^{1/4}$$

where d_p = prototype nominal grain diameter and λ = 20 (= model scale). Assuming d_p = 0.30 mm, the model grain diameter adopted was d_m = 0.15 mm.

Breakwater and groin armor rocks were modeled considering the Hudson formula. In order to achieve armor rock similarity between model and prototype the following relationship must be satisfied:

$$\frac{W_M}{W_P} = \frac{\rho_{RM}}{\rho_{RP}} \frac{1}{\lambda^3} \frac{\left(\frac{\rho_{RP}}{\rho_{WP}} - 1\right)^3}{\left(\frac{\rho_{RM}}{\rho_{WM}} - 1\right)^3} \qquad (1)$$

where $W_{M(P)}$ is the 50 percentile weight of the model (prototype) armor rock, λ is the model scale, $\rho_{RM(P)}$ is the density of the model (prototype) armor rock and $\rho_{WM(P)}$ is the density of the model (prototype) water. The armor rock used in the model was sampled and the weight distribution is shown in Figure 2-8.

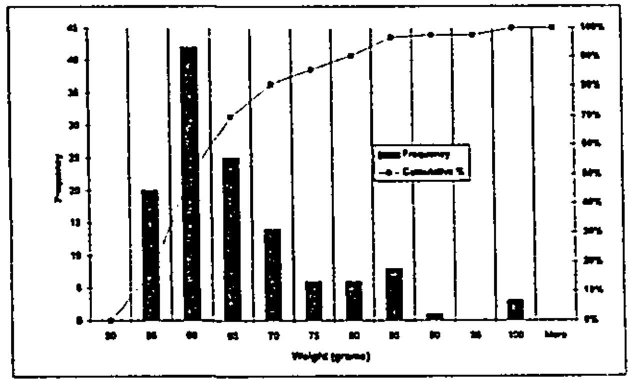


Figure 2-8: Model armor rock weight distribution

Table 2-1 summarizes the values of these parameters.

W_P = 1,500 lbs	W_M = 60 grams (= 0.14 lbs)
ρ_{RP} = 160 lbs/ft³ (assumed)	ρ_{RM} = 170 lbs/ft³
ρ_{WP} = 64 lbs/ ft³	ρ_{WM} = 62.4 lbs/ ft³

Table 2-1: Armor rock parameters.

Considering the values shown in Table 2-1 and substituting into Eq.(1), the prototype armor rock weight modeled in the experiments was $W_p = 1{,}500$ lbs. This armor unit weight is heavier than the design (target) armor unit weight, $W_p = 1{,}300$ lbs, and therefore the breakwater armor layer was modeled slightly conservatively. It is important to note that Eq.(1) is very sensitive to the density of the prototype rock. Any difference in the density of the rock used at the time of construction of the breakwater with the density assumed in this analysis ($\rho_{RP} = 160$ lbs/ft^3) will change the design target weight. For example, if the density of the rock that will be used in the construction of the breakwater is $\rho_{RP} = 165$ lbs/ft^3, the prototype armor unit weight based on the results of the model tests would be $W_p = 1{,}340$ lbs.

The core material for both the groin and the breakwater was 3/8" rock. A 1/4" plywood sheet was placed along the centerline of these structures to make them impermeable.

2.3 Construction Method

The model basin at SIO's Hydraulics Laboratory has a depth of 24 inches. Based on calibration data, the maximum wave making capabilities can be obtained for a minimum water depth of 18 inches. This depth was therefore selected in order to maximize model scale and minimize the material used for the model construction.

The bathymetric contours and structures locations shown in Figure 2-1 were reproduced on the basin floor and their elevations, relative to a conveniently selected benchmark, were set using typical surveying equipment.

Restraining walls with +10 ft MLLW prototype elevations, labeled "walls" in Figure 2-1, were built on the back of the model in order to minimize the amount of fill material and keep water inlets clear. The space delimited by these walls and the basin's walls was flooded.

The curvilinear bathymetric contours were approximated by straight pieces of 1" x 3" wood beams. These beams were set at the required elevations above the basin floor and supported by 4" x 4" wood stands glued to the basin floor at selected locations. The elevations for the seawall and walkway were set according to the survey dated 4/25/90. The basin floor in front of the waver maker (18" deep) represented a prototype depth of 30 ft. A smooth transition ramp with a slope of 1V:5H was constructed between the -6 ft MLLW contour and the basin floor to minimize the effects of undesirable wave transformation due to abrupt depth changes.

The basin was filled with "screen fill" material to the point where the top surface of the horizontal 1" x 3" wood beams, representing the bathymetric contours, cleared the fill material by approximately 2 inches. The volume remaining, delimited by the top of the fill material and the top of the 1" x 3" wood beams, was filled with cement. The cement was careful smoothed to minimize frictional effects. Figure 2-9 shows a view of the model during the pouring of the cement.

The north groin in the Configuration 1, Existing Condition model was represented by a thick, vertical wood wall. For the Configuration 2, Groin Extension plan, the thick wood wall representing the existing groin was removed and thin plywood boards, representing the groin centerline (both existing and extension) were glued to the basin floor. Figure 2-10 shows the partially constructed Groin Extension, with the completed placement of the core material consisting of 3/8 inch nominal size rock. To aid in achieving the required design profile, wood templates were precut to the required design shape and used to form the core material. Figure 2-10 shows an example of a wood template which has been precut to the design profile of the groin armor stone layer, and the individual 1-1/2 inch nominal size rocks to be used for the armor layer.

The construction of the Configuration 3, Segmented Breakwater model segments was performed in a similar manner to the construction of the groin extension. For the north breakwater segment, the Configuration 2 groin extension was removed and a series of straight plywood boards were glued to the model basin floor representing the curved breakwater segment centerline. Figure 2-11 shows the partially constructed north breakwater segment. The top of the plywood boards represents the top of the breakwater. Figure 2-12 shows the starting construction of the core material for the south breakwater segment. Notice the triangular base supports for the plywood centerline which are glued to both the plywood and the basin floor, and the precut template for the core profile section.

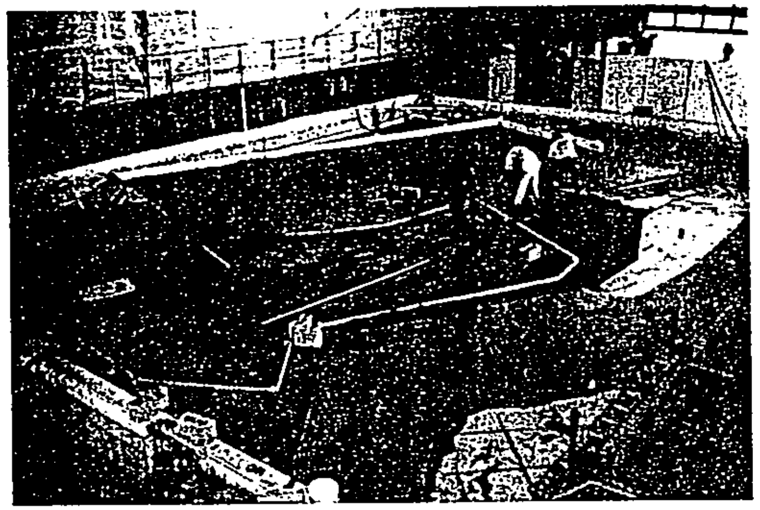


Figure 2-9: Model Construction.

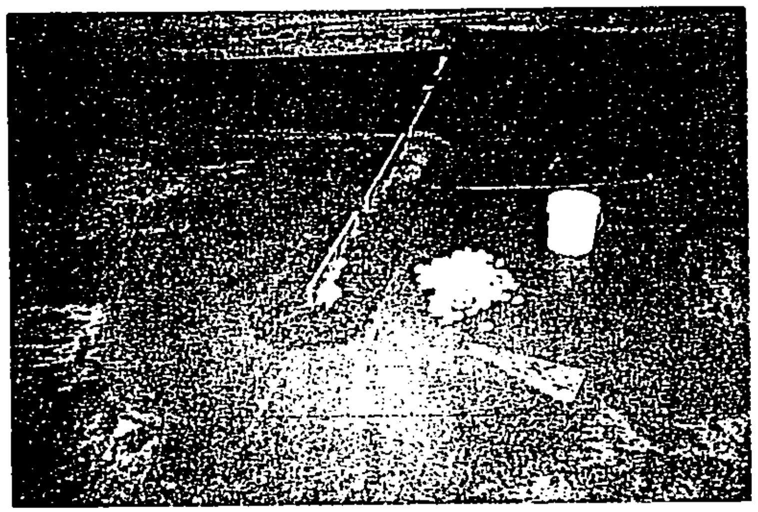


Figure 2-10: Construction of groin extension.


Figure 2-11: North breakwater segment construction.

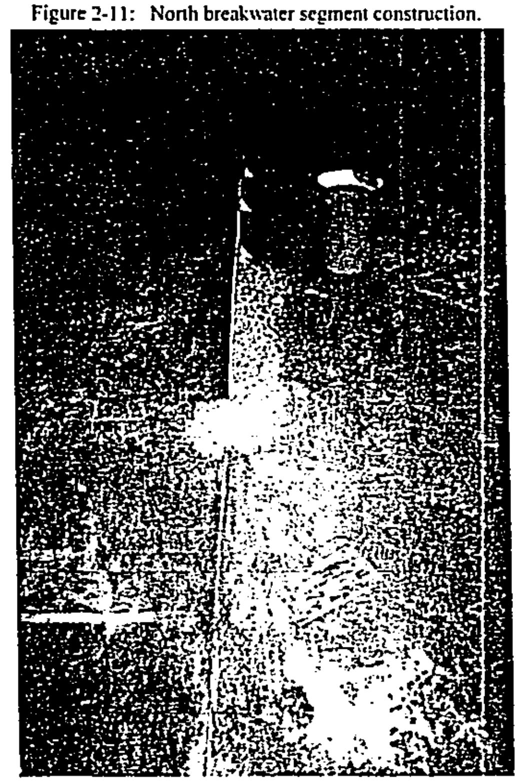


Figure 2-12: South breakwater segment construction

3.0 TEST PROCEDURE

3.1 Test Conditions

Both regular (single frequency) and random waves were used during the tests. The regular wave tests were primarily focused on the development of the planform evolution of the movable-bed beach shoreline, while the random wave tests were focused on the groin or breakwater structural stability. The following conditions applied to the model tests.

- Wave Calibration: Wave conditions were measured and calibrated in a water depth of -6' MLLW, directly fronting the wave maker and about midway along its length.
- Wave Direction: Only one wave direction was tested: 225 degrees T. This is the predominant nearshore wave approach direction and is 20 degrees from the perpendicular to the south basin crib wall (245 degrees T).
- Wave Periods: Three (3) wave periods were tested: T = 7 and 14 sec for the regular wave tests and T_p = 8 sec for the random waves tests, where T_p is the peak period.
- Wave Heights: Two (2) wave heights were tested: H_{rms} = 3 ft for the regular wave tests (upper limit of the predominant Seasonal Wave conditions), and H_s = 3.6 ft for the random wave tests (Design Wave condition), where H_s = the significant wave height and H_{rms} = the root-mean-squared wave height.
- Water Level: All tests were performed with one (1) water level = +3 ft MLLW.

3.2 Calibration of Wave Conditions

Regular waves were generated by means of a signal generator that was used to set the desired wave frequencies. The wave heights were adjusted by setting a gain control which directly determined the vertical displacement of the wave maker plunger. Random waves were generated from a time series synthesized from a Bretschneider spectrum. The length of the generated random wave time-series was 16,384 points, generated at 20 Hz, representing a 13.65 minute long time-series. This random wave time-series was continually repeated during the 6 hour test period. Figure 3-1 describes the wave spectrum for the random wave tests where the blue line is the theoretical frequency spectral density function at the wave maker and the magenta line is the measured wave spectrum at the wave gage located in a prototype water depth of -5.5 ft MLLW. The differences in the spectra at the higher frequencies are due to wave shoaling processes. Figure 3-2 describes a segment of the random wave time-series input to the wave maker.

Prior to the model tests, the wave conditions were calibrated. A capacitance type wave gauge was used and the data sampling rate was 10 Hz. For regular waves, the calibration procedure consisted of adjusting the signal generator frequency and output gain until wave conditions in the basin were fully developed. The PC-based computer data acquisition system was then started and data was collected for 1 minute. The recorded data was analyzed on a spreadsheet and decisions were made on whether to adjust the gain or frequency to achieve the desired wave conditions.

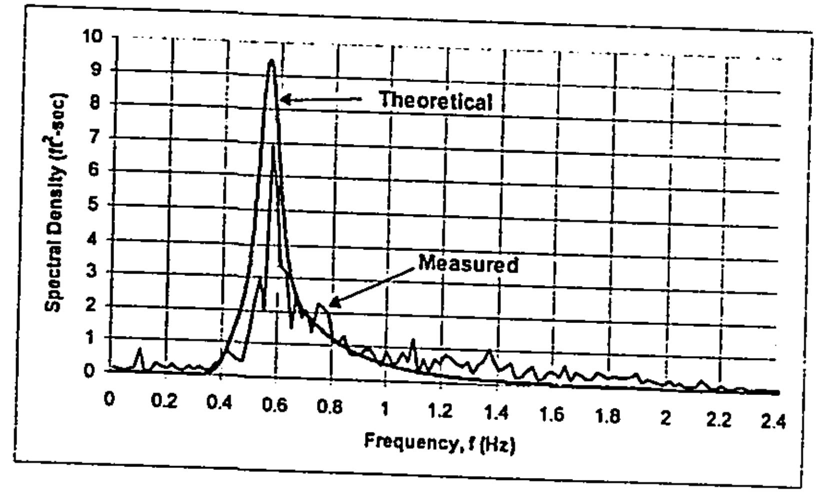


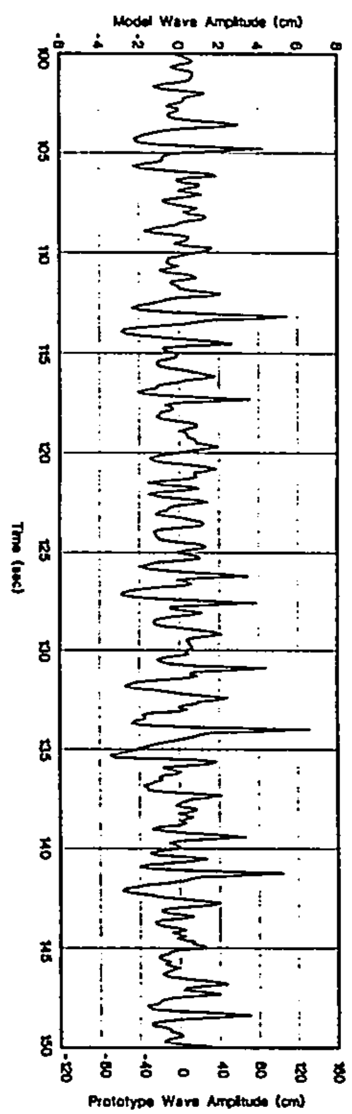
Figure 3-1: Wave spectrum used for the random wave tests.

The procedure to calibrate the random wave conditions consisted of recording the generated waves for approximately 7 minutes after steady state conditions were established in the basin. The recorded data was analyzed on a spreadsheet and decisions were made on whether to make adjustments to the wave maker gain control to achieve the desired H_{rms}.

After all wave conditions were calibrated, the test program began. For each regular wave test, the required wave generator gain and frequency calibration values were reproduced to obtain the desired wave height and wave period test conditions. For the random wave tests, the calibrated wave time series was input to the wave maker, and the time-series was constantly repeated until the end of the test program.

3.3 Test Program

The test program started with Configuration 1, which was the simplest configuration, and ended with Configuration 3, which was the most complex. The length of each test was 6 hours except for Tests 1 and 2, which lasted 5 hours. Table 3-1 describes the test conditions.



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Waikiki Beach Improvement Project
Kuhio Beach Physical Model Test, Phase 2

Example of a segment of the random wave time-series input to the wave maker

FIGURE 3-2

Configuration	Test	Beach	Waves
1	1	Uniform	Regular, H_{rms} = 3 ft., T = 7 sec.
1	2	Uniform	Regular, H_{rms} = 3 ft., T = 14 sec.
2	3	Maximum Fillet	Regular, H_{rms} = 3 ft., T = 7 sec.
2	4	Equilibrium	Regular, H_{rms} = 3 ft., T = 7 sec.
2	5	Equilibrium	Regular, H_{rms} = 3 ft., T = 14 sec.
2	6	Equilibrium	Random, H_s = 3.6 ft., T_p = 8 sec.
3	7	Crescent	Random, H_s = 3.6 ft., T_p = 8 sec.
3	8	Crescent	Regular, H_{rms} = 3 ft., T = 14 sec.
3	9	Crescent	Regular, H_{rms} = 3 ft., T = 7 sec.

Table 3-1: Summary of test conditions.

Breakwater structural stability and wave overtopping were checked visually and recorded on videotape during the tests.

Initial and final beach configurations were documented by measuring the perpendicular distance between a baseline and two reference lines, the "Shoreline" and the "Beach Top", at various station locations along the baseline. Figure 3-3 shows an example of the beach survey procedure. The before and after "Shoreline" location is defined by the intersection of the beach with the still water level (+3 ft MLLW). The initial "Beach Top" line represents the break-line between the flat berm at elevation + 6.0 ft MLLW and the sloping beach for initial beach conditions. The final "Beach Top" line represents the highest elevation point of sand buildup greater than + 6.0 ft MLLW after the test run. If the wave runup did not exceed the berm height, then the initial "Beach Top" line was used for the final "Beach Top" line. To assist in clearly defining the "Shorelines" and the "Beach Top" lines, black wool string was placed along these lines both prior to and after a test run.

The survey reference coordinate system consisted of "Y" and "X" orthogonal axes. The "Y" axis ran along the centerline of the existing groin walkway with the origin located on the back wall at 251 ft from the end of the existing groin (or 240 ft from the intersection between the crib wall and walkway centerline). The "X" axis, or baseline, was the back wall of the model which is oriented perpendicular to the "Y" axis, and which is almost at the same location and alignment of the existing seawall along Kalakaua Avenue. In the description of all the configurations shown in Section 1, a "reference point" has been noted which represents the origin of the X,Y coordinate system.

A typical day consisted of testing the desired configuration for 6 hours, then draining the model basin, measuring the planform changes and rebuilding the beach to initial conditions. This procedure typically took about 10 hours to complete. The basin was refilled overnight and was ready for testing the next day.

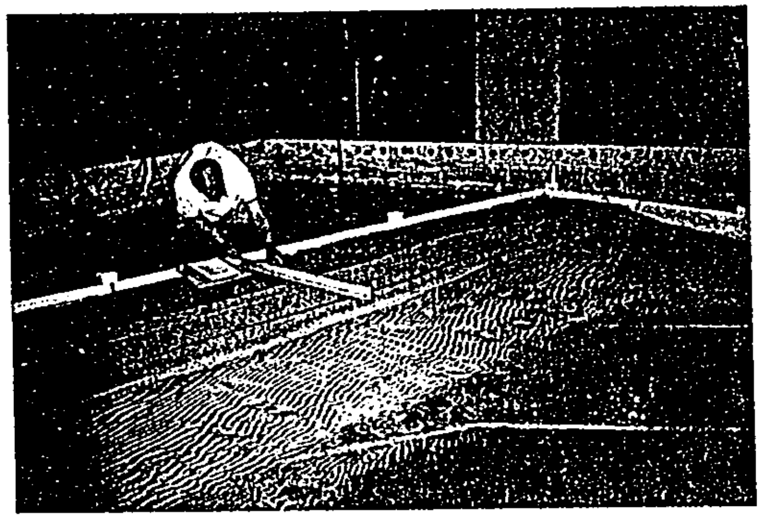


Figure 3-3: Example of beach survey methodology.

4.0 TEST RESULTS

4.1 Configuration 1 - Existing Condition

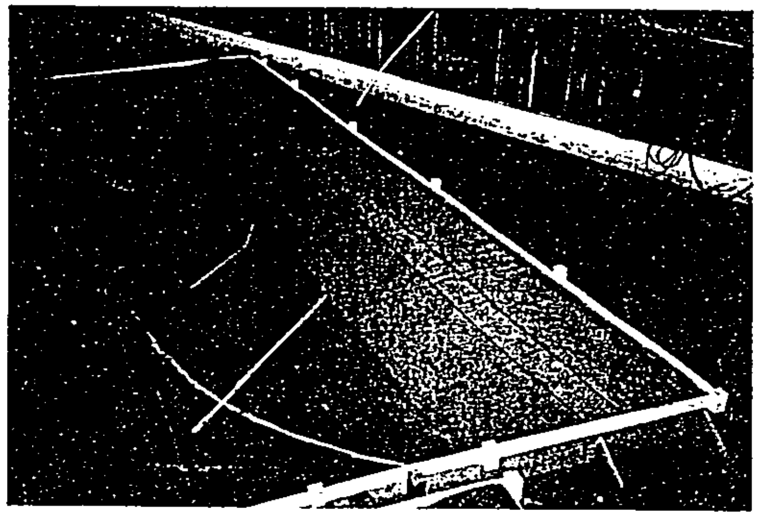
Configuration 1 was tested with two regular wave conditions as described in Table 3-1. The Test 1 wave conditions were regular waves with H_{rms} = 3 ft and T = 7 sec. Figure 4-1 shows photos of the initial beach planform and the final planform after a test period of 5 hours. As shown in Figure 4-1, while the final Shoreline and Beach Top line are relatively smooth, there is a complex pattern of the beach below the still water line involving both planform and slope changes along the length of the beach. There were also complex ripple patterns in the sand slope below the still water elevation.

Figure 4-2 shows the initial and final beach Shoreline and beach maximum elevation (labeled "Beach Top") as obtained from beach survey measurements. Figure 4-2 shows an erosion of the beach shoreline from near the center of the basin to the Kapahulu storm drain wall, a distance of a little more than one-half the basin length. The shoreline retreat varied from about 12 ft in the central section to 14 - 19 ft near the Kapahulu storm drain wall. In the northern half of the basin, sand accretion occurred and was most advanced near the walkway/groin north end where the shoreline moved seaward as much as 20 ft. There was no sand transport around the north groin. However, rip currents were observed along both the north groin and Kapahulu storm drain wall.

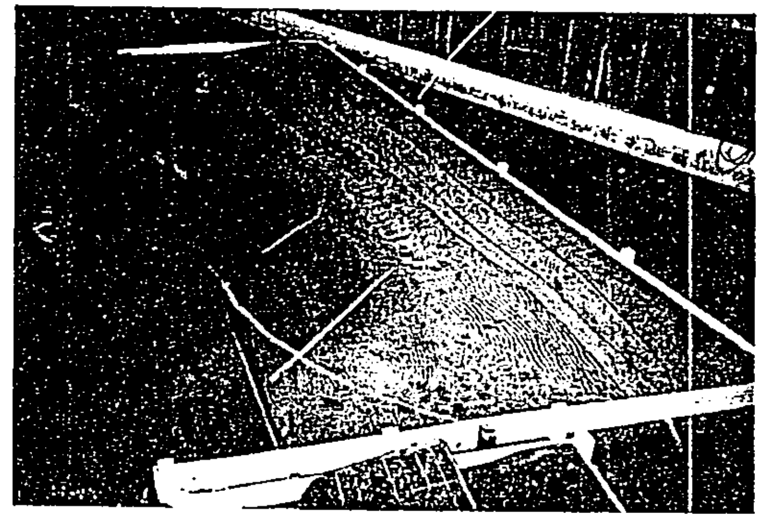
Wave conditions for Configuration 1, Test 2, were regular waves with H_{rms} = 3 ft and T =14 sec. Figure 4-3 shows photos of the initial and final beach planforms after a run time of 5 hours. Figure 4-4 graphically describes the initial and final beach Shoreline and beach maximum elevation (labeled "Beach Top") as obtained by survey measurements.

Figure 4-4 indicates that the Beach Top line retreated along the entire basin width and the Shoreline generally followed this trend except near the groin area and along a limited section *about 300 ft from the groin where almost no changes in the Shoreline were recorded.* The Beach Top erosion rates varied from about 4 to 10 ft. Near the groin, the Shoreline accreted about 18 ft over a short distance. No sand was transported around the north groin.

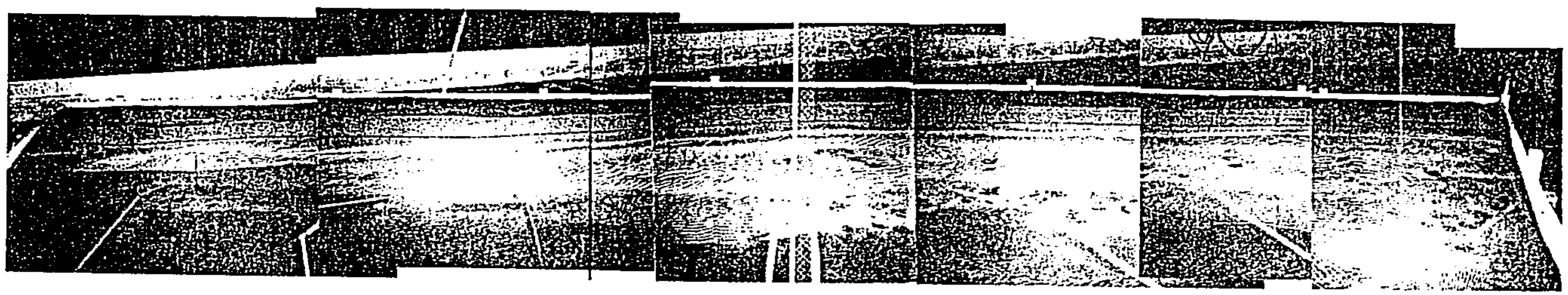
Comparing Figures 4-2 and Figure 4-4, it is noted that the longer wave period (T=14 sec) did not change the beach as much as the shorter (T = 7 sec) wave period. For the SW wave direction approach, the shallow offshore bathymetry produces greater changes in wave direction (wave refraction), resulting in smaller angles of incidence for the longer versus the shorter period waves. For the same wave height, the larger the angle of incidence of the waves on the beach, the greater the sand transport with its consequent effect on beach evolution.



(A) Initial beach prior to testing.

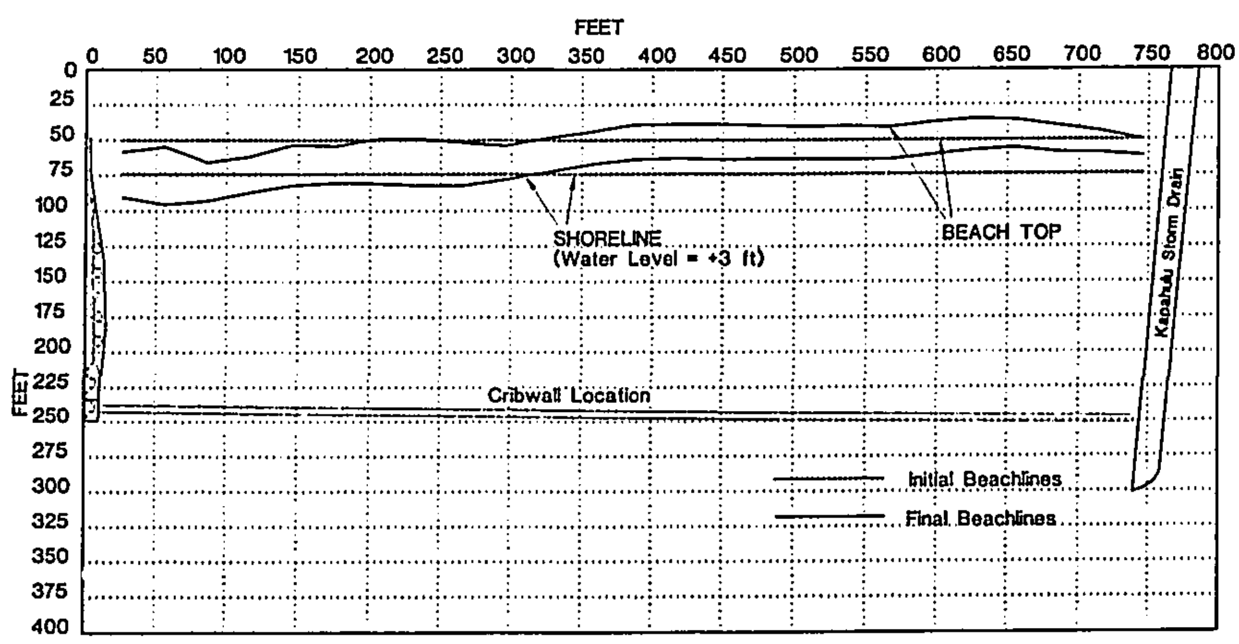


(B) Final beach after testing as viewed from the south end of the basin.

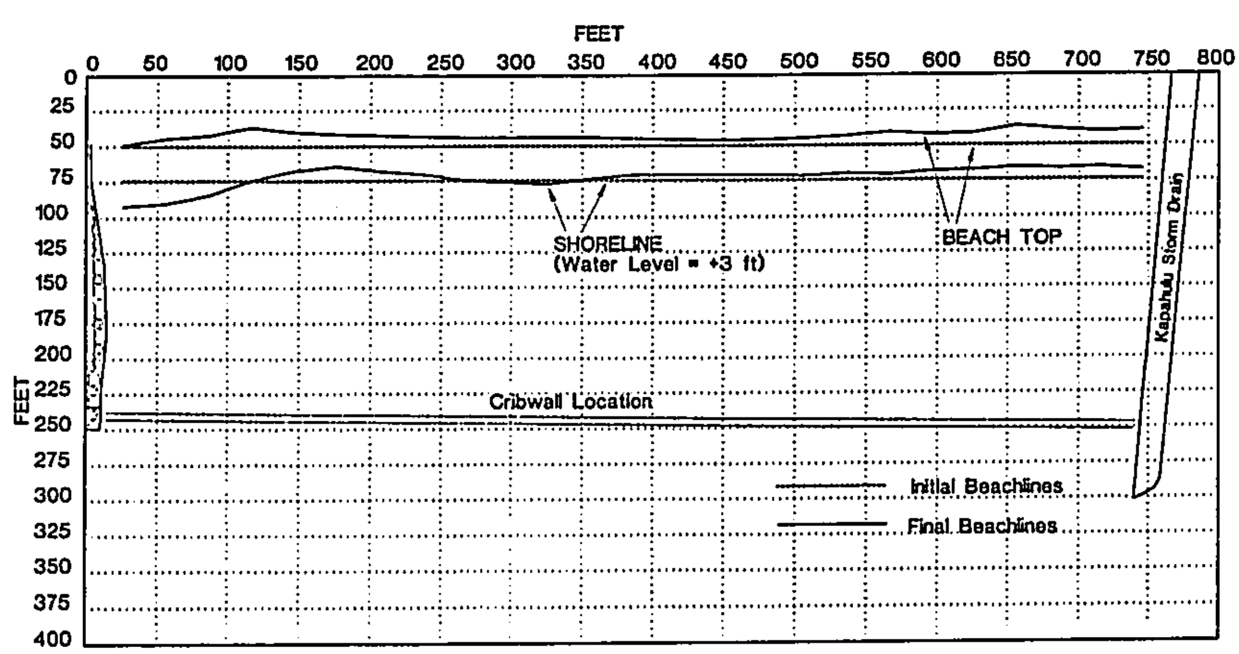


(C) Mosaic frontal view of the final evolution of the beach.

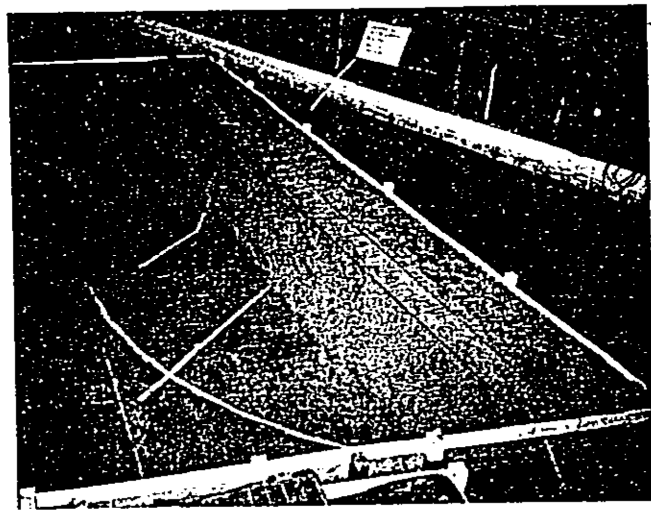
Figure 4-1: Configuration 11, Test 1, Initial uniform beach tested with regular waves. H_{rms} = 3 ft and T = 7 sec.



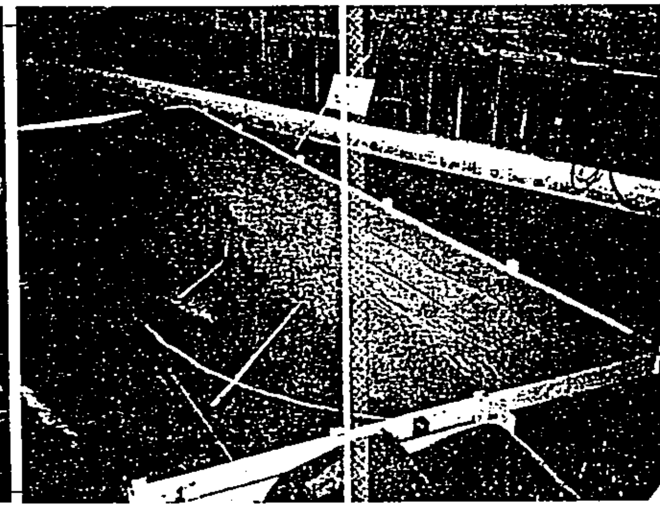
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Physical Model Test, Phase 2	SURVEY RESULTS, CONFIGURATION 1, TEST 1, INITIAL UNIFORM BEACH, Regular Waves Hrms = 3 ft, T = 7 sec	FIGURE 4-2



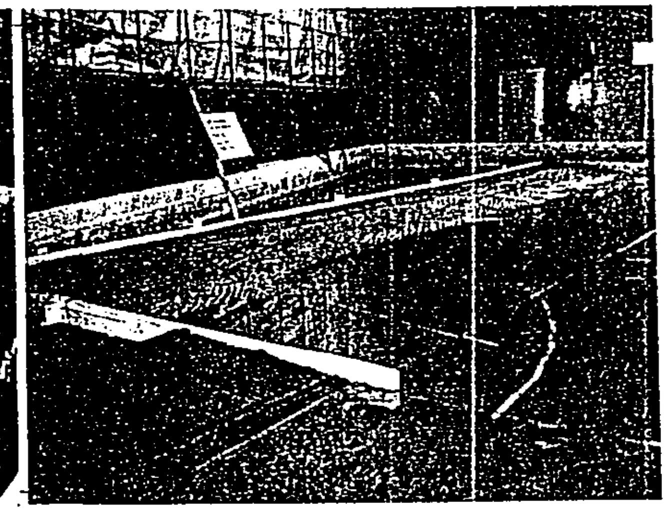
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Physical Model Test, Phase 2	SURVEY RESULTS, CONFIGURATION 1, TEST 2, INITIAL UNIFORM BEACH, Regular Waves Hrms = 3 ft, T = 14 sec	FIGURE 4-4



(A) Initial beach prior to testing.



(B) Final beach after testing as viewed from south end of the basin.



(C) Final beach after testing as viewed from the north end of the basin.

(D) Mosaic frontal view of the final evolution of the beach.

Figure 4-3: Configuration 1, Test 2. Initial uniform beach tested with regular waves. H_{mo} = 3 ft and T = 14 sec.

4.2 Configuration 2 - Groin Extension

For the first Configuration 2 test, Test 3, the initial beach shape was represented by the "maximum fillet" beach as shown in Figure 1-4. The purpose of this starting beach was to obtain an "equilibrium" beach shape by effecting sand transport on a non-equilibrium beach. Based on the results of Tests 1 and 2, because longshore transport was more pronounced with the short period waves, the maximum fillet beach was tested with short period regular waves, $H_{rms} = 3$ ft and $T = 7$ sec. Figure 4.5 shows photos of the initial and final beach planforms for the maximum fillet beach after 6 hours of regular wave attack. Figure 4-6 graphically describes the initial and final beach Shoreline and beach maximum elevation (labeled "Beach Top") as obtained from survey measurements.

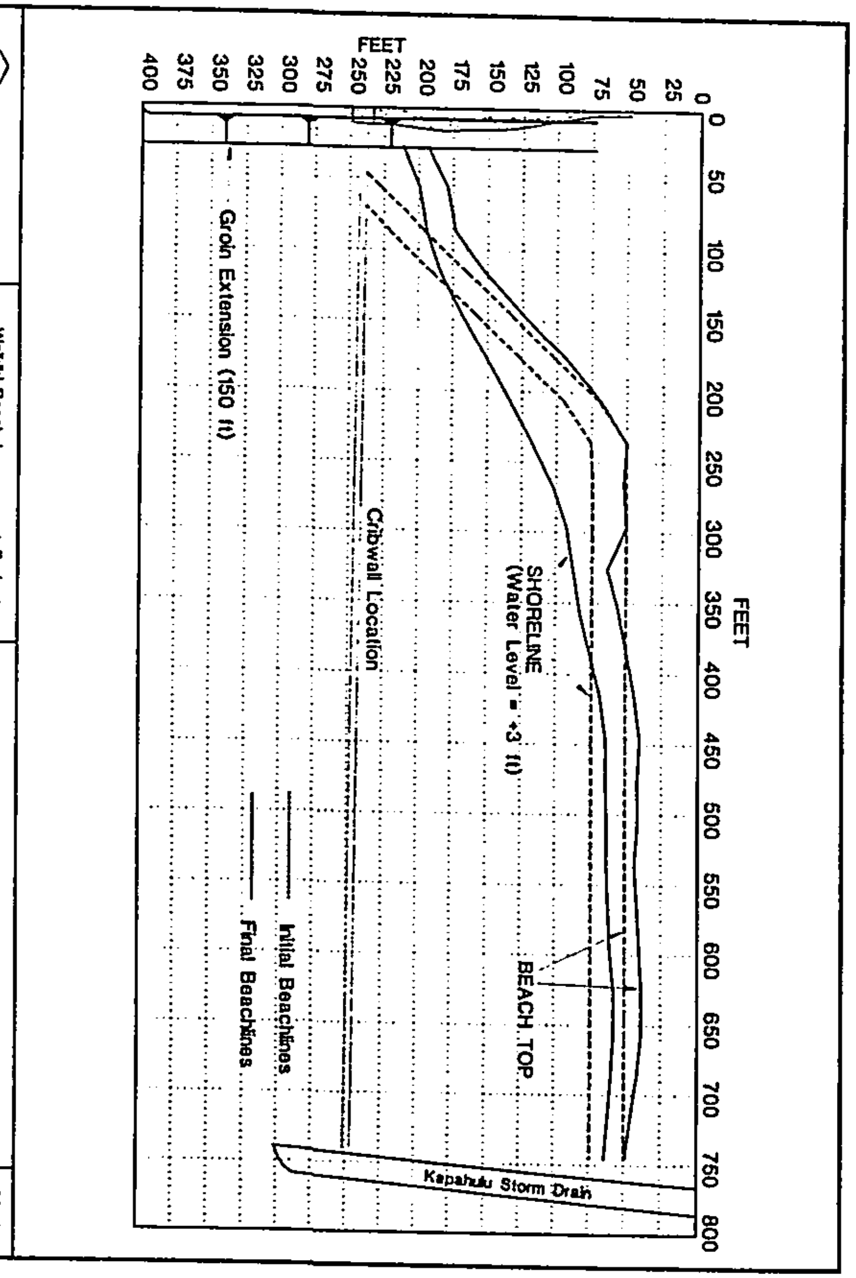
Figure 4-6 shows a retreat of the Beach Top and Shoreline of approximately 15 ft along the Kapahulu storm drain half of the beach, significant accretion of the Shoreline in an area between 150 to 350 ft from the groin (at the "elbow") and a significant retreat of the Beach Top and Shoreline of approximately 75 ft at the groin end.

The sand moved from both ends towards the "elbow" or "corner" of the beach where the Shoreline gained approximately 40 ft of width. As can be seen in the photos, some sand was lost due to seaward transport at the groin, but it was not significant relative to the amount that moved toward the central section of the beach. The slope of the beach after the tests was less steep than the initial conditions and it was estimated to be approximately 1V:10H.

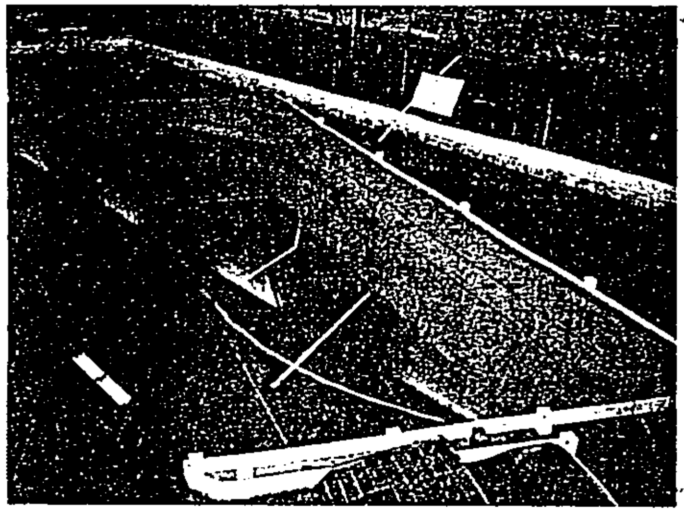
Based on the Test 3 results of the evolution of the "maximum fillet" beach shape, an "equilibrium" beach shape was constructed as the starting beach planform for subsequent Configuration 2 tests. Figure 1-5 describes the initial "equilibrium" beach shape, which has essentially the same geometric shape as the "maximum fillet" beach, but the fillet angle was more gradual and the beach slope in the area of the fillet was 1V:10H to more closely approximate the final results from Test 3.

Wave conditions for Configuration 2, Test 4, were regular waves with $H_{rms} = 3$ ft and $T = 7$ sec. Figure 4-7 shows photos of the initial and final beach planforms for the equilibrium beach and Figure 4-8 graphically shows the beach Shoreline and Beach Top maximum elevation after 6 hours of testing as obtained from survey measurements.

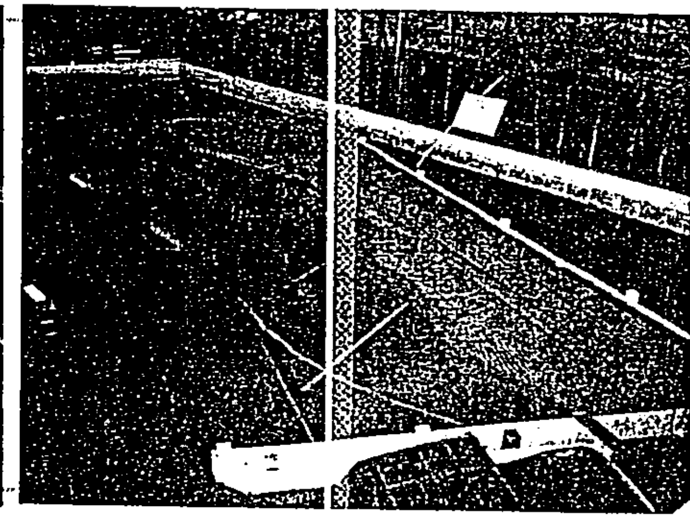
Figure 4-8 shows that there is significant accretion of sand (25 ft increase of width of Shoreline and Beach Top) in the area between 100 to 400 ft from the groin. The Shoreline retreated at the Kapahulu storm drain end of the beach approximately 12 ft, and a similar order of retreat of the Shoreline was observed at the groin end. No seaward transport, or beach loss of sand around the end of the groin was observed.



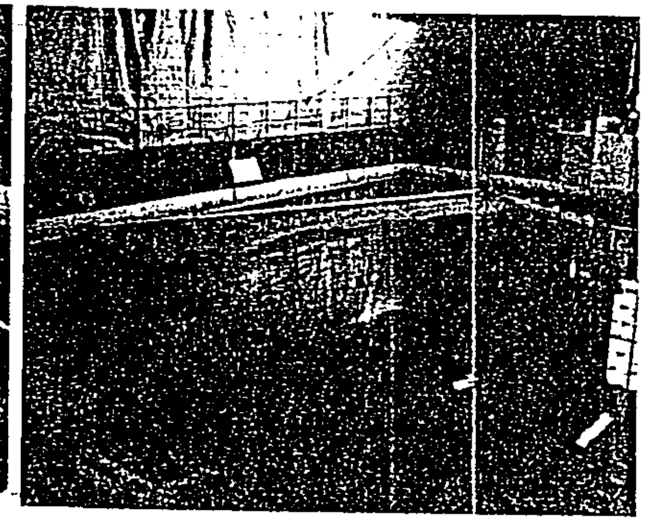
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Physical Model Test, Phase 2	SURVEY RESULTS, CONFIGURATION 2, TEST 3, MAXIMUM FILLET, Regular Waves Hrms = 3 ft, T = 7 sec	FIGURE 4-6



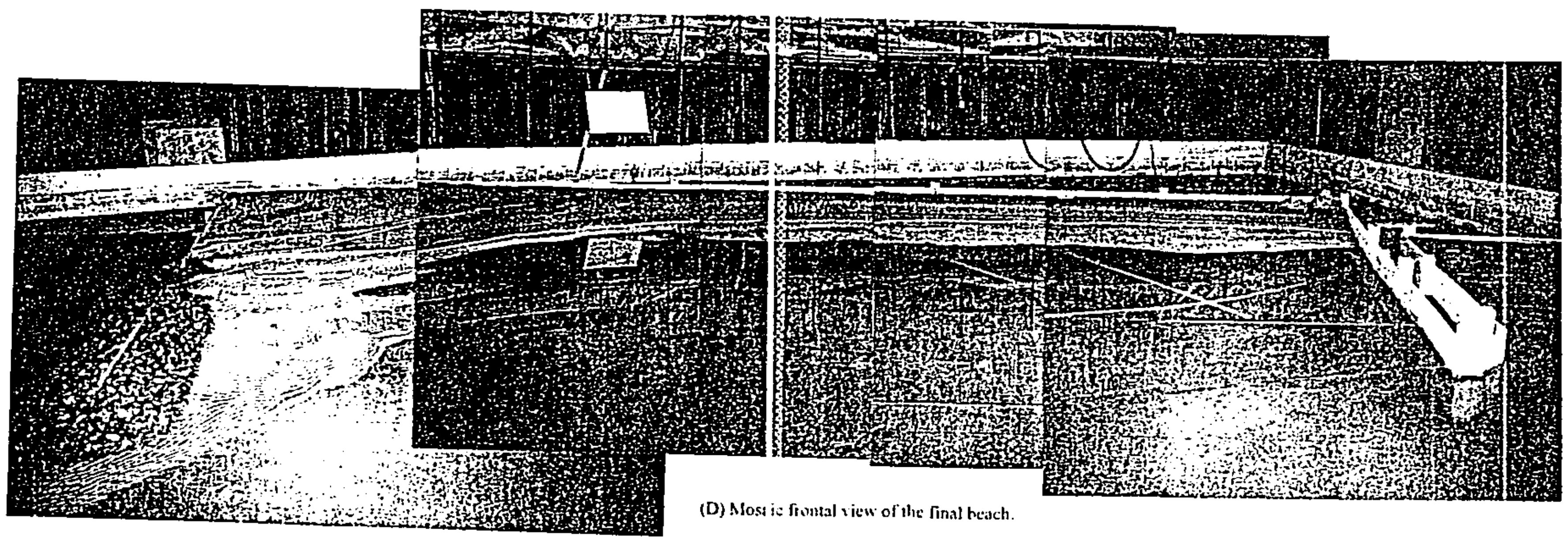
(A) Initial beach prior to testing.



(B) Final beach after testing as viewed from the south end of basin.

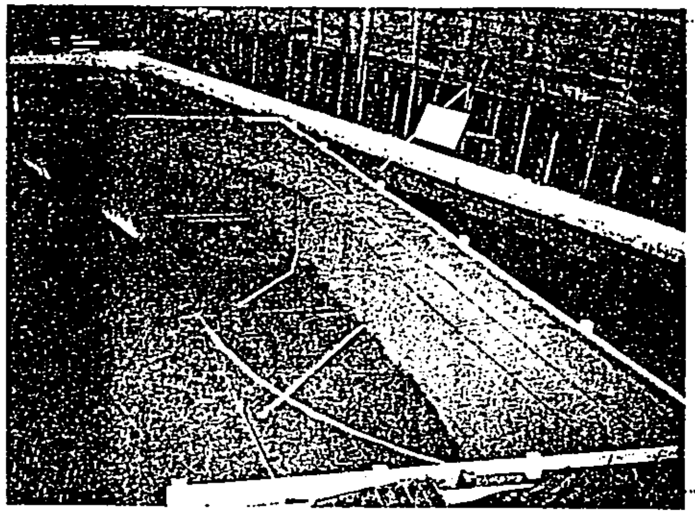


(C) Final beach after testing as viewed from the north end of the basin.

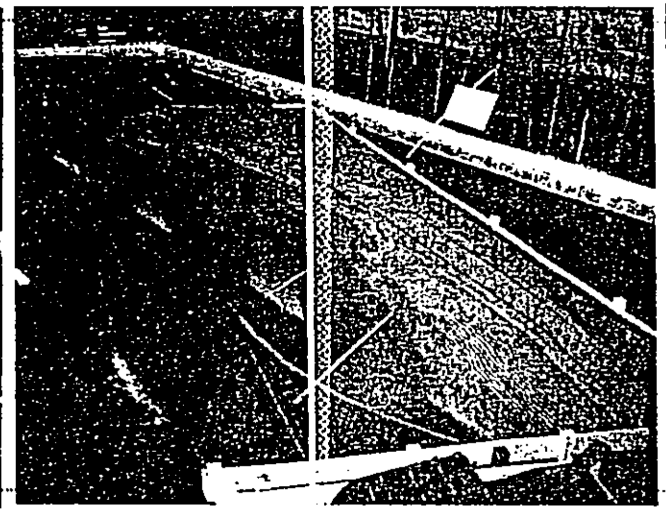


(D) Mosaic frontal view of the final beach.

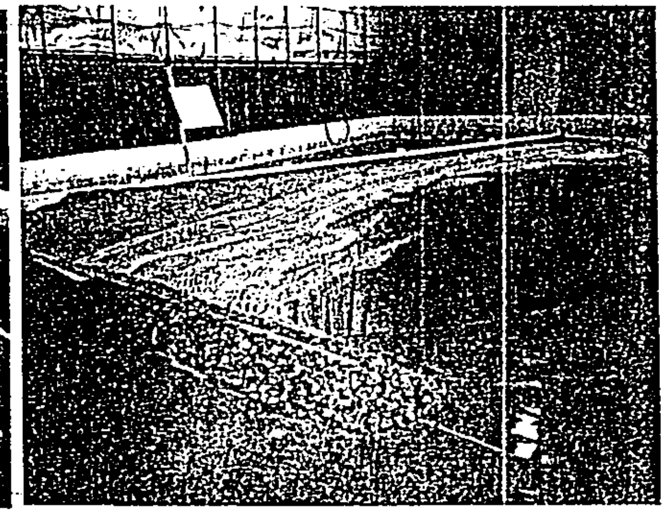
Figure 4-5: Configuration 2, "Maximum Fillet" beach tested with regular waves, H_{lab} = 3 ft and T = 7 sec.



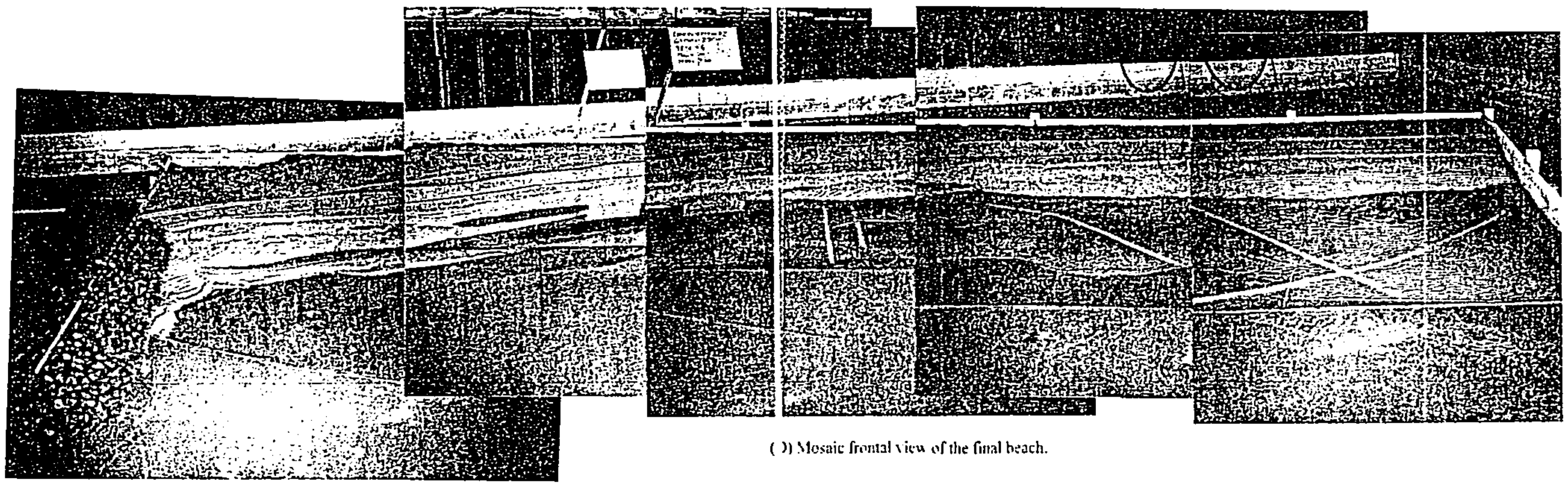
(A) Initial beach prior to testing.



(B) Final beach after testing as viewed from the south end of basin.



(C) Final beach after testing as viewed from the north end of the basin.



(D) Mosaic frontal view of the final beach.

Figure 4-7: Configuration 2, Test 4, Initial "equilibrium" beach tested with regular waves, H_{mo} = 3 ft and T = 7 sec.

Wave conditions for Configuration 2, Test 5, were regular waves with H_{rms} = 3 ft and T = 14 sec. Figure 4-9 shows photos of the initial and final beach planforms for the equilibrium beach, and Figure 4-10 graphically shows the beach Shoreline and Beach Top maximum elevation after 6 hours of testing as obtained from survey measurements.

Figure 4-10 shows that there is accretion of sand in the central section of the beach (25 ft increase of width of Shoreline and Beach Top), in an area between 200 to 400 ft from the groin. The beach lines retreated a small amount at the Kapahulu storm drain end of the beach and toward the groin end. No seaward transport, or loss of sand around the end of the groin was observed.

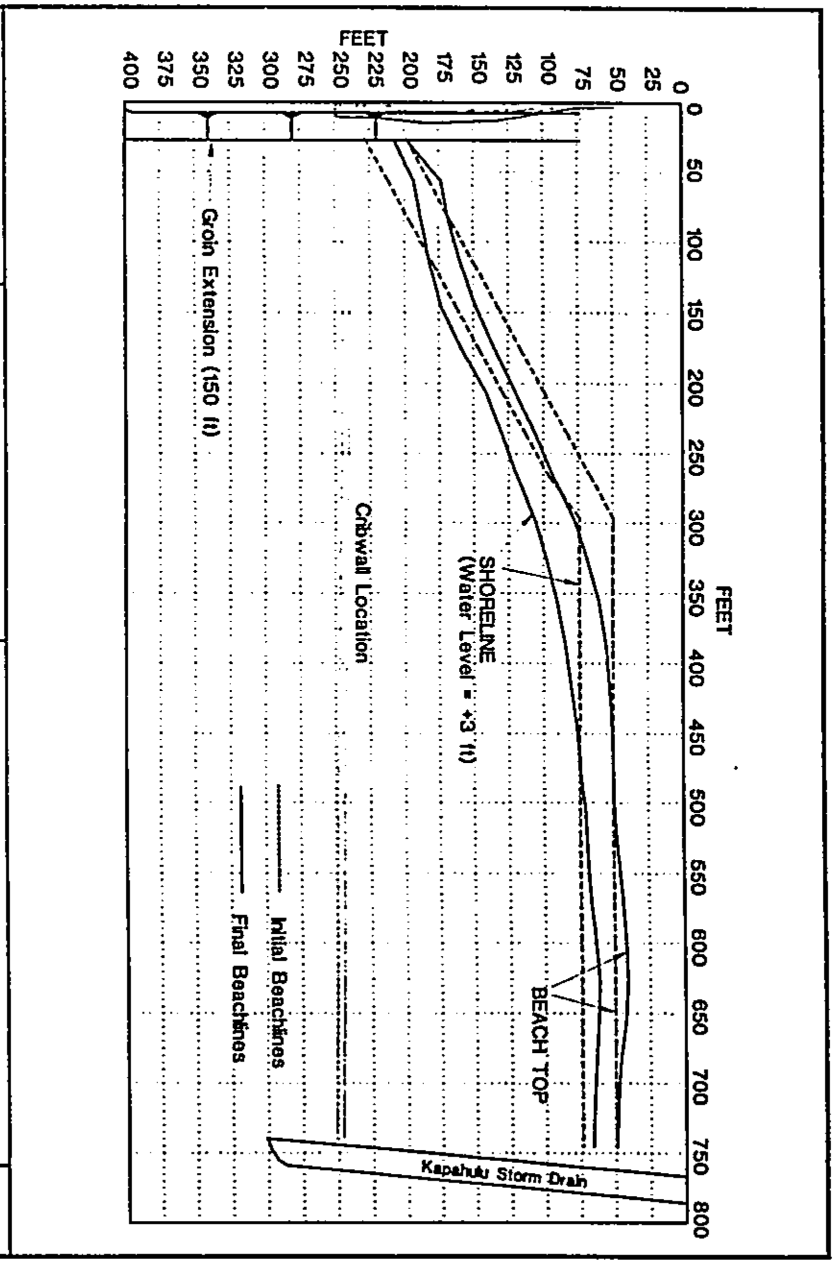
Wave conditions for Configuration 2, Test 6, were random waves with H_s = 3.6 ft and T_p = 8 sec. Figure 4-11 shows photos of the initial and final beach planforms for the equilibrium beach, and Figure 4-12 graphically shows the beach Shoreline and Beach Top maximum elevation after 6 hours of testing as obtained from survey measurements.

The evolution of the beach shown in Figure 4-12 due to random wave attack is similar to the previous results obtained for regular waves, although the beach planform shape is smoother. However, the retreat of the beach near the Kapahulu storm drain end is about 25 ft, which is the maximum observed for all tests. The beach gained width in the area between 200 to 450 ft from the groin, extending seaward a maximum of approximately 35 ft. No seaward transport, or loss of sand around the end of the groin was observed. During all the Configuration 2 tests, the groin suffered no damage and experienced no overtopping.

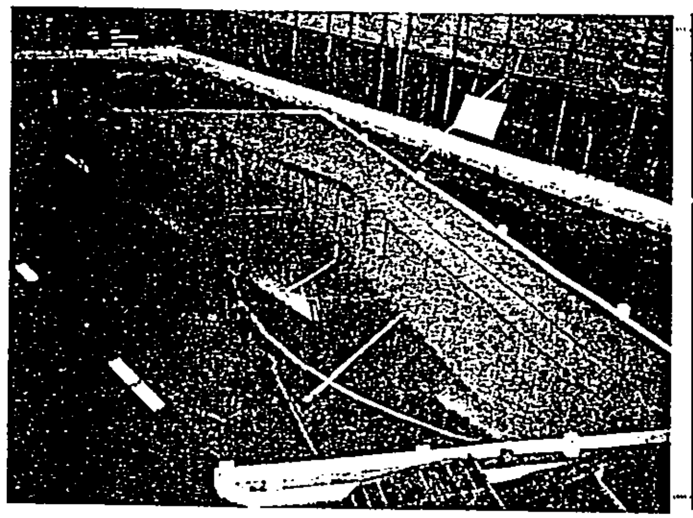
4.3 Configuration 3 - Segmented Breakwater

Wave conditions for Configuration 3, Test 7, were random waves with H_s = 3.6 ft and T_p = 8 sec. The initial beach configuration is shown in Figure 1-7 which is represented by a crescent "bay" shaped beach which is constructed from a series of 6 straight, uniform beach profiles with a slope of 1V:8H. This initial crescent beach was used in all Configuration 3 tests. Figure 4-13 shows photos of the initial and final beach planforms, and Figure 4-14 graphically shows the beach Shoreline and Beach Top maximum elevation after 6 hours of testing as obtained from survey measurements.

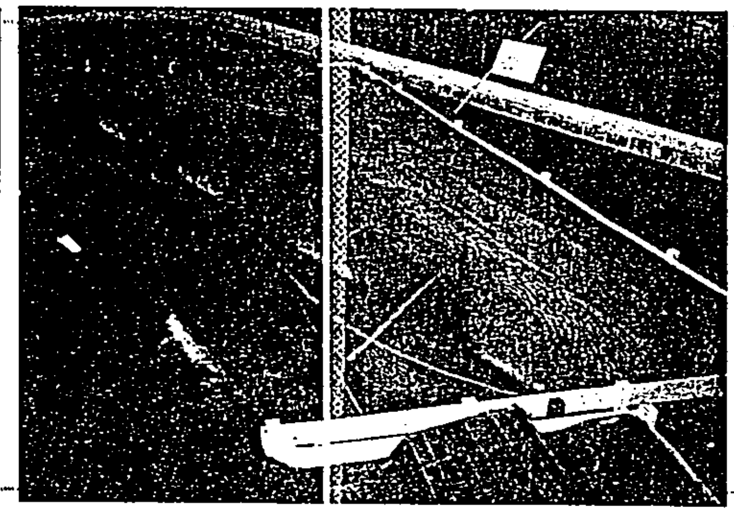
Figure 4-14 indicates that the final beach planform remained relatively unchanged from the initial conditions, except for the area between 150 to 450 ft from the groin where the Shoreline moved slightly seaward. Figure 4-14 primarily indicates that the Shoreline moved seaward while the Beach Top line remained nearly the same as the initial condition. The only area where the final Beach Top line showed some affect from wave overtopping is in the north-central area of the beach, where the waves from the SW can propagate through the breakwater gap with little wave height reduction. In this area, it was observed that approximately 5% of the waves overtopped the +6 ft MLLW beach elevation.



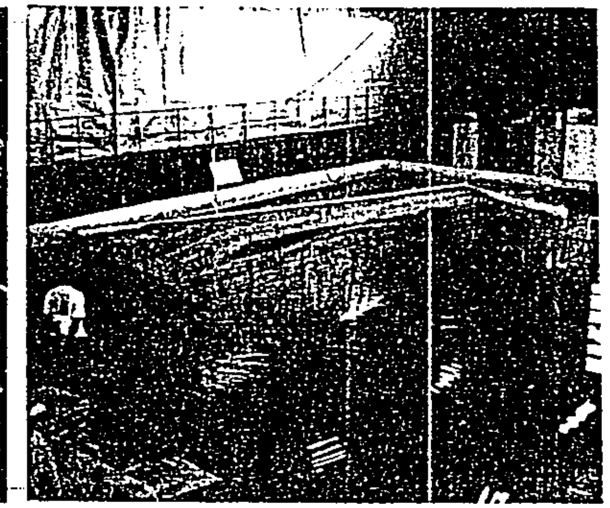
Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project, Kuhio Beach Physical Model Test, Phase 2 | SURVEY RESULTS, CONFIGURATION 2, TEST 4, EQUILIBRIUM BEACH, Regular Waves Hrms = 3 ft, T = 7 sec | FIGURE 4-8



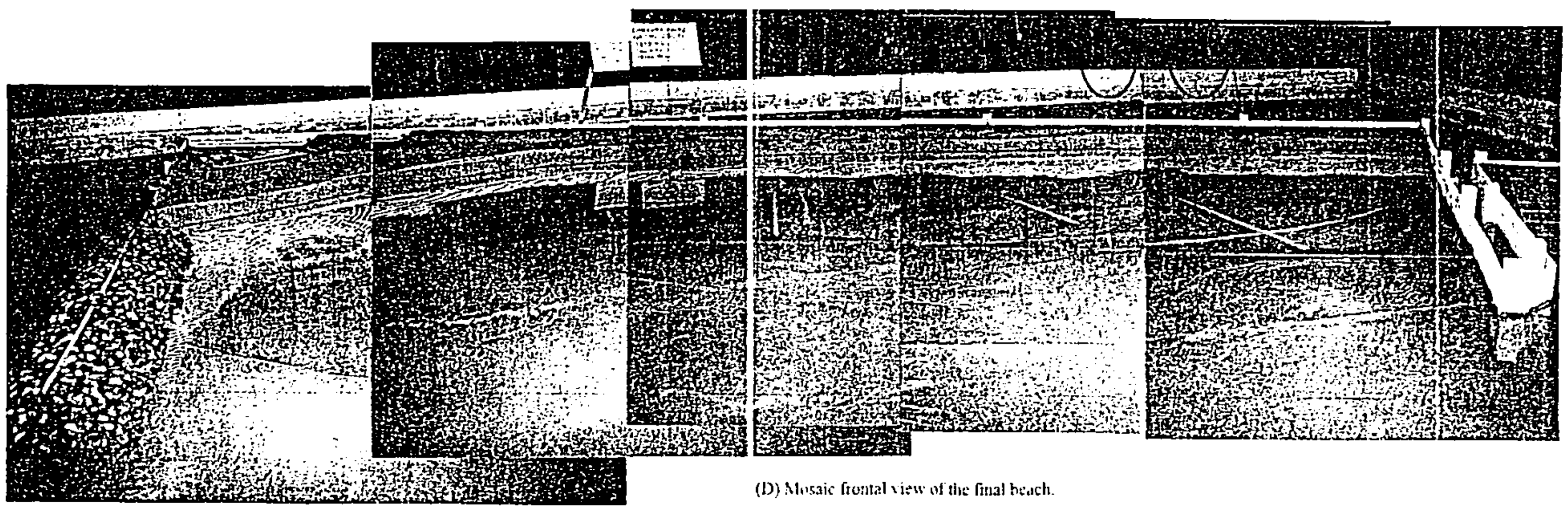
(A) Initial beach prior to testing.



(B) Final beach after testing as viewed from the south end of the basin.

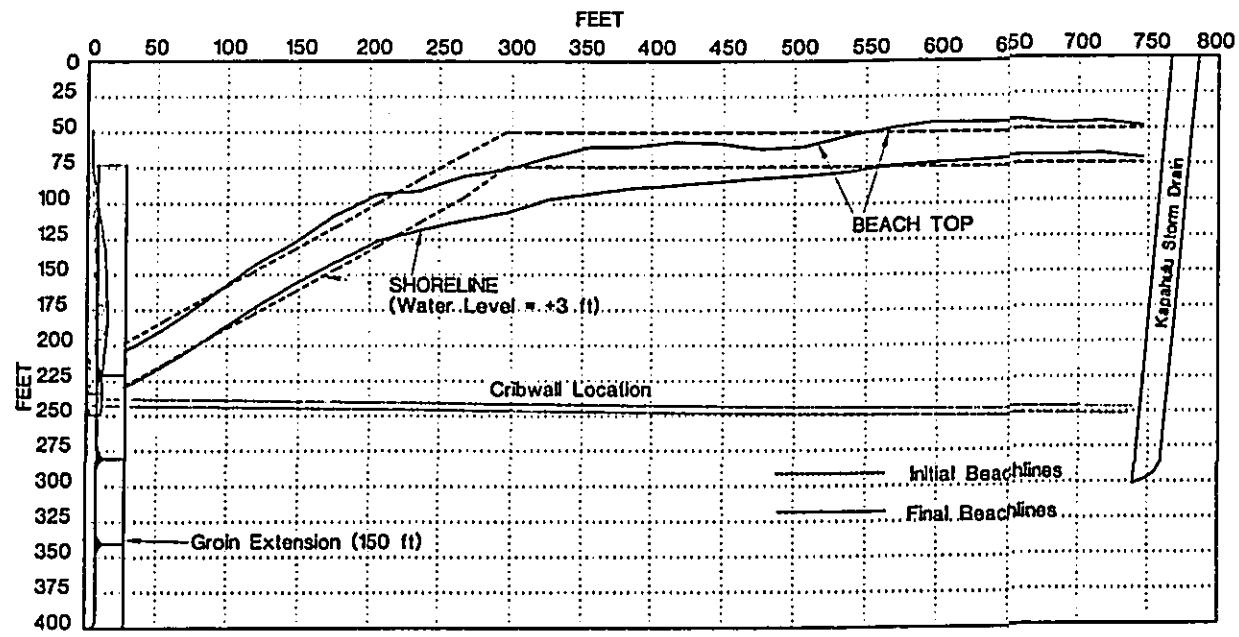


(C) Final beach after testing as viewed from the north end of the beach.

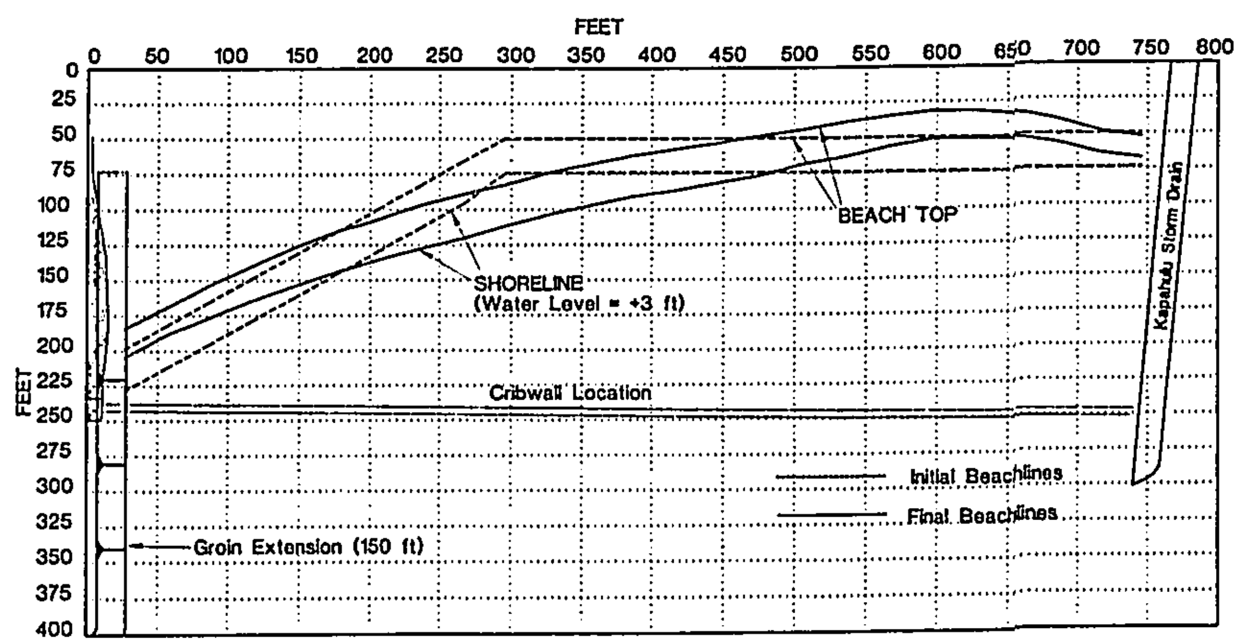


(D) Mosaic frontal view of the final beach.

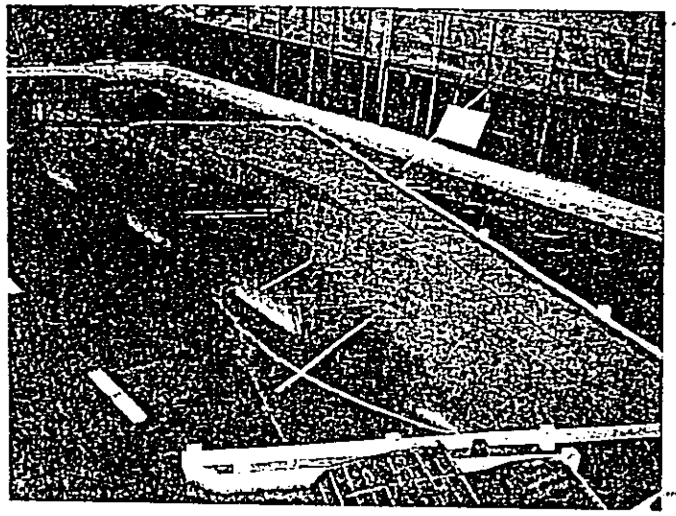
Figure 4-9: Configuratiion 2, Test 5, Initial "equilibrium" beach tested with regular waves, H_{mo} = 3 ft and T = 14 sec.



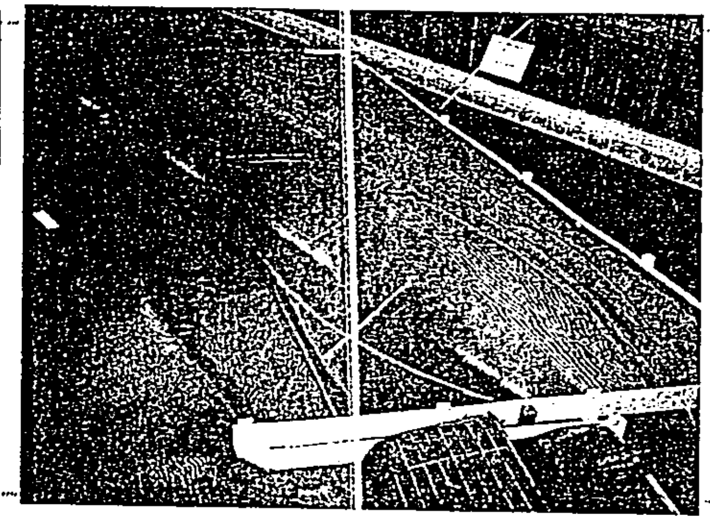
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Physical Model Test, Phase 2	SURVEY RESULTS, CONFIGURATION 2, TEST 5, EQUILIBRIUM BEACH Regular Waves Hrms = 3 ft, T = 14 sec	FIGURE 4-10



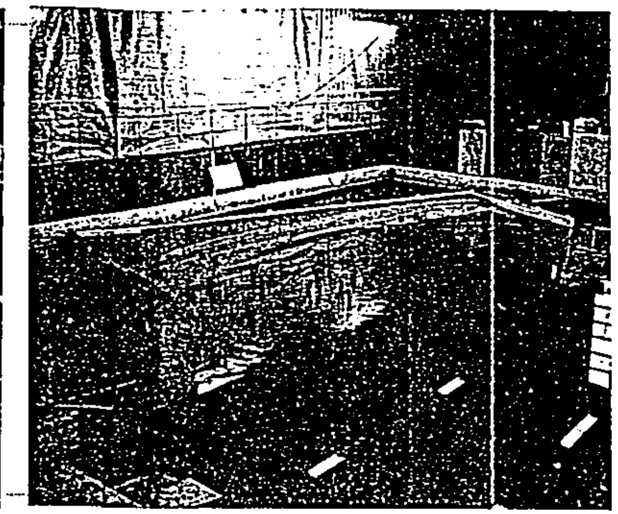
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Physical Model Test, Phase 2	SURVEY RESULTS, CONFIGURATION 2, TEST 6, EQUILIBRIUM BEACH Random Waves Hs = 3.8 ft, Tp = 8 sec	FIGURE 4-12



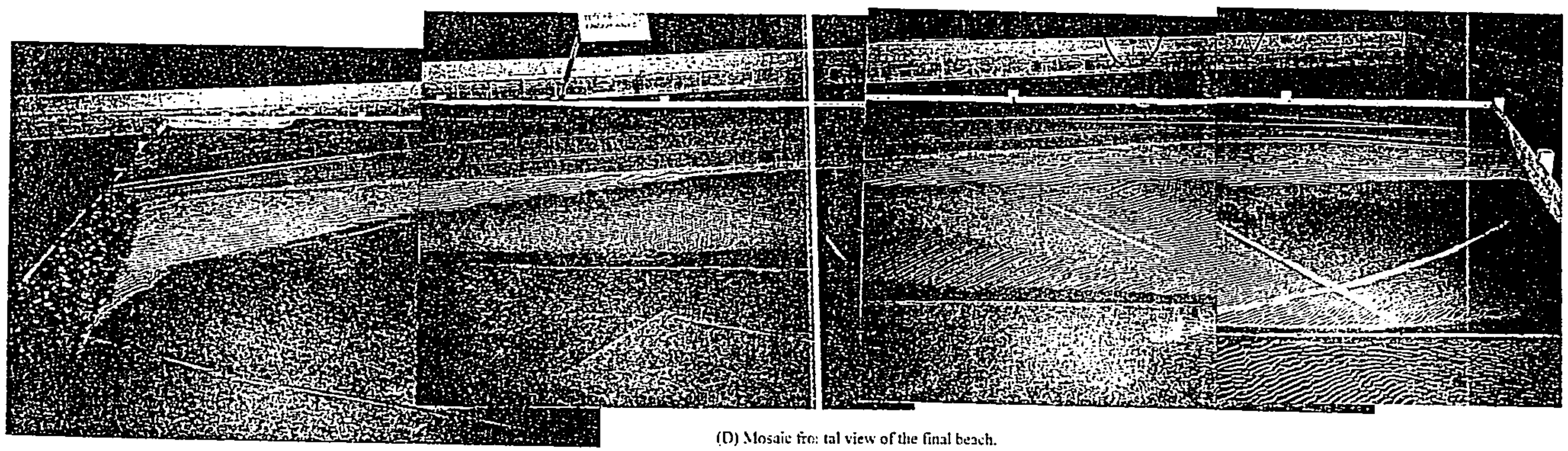
(A) Initial beach prior to testing.



(B) Final beach after testing as viewed from the south end of basin.

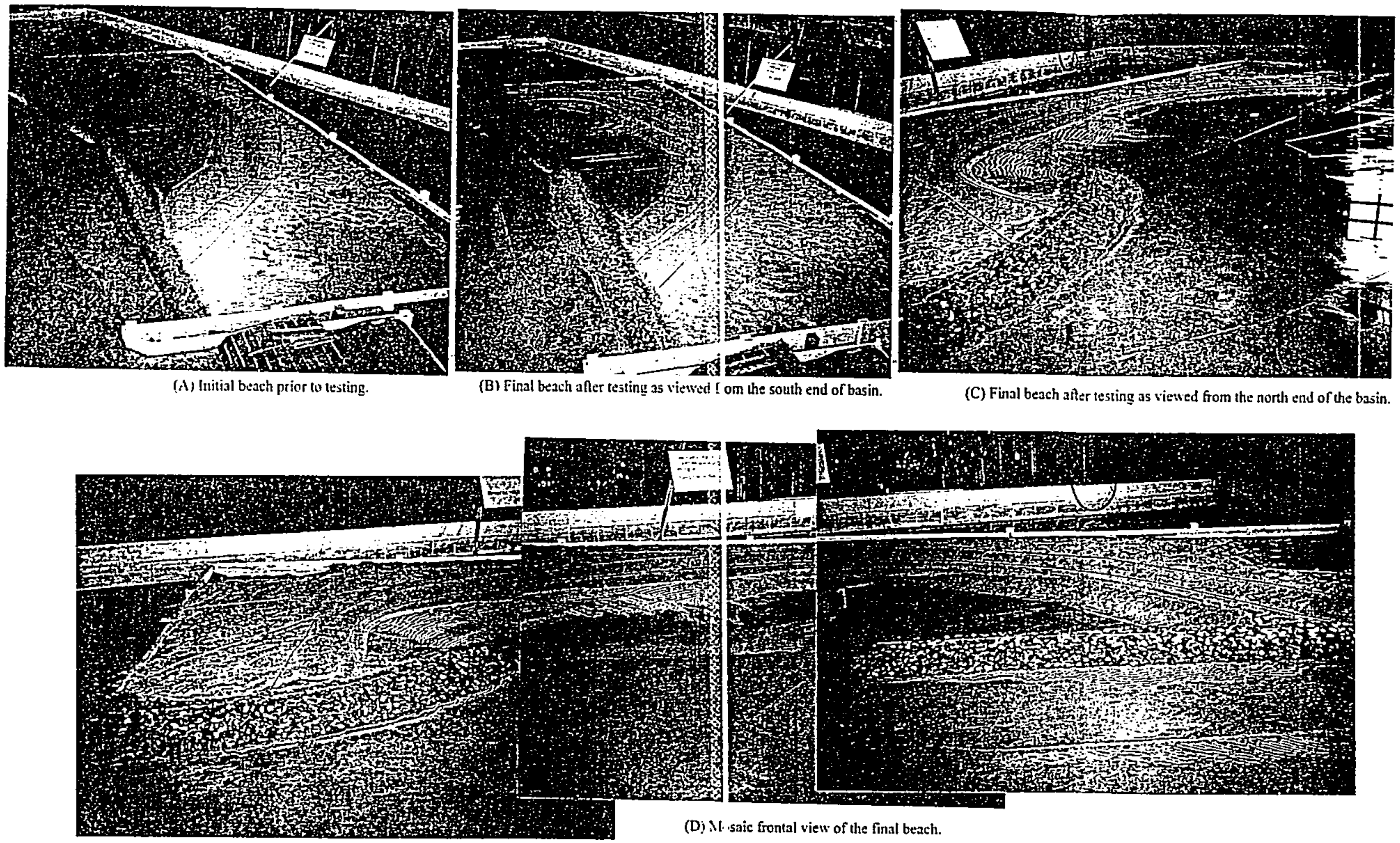


(C) Final beach after testing as viewed from the south end of the basin.



(D) Mosaic frontal view of the final beach.

Figure 4-11: Configuration 2, Test 6, Initial "equilibrium" beach tested with random waves, H_s = 3.6 ft and T_p = 8 sec.



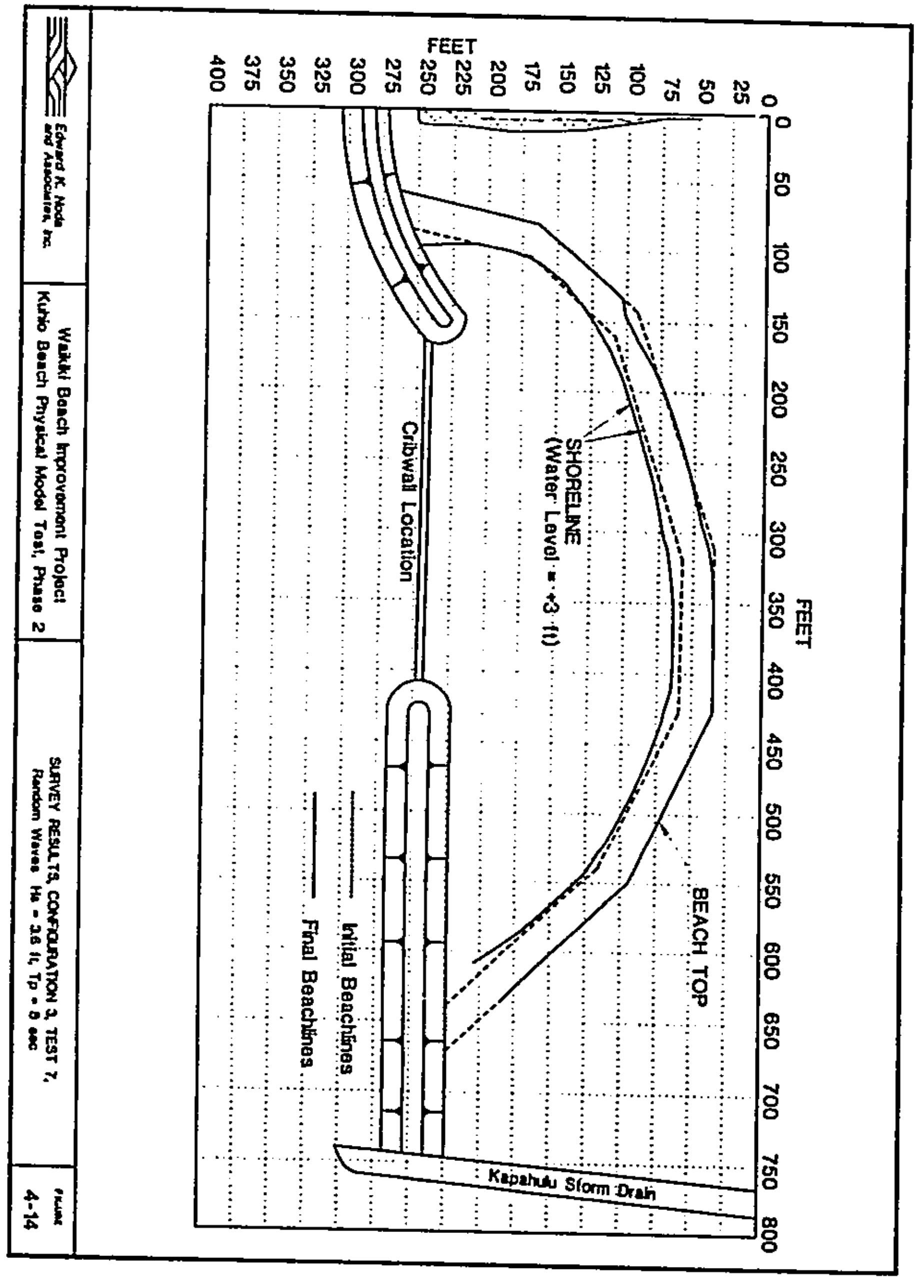
(A) Initial beach prior to testing.

(B) Final beach after testing as viewed from the south end of basin.

(C) Final beach after testing as viewed from the north end of the basin.

(D) Mosaic frontal view of the final beach.

Figure 4-13: Configuration 3, Test 7, tested with random waves. H_s = 3.6 ft and T_p = 8 sec.



Related to breakwater performance, the North breakwater segment experienced low wave overtopping and suffered no wave damage. Approximately 25% of the waves overtopped the North breakwater crest. The presence of "Queens", a surfing shoal just offshore, helped mitigate the effects of the waves on the breakwater. The South breakwater segment experienced no damage and approximately 75% of the waves overtopped the crest. Since the angle of incidence of the waves was not normal to the South breakwater segment the reflection produced by this breakwater would have minimal adverse effects on "Graveyards", a body surfing site just offshore.

Regular wave tests followed the random wave test. Wave conditions for Configuration 3, Test 8, were regular waves with H_{rms} = 3 ft and T = 14 sec. Figure 4-15 shows photos of the initial and final beach planforms, and Figure 4-16 graphically shows the beach Shoreline and Beach Top maximum elevation after 6 hours of testing as obtained from survey measurements.

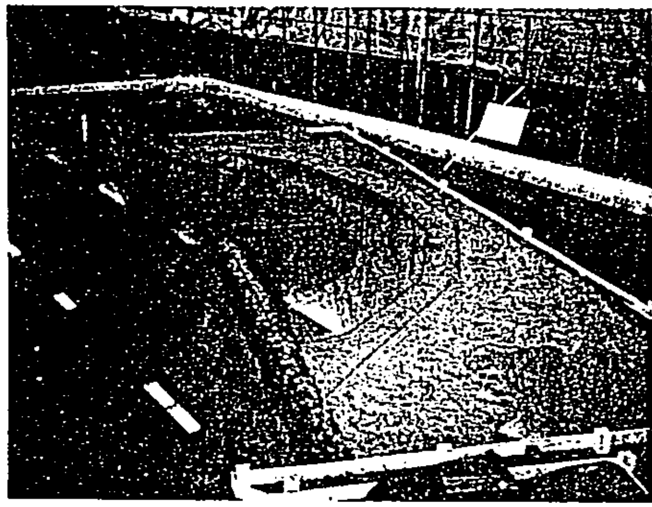
Figure 4-16 shows that the beach Shoreline moved seaward along most of the shoreline with the largest changes occurring about 100 - 250 ft from the north groin where a maximum seaward advance of about 15 was measured. The Beach Top line showed movement (seaward) only along the section between 150 - 300 ft from the groin, where this section is directly exposed to waves from the SW entering through the breakwater gap. In this section, no wave overtopping of the + 6 ft MLLW berm was noted.

Related to the breakwater performance, the North breakwater segment experienced no overtopping and no structural damage. The South breakwater segment experienced no damage and all waves splashed over the crest (100% overtopping).

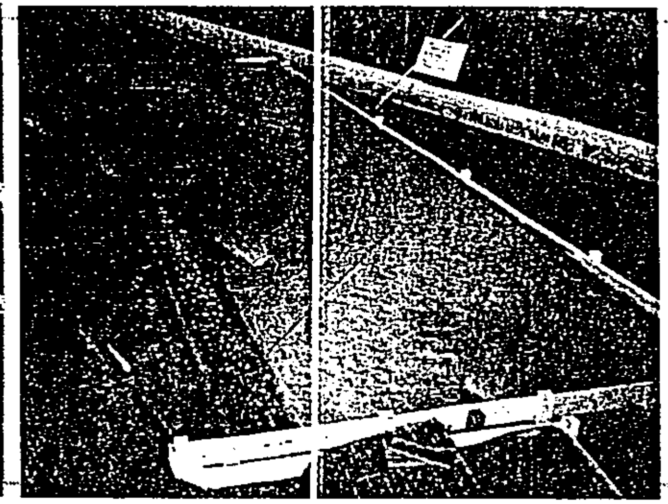
Wave conditions for final Configuration 3, Test 9, were regular waves with H_{rms} = 3 ft and T = 7 sec. Figure 4-17 shows photos of the initial and final beach planforms, and Figure 4-18 graphically shows the beach Shoreline and Beach Top maximum elevation after 6 hours of testing as obtained from survey measurements.

Figure 4-18 indicates that the results obtained for Test 9 were very similar to those of the previous Test 8 for a wave period of T = 14 sec. The Shoreline generally shows seaward movement along most of the bay with the largest changes occurring about 150 - 250 ft from the north groin where a maximum seaward advance of about 12 was measured. The Beach Top line showed some movement (seaward) only along the section between 150 - 300 ft from the groin where this section is directly exposed to waves from the SW entering through the breakwater gap. In this section, very little wave overtopping of the + 6 ft MLLW berm was noted.

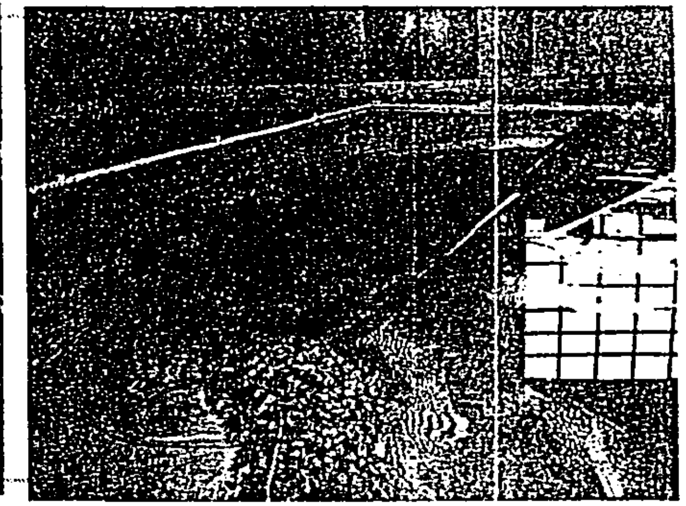
Related to the breakwater performance, the North breakwater segment experienced no overtopping and no damage. The South breakwater segment experienced no damage and all waves splashed over the crest (100% overtopping).



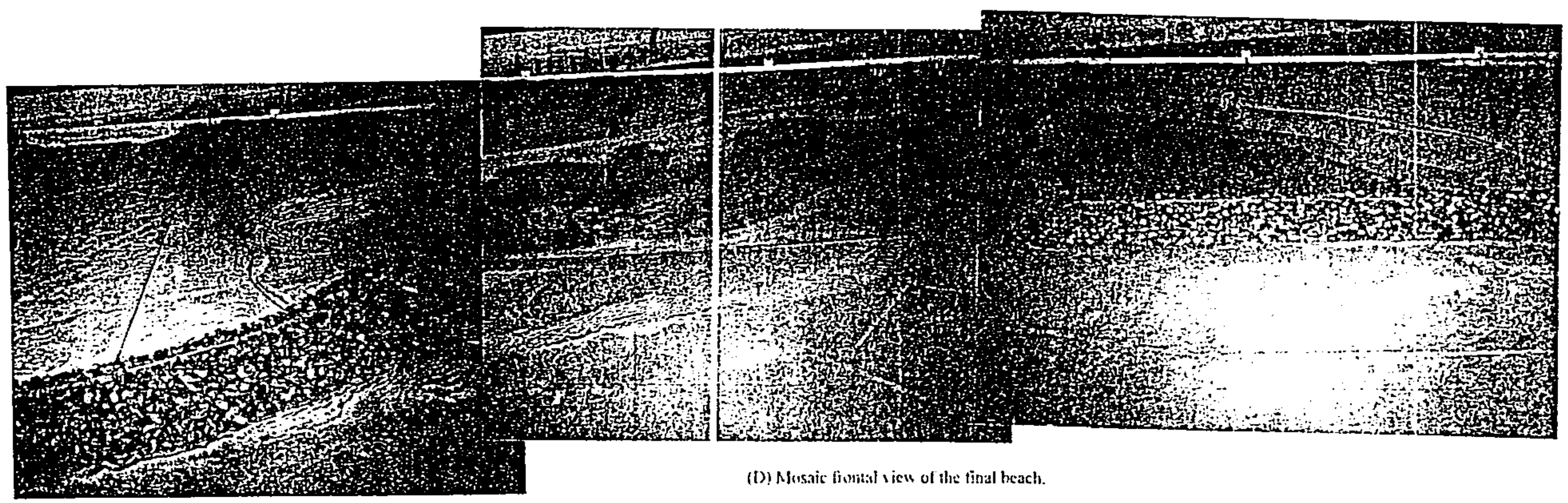
(A) Initial beach prior to testing.



(B) Final beach after testing as viewed from the south end of the basin.

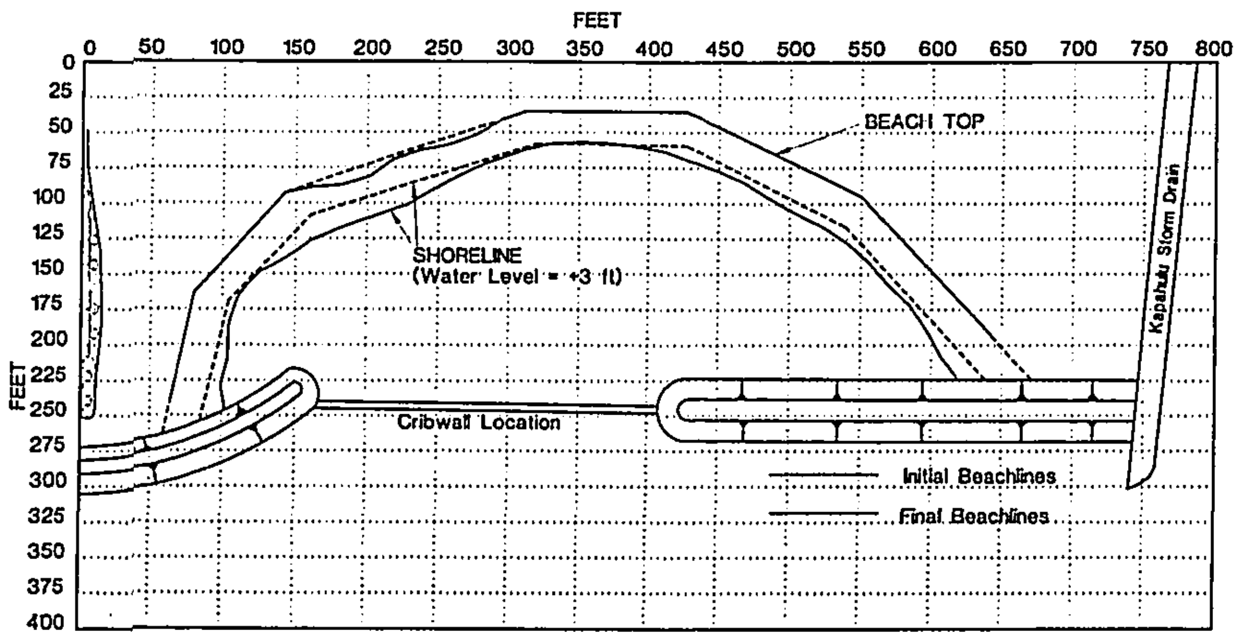


(C) Final beach after testing as viewed from the north end of the beach.

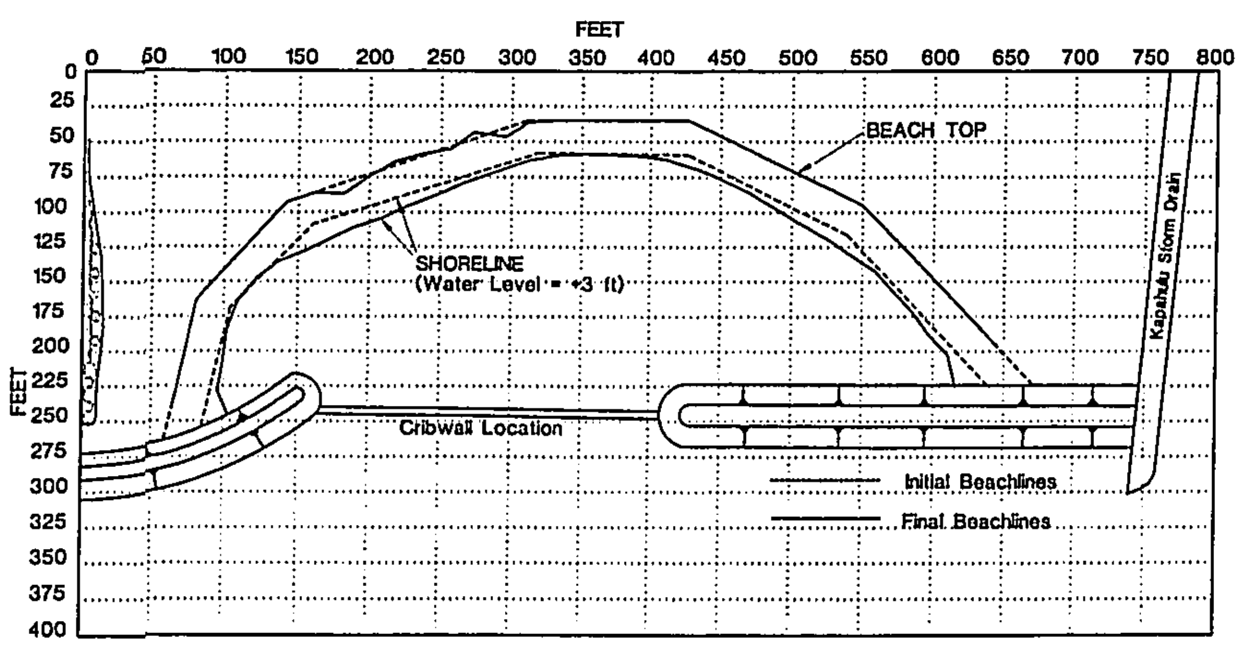


(D) Mosaic frontal view of the final beach.

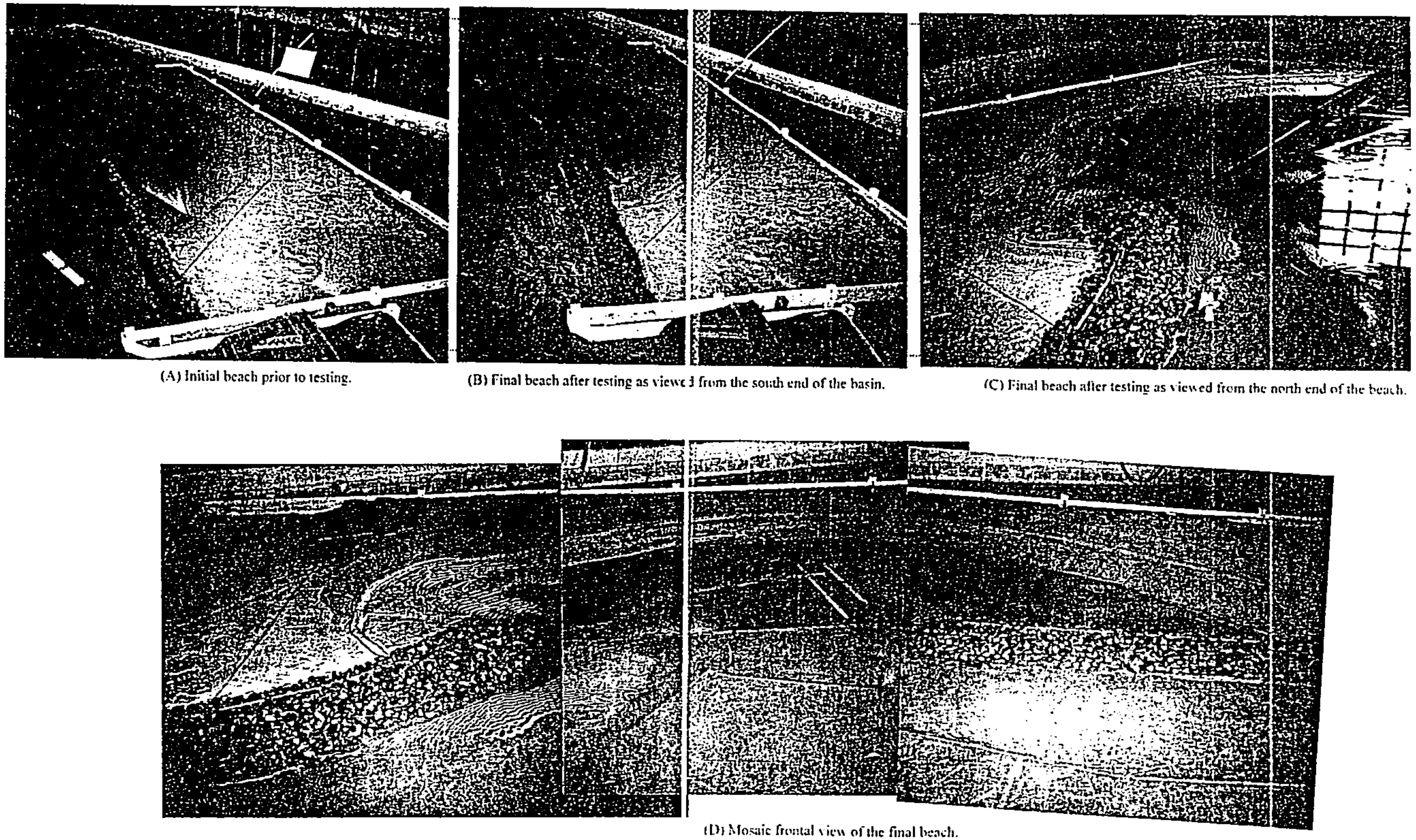
Figure 4-15: Configuration 3, Test 8, Tested with regular waves. H_{mo} = 3 ft and T = 14 sec.



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Physical Model Test, Phase 2	SURVEY RESULTS, CONFIGURATION 3, TEST 8, Regular Waves Hrms =3 ft, T = 14 sec	FIGURE 4-16



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Physical Model Test, Phase 2	SURVEY RESULTS, CONFIGURATION 3, TEST 9, Regular Waves Hrms = 3 ft, T = 7 sec	FIGURE 4-18



(A) Initial beach prior to testing.

(B) Final beach after testing as viewed from the south end of the basin.

(C) Final beach after testing as viewed from the north end of the beach.

(D) Mosaic frontal view of the final beach.

Figure 4-17: Configuration 3, Test 9, Tested with regular waves, H_{mo} = 3 ft and T = 7 sec.

5.0 SUMMARY AND RECOMMENDATIONS

The model tests for the Kuhio Beach, Phase 2 study were performed at the Hydraulics Laboratory at the Scripps Institution of Oceanography, La Jolla, California. The Hydraulics Laboratory's wave basin is approximately 50 ft wide, 60 ft long and 2 ft deep. It features an electro-hydraulic, plunger type wave maker with a wave front of approximately 53 ft wide and is capable of generating both regular (constant period) and random waves.

The following were the objectives of the Phase 2 Kuhio Beach physical model tests:

- To verify the structural stability of the proposed breakwater design.
- To evaluate the degree of wave overtopping of the breakwater.
- To evaluate the planform behavior of the beach protected by the segmented breakwater system.
- To assess other concepts.

To obtain the largest model scale, only the Kuhio Beach south basin was modeled at an undistorted scale of 1:20 (model:prototype). Three (3) configurations were tested consisting of the following:

Configuration 1: "Existing Condition": This configuration represented existing conditions except that the wave protective concrete crib wall was removed to -2 ft MLLW. An initial uniform beach was constructed with a 50 ft wide flat berm at elevation +6 ft MLLW and a 1V:8H beach slope to the bottom of the basin at -4 ft MLLW.

Configuration 2: "Extended Groin": This configuration represented a 150 ft groin extension to the existing dividing groin between the north and south basins. Two (2) different initial "fillet" beach shapes were tested consisting of a "maximum" fillet and "equilibrium" fillet beach.

Configuration 3: "Segmented Breakwater": This configuration, which is considered to be the most promising alternative, consisted of a half segment of a curved, rubblemound breakwater on the north end and a straight breakwater segment on the south end with its centerline located over the existing crib wall. There is a wide gap between the north and south segmented breakwaters. The initial beach planform was represented by a crescent shaped "bay" beach.

The model was constructed as a semi-movable bed model within the south basin and an offshore "fixed bed" area. The offshore bathymetry was reproduced to the -6 ft MLLW contour and the existing crib wall was modeled with an elevation of -2 ft MLLW.

The beach material was sand. The model grain size was determined based on Dalrymple's profile parameter and had a median diameter of 0.15 mm. The breakwaters and groin were modeled based on the Hudson formula and were constructed using rocks varying in size from 3/8" (underlayer) to 60 grams (armor), with an impermeable core.

Regular and random wave tests, with a duration of typically 6 hours (model scale), were performed at a single water level of +3 ft MLLW and one wave direction, 225 degrees T. This is the predominant nearshore wave approach direction and is 20 degrees from the perpendicular to the south basin crib wall (245 degrees T). Regular wave conditions were H_{rms} = 3 ft and T = 7 and 14 seconds. Random wave conditions were synthesized from a Bretschneider spectrum with H_s = 3.6 ft and T_p = 8 seconds.

One wave gage was installed in front of the wave maker at a prototype depth of -5.5 ft MLLW to calibrate wave conditions before the tests. Breakwater stability and overtopping were checked visually and recorded on video tape during tests. Initial and final beach planforms were documented by measuring the distance between a baseline and the top of the beach and the shoreline at different stations along the beach.

Configuration 1 (Existing Condition) was tested with regular waves H_{rms} = 3 ft and T = 7 and 14 seconds. The test with wave period, T = 7 seconds, was found to cause the most rapid changes in beach planform since waves with shorter periods refract less than longer period waves. These waves arrived at the beach with a greater angle of incidence and therefore produced greater sediment transport. The Kapahulu storm drain end of the beach experienced a retreat of the beach of approximately 14 to 19 ft and sand accretion occurred on north groin end, moving the shoreline at that location approximately 20 ft seaward. The T = 14 sec wave test showed a loss of beach width where the entire beach retreated approximately 10 ft. The shoreline showed the same trend as the previous shorter period test with a general shoreline retreat on the Kapahulu storm drain end while some accretion was observed on the north groin end.

Tests for Configuration 2 (Extended Groin) started with a "maximum fillet" beach with the purpose of obtaining an "equilibrium" beach shape for future tests. The maximum fillet beach was tested with short period regular waves, H_{rms} = 3 ft and T = 7 seconds. It experienced a retreat of approximately 15 ft on the Kapahulu storm drain end, significant sand accretion in an area between 150 to 350 ft from the groin (at the "elbow") and a significant retreat of the beach of approximately 75 ft at the groin end. The sand moved from the ends towards the "elbow" or "corner" of the beach where the shoreline gained approximately 40 ft of width. A small amount of sand was lost due to seaward transport at the groin. The slope of the beach after the tests was less steep and it was estimated to be approximately 1V:10H.

Equilibrium beach tests were continued for Configuration 2 with a starting beach which had essentially the same planform as the "maximum fillet" beach but the fillet at the groin was more gradual as indicated by the maximum fillet test results. Also the beach slope was changed to a more gentle 1V:10H. Regular wave test results with H_{rms} = 3 ft and T = 7 seconds showed that there was a significant accretion of sand in the central section of the beach (25 ft increase of width of Shoreline and Beach Top), in the area between 100 to 400 ft from the groin. The beach Shoreline and Beach Top retreated at the Kapahulu storm drain end approximately 12 ft, while a small retreat of the shoreline was observed at the groin end. No seaward transport, or loss of sand around the end of the groin was observed. Regular wave tests with H_{rms} = 3 ft and T = 14 seconds showed accretion of sand in the central section of the beach (25 ft increase of width of Shoreline and Beach Top), in an area between 200 to 400 ft from the groin. The beach Shoreline and Beach Top retreated at the Kapahulu storm drain end approximately 8 ft, while the beach remained unchanged within 200 ft from the groin. No seaward transport, or loss of sand around the end of the groin was observed. Random wave tests with H_s = 3.6 ft and T_p = 8 seconds showed a beach evolution that was similar to the results obtained for the T = 7 seconds regular waves. The beach planform was smoother, but the retreat of the beach at the Kapahulu storm drain end was about 25 ft, the maximum observed in all tests. The beach gained width in the area between 200 to 450 ft from the groin, extending seaward a maximum of approximately 35 feet. No seaward transport, or loss of sand around the end of the groin was observed. During all these tests the groin had no damage and experienced no overtopping.

Configuration 3 (Segmented Breakwater) were initiated with random wave test conditions, H_s = 3.6 ft and T_p = 8 seconds and the results left the beach planform shape relatively unchanged except for the area between 150 to 350 ft from the north groin where the shoreline moved seaward a few feet. In this area, it was observed that approximately 5% of the waves overtopped the +6 ft MLLW beach elevation. The north breakwater segment experienced about 25% wave overtopping and no damage. The south breakwater segment experienced no damage and approximately 75% of the waves overtopped the crest.

Regular wave tests followed the random wave test. The beach planform under regular waves tests, with H_{rms} = 3 ft and T = 14 seconds, remained relatively unchanged except for the area between 100 to 300 ft from the north groin where the shoreline moved seaward a maximum of approximately 15 feet. In this area, it was observed that there was no overtopping of the +6 ft MLLW beach elevation. The north breakwater segment experienced no wave overtopping and no damage. The south breakwater segment experienced no damage and all waves splashed over the crest (100% wave overtopping).

The final test involved regular waves with H_{rms} = 3 ft and T = 7 seconds. The resulting beach planform was similar to the previous test (T = 14 sec). The beach planform remained relatively unchanged except for the area between 150 to 300 ft from the north groin where the shoreline moved seaward a maximum of approximately 12 feet. In this area, it was observed that there was no overtopping of the +6 ft MLLW beach elevation. The north breakwater segment experienced no wave overtopping and no damage. The south breakwater segment experienced no damage and all waves splashed over the crest (100% wave overtopping).

The results of the model testing indicate that:

- Without the crib walls protecting the beach, the existing beach would not be stable under typical wave activity.

- An extended groin could effectively stabilize a dry beach along the entire shoreline within the basin, however, it would not provide the shelter from wave action that a shore-parallel structure would provide.
- A segmented breakwater plan can effectively stabilize a much larger beach area than presently exists, while also providing a calm wading area.
- The rubblemound breakwater segments can be structurally stable using armor stones of sufficient size and with a low height to minimize impacts to the seaward view plane.
- A breakwater height of +5 ft MLLW would sustain overtopping, but less than currently occurs with the crib walls (which are at elevation +3 ft MLLW).
- A segmented breakwater plan will mitigate the present hazards associated with the offshore crib walls, while providing the same amenities such as a calm wading area and protected beach.

The State is planning to proceed with improvements to Kuhio Beach. This 2nd phase of model testing provides engineers with important data to design modifications to the existing crib walls, so that Kuhio Beach can become a much enhanced amenity to Waikiki. Together with the surrounding infrastructure improvements planned by the City, the State's initiatives to improve the beach will be a major step towards the revitalization of Waikiki.

6.0 REFERENCES

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Edward K. Noda and Associates, Inc. (1991a), "Coastal Processes and Conceptual Design Considerations for Waikiki Beach Improvements," EKNA Report No. EKN-1201-R-5-1, prepared for the State of Hawaii, Department of Transportation, Harbors Division, July.

Edward K. Noda and Associates, Inc. (1991b), "Waikiki Beach Improvement Project, Alternatives and Economic Feasibility Evaluation", EKNA Report No. EKN-1201-R-6-1, Prepared for the State of Hawaii, Department of Transportation, Harbors Division, December.

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Appendix B

Numerical Modeling Analysis of Kūhiō Beach Improvements

KUHIO BEACH IMPROVEMENTS
NUMERICAL MODELING AND ANALYSIS

WAIKIKI BEACH IMPROVEMENTS
HONOLULU, HAWAII
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EKNA Project No. 1201-26F

November 1998

KUHIO BEACH IMPROVEMENTS
NUMERICAL MODELING AND ANALYSIS

TABLE OF CONTENTS

NUMERICAL MODELING AND ANALYSIS OF KUHIO BEACH

1. INTRODUCTION

In a recently completed task effort, a Phase 2 physical model study was performed of Kuhio Beach to obtain more detailed data on the design performance of the recommended plan and alternative concepts (Edward K. Noda and Associates, Inc., 1998). To provide the largest scale model for the selected model test facilities, only the south or Diamond Head basin was modeled at a scale of 1:20. The model test results would also be applicable to the design of the north or Ewa Basin.

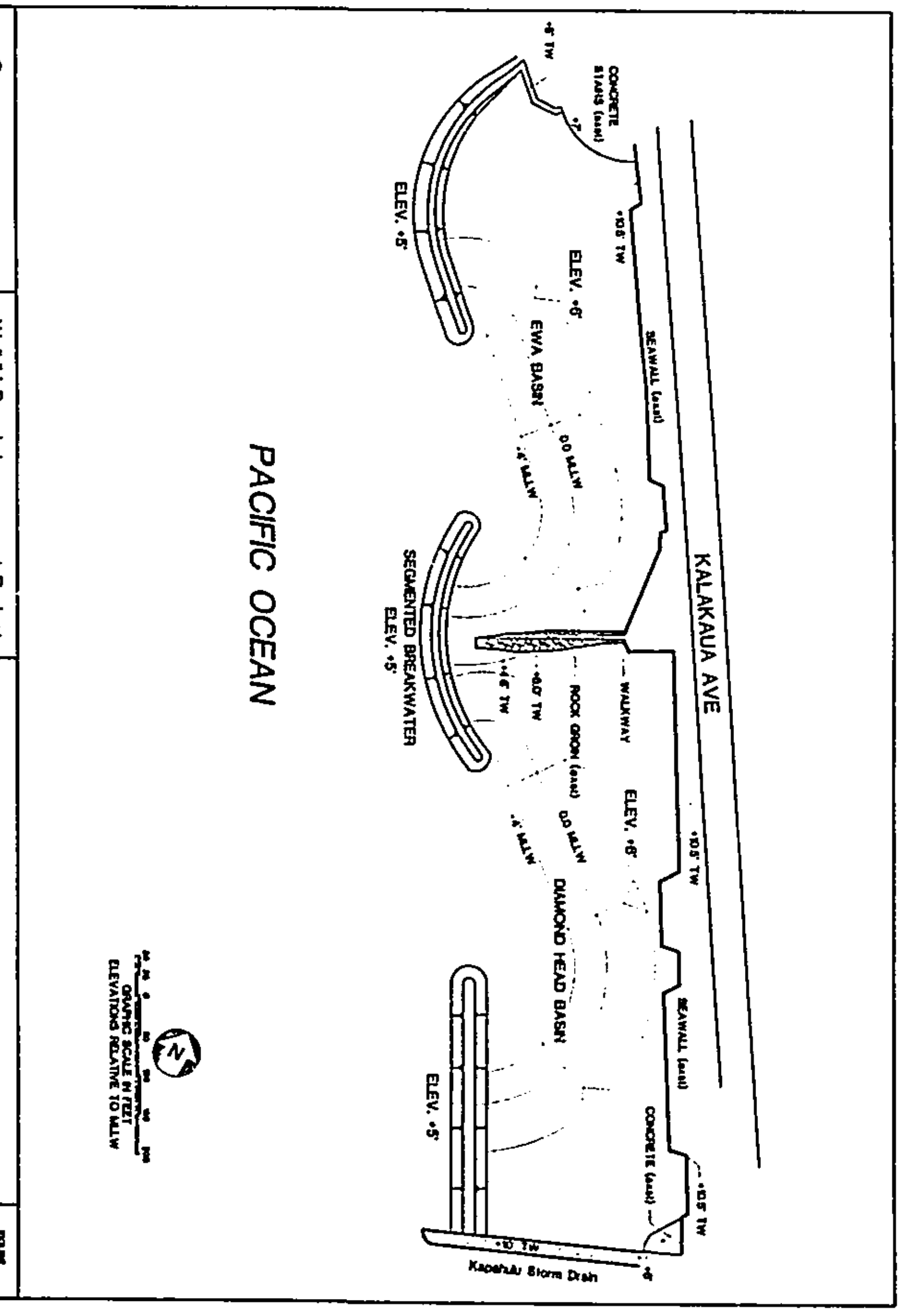
One of the objectives of the Phase 2, three-dimensional physical model test was to evaluate the planform behavior of the beach protected by the recommended segmented breakwater system, with the objective of developing a large stable beach area and a sufficient calm and safe wave protected water area behind the breakwater segments. Figure 1-1 depicts the segmented breakwater concept. The segmented breakwater concept is designed with wide enough gaps between the breakwater segments to prevent strong return-flow currents and to provide water flushing and maintenance of good water quality in the basins. Waves passing through the breakwater openings would create wave diffraction zones in the lee of the breakwater segments, which determine the planform shape of the beach.

Based on the planform results from the Phase 2 segmented breakwater physical model tests, the following are the objectives of the present numerical modeling effort:

1. Apply analytical and/or numerical modeling techniques in order to understand and model the equilibrium planform shape of the beach, as obtained from the physical model tests of the Diamond Head basin.

2. Utilize numerical modeling techniques to evaluate and develop beach profile configurations of the beach protected by the segmented breakwater.

3. Develop equilibrium beach planform shapes for the Ewa Basin.



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	Segmented Breakwater Concept	FIGURE 1-1

2. SUMMARY OF PHYSICAL MODEL TESTS AND RESULTS

2.1 Segmented Breakwater System Description

Figure 2-1 describes the Segmented Breakwater plan that was tested in the Phase 2 model study. The southern breakwater segment extends from the Kapahulu storm drain northward about 340 feet in a straight alignment over the existing crib wall footprint. The northern rubblemound breakwater section, with a length of about 160 feet, represents a half segment of the proposed curved middle breakwater design segment centered on the basin-dividing existing groin. The large gap between the breakwater segments is about 250 feet wide and is designed for free-flow water exchange to improve water quality and to prevent strong return flows in order to minimize the development of deep scour holes. The crib wall has been removed down to elevation -2.0 feet MLLW, which is the approximate depth of the fronting reef flat. The large gap or opening is not centered, but has been shifted towards the north direction in recognition of the direction of dominant wave attack and the need to provide as much berm width as possible for erosion protection. The incident waves will pass through the breakwater opening and create wave diffraction zones behind each breakwater segment, thereby determining the circular planform shape of the shoreline and the resulting dry beach area. The initial beach was crescent shaped, with a berm elevation of +6 feet MLLW and a beach slope of 1V:8H.

2.2 Test Facility

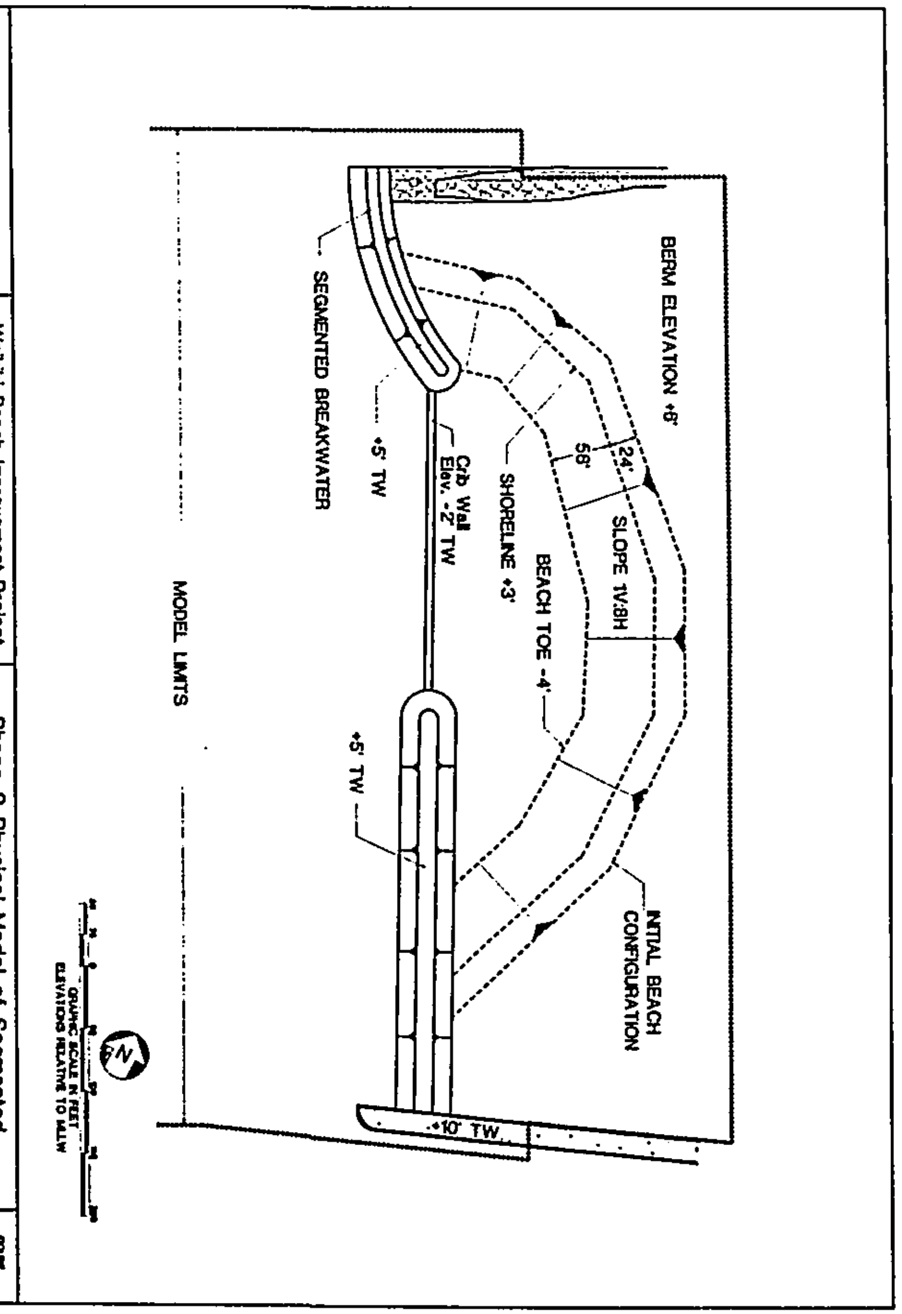
The Phase 2 Kuhio Beach 3-D physical model tests were performed at the Scripps Institution of Oceanography's (SIO) Hydraulics Laboratory located at the University of California at San Diego, La Jolla, California. The model basin is 52 feet wide x 45 feet long x 2 feet deep and has an electro-hydraulic servo, plunger type wave generator with a wave front of approximately 53 feet that is capable of producing both monochromatic (single wave period) and random waves. The basin is equipped with wave absorbers.

Figure 2-2 describes a layout of the entire model basin at the SIO Hydraulics Laboratory and shows the offshore bathymetry contours in feet MLLW and the orientation of the wave maker relative to the modeled area.

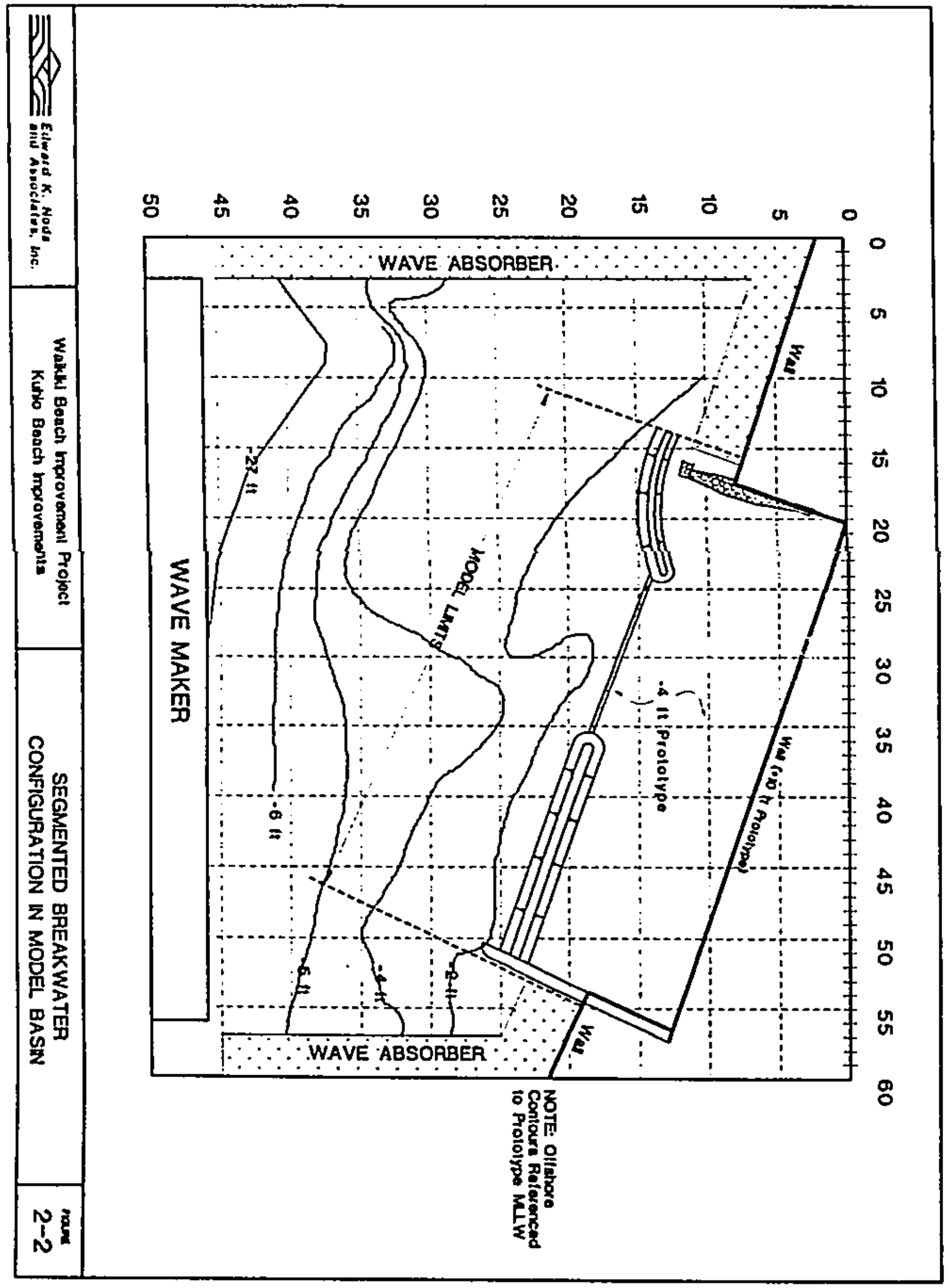
2.3 Model Scale and Configuration

The segmented breakwater model was constructed as a semi-movable bed model where the basin's beach was modeled as a "movable bed" and the offshore reef area as a "fixed bed" from the crib wall alignment to approximately the -6 feet MLLW depth contour. The model was designed following Froude scaling at a model to prototype scale of 1:20. The breakwaters were modeled as impermeable structures.

The segmented breakwater configuration was modeled with the existing crib wall removed to



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project Kuhio Beach Improvements | Phase 2 Physical Model of Segmented Breakwater Concept Diamond Head Basin | FIGURE 2-1



elevation - 2.0 feet MLLW and the water depth within the basin was -4 feet MLLW. The initial beach shape for this segmented breakwater configuration featured a crescent "bay" like beach. In order to facilitate construction of the initial beach planform, it was approximated by 6 straight sections of uniform beach, each with a slope of 1V:8H. The beach had a flat berm elevation of +6 feet MLLW. Figure 2-3 shows a photograph of the initial "bay" like beach at the start of wave attack.

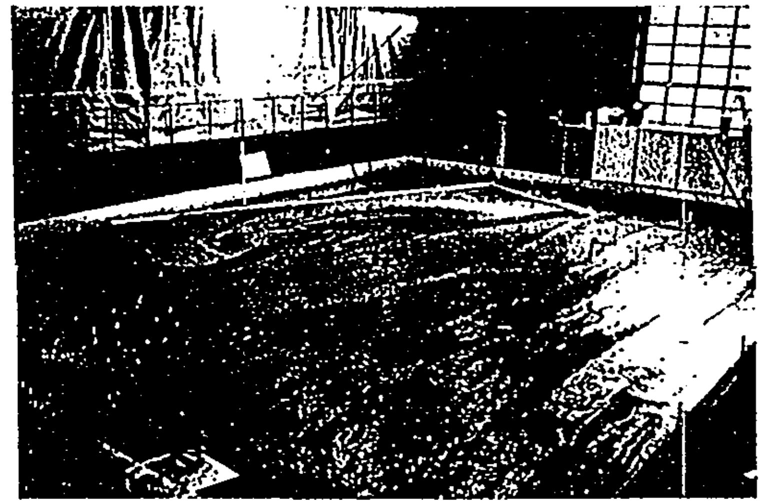


Figure 2-3: Photo of the Segmented Breakwater Concept with the Initial Beach Configuration

2.4 Model Beach Material

The model beach material was sand and the model grain size was determined based on Dalrymple's profile parameter. According to Dalrymple (1992), beach similarity requires the Dalrymple parameter to be the same between model and prototype. Assuming that the model is scaled according to Froude scaling law and the same type of sediment and fluid is used in the model and in the prototype, the nominal grain diameter for the model d_m is given by:

$$d_m = d_p / \Delta^{1.4}$$

where d_p = prototype nominal grain diameter and Δ = 20 (= the reciprocal of the model scale). Assuming d_p = 0.30 mm, the model grain diameter adopted was d_m = 0.15 mm.

2.5 Model Test Conditions

Both regular (single frequency) and random waves were used during the tests. The regular wave tests were primarily focused on the development of the planform evolution of the movable-bed beach shoreline, while the random wave tests were focused on the groin or breakwater structural stability. The following conditions applied to the segmented breakwater model tests.

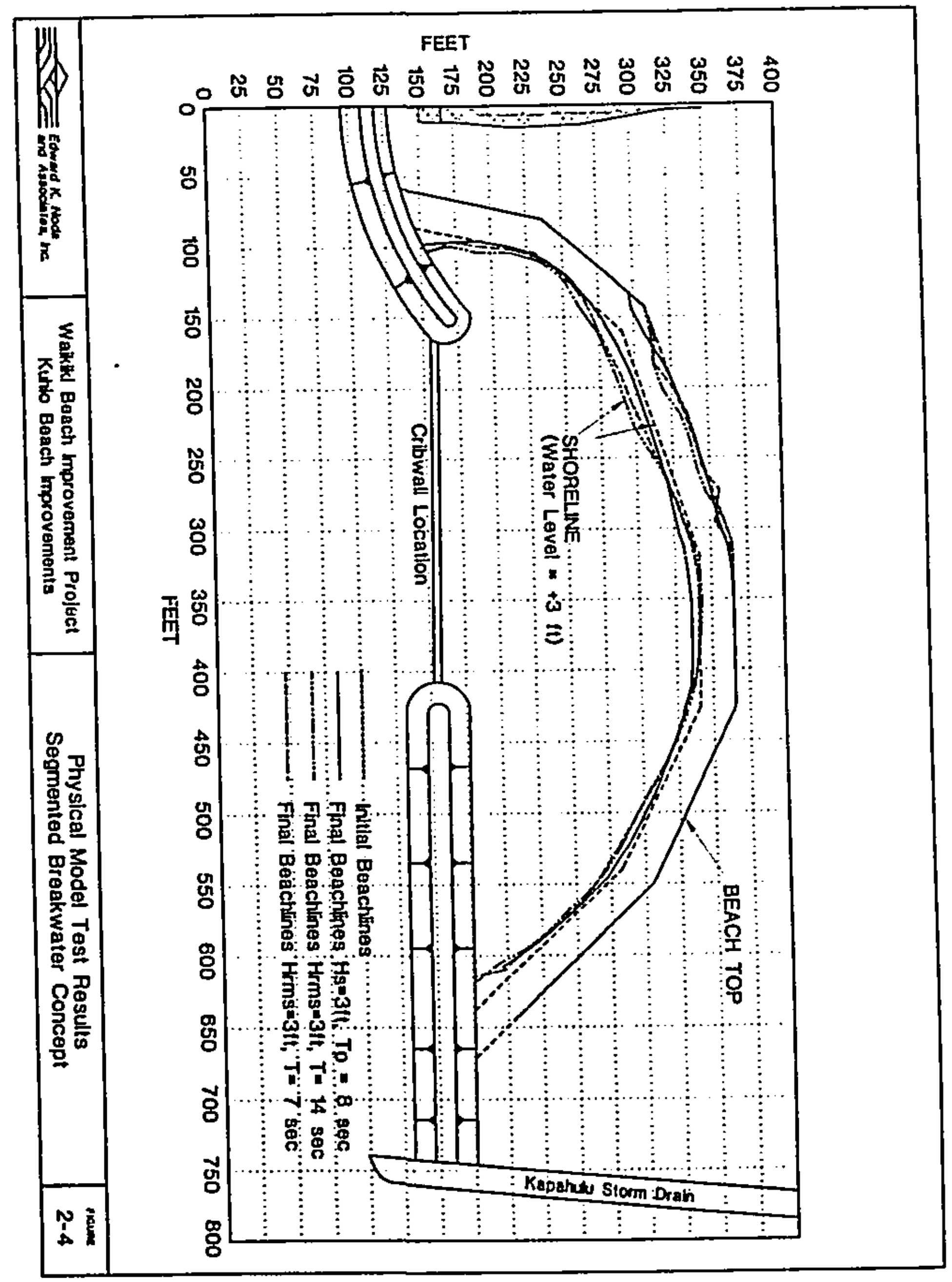
- Wave Calibration: Wave conditions were measured and calibrated in a water depth of −6 feet MLLW, directly fronting the wave maker and about midway along its length.
- Wave Direction: Only one wave direction was tested: 225 degrees T. This is the predominant nearshore wave approach direction and is 20 degrees from the perpendicular to the south basin crib wall (245 degrees T).
- Wave Periods: Three (3) wave periods were tested: T = 7 and 14 seconds for the regular wave tests and T_p = 8 seconds for the random waves tests, where T_p is the peak period.
- Wave Heights: Two (2) wave heights were tested: H_{rms} = 3 feet for the regular wave tests (upper limit of the predominant Seasonal Wave conditions), and H_s = 3.6 feet for the random wave tests (Design Wave condition), where H_s = the significant wave height and H_{rms} = the root-mean-squared wave height.
- Water Level: All tests were performed with one (1) water level = +3 feet MLLW.
- Test Length: The length of each test was 6 hours.

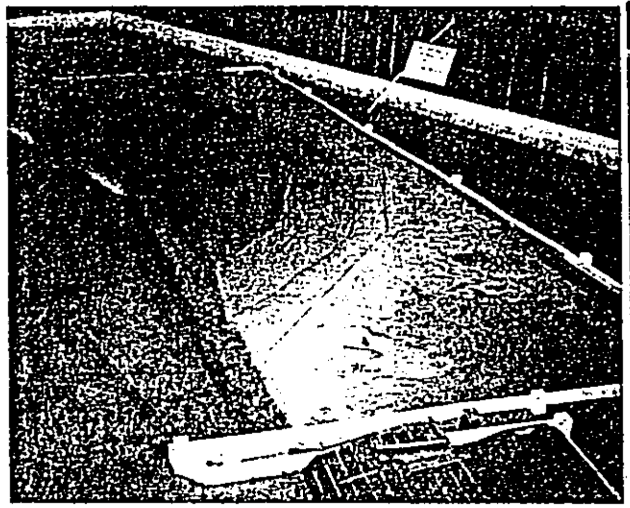
2.6 Beach Change Documentation

Initial and final beach configurations were documented by measuring the perpendicular distance between a baseline and two reference lines, the "Shoreline" and the "Beach Top", at various station locations along the baseline. The before and after "Shoreline" location is defined by the intersection of the beach with the still water level (+3 feet MLLW). The initial "Beach Top" line represents the break-line between the flat berm at elevation + 6.0 feet MLLW and the sloping beach for initial beach conditions. The final "Beach Top" line represents the highest elevation point of sand buildup greater than + 6.0 feet MLLW after the test run. If the wave runup did not exceed the berm height, then the initial "Beach Top" line was used for the final "Beach Top" line. To assist in clearly defining the "Shorelines" and the "Beach Top" lines, black wool string was placed along these lines both prior to and after a test run.

2.7 Test Results

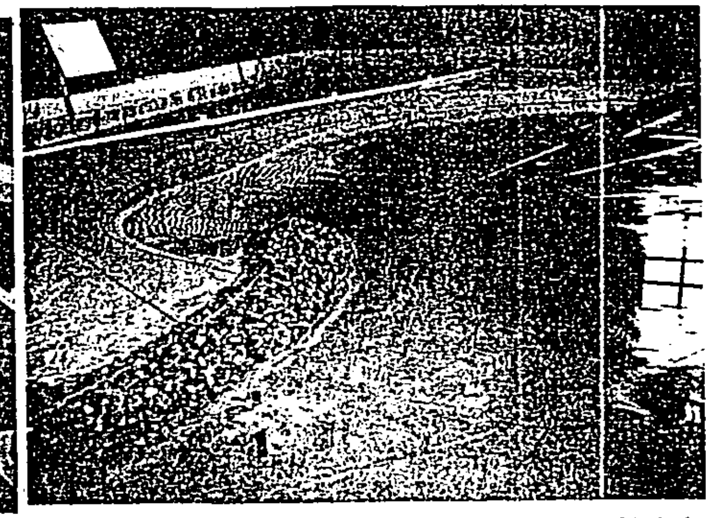
In general, the results for the two (2) regular wave tests (T=7 seconds and T=14 seconds) and the random wave test (T_p = 8 seconds) are very similar. Figure 2-4 shows the planform results of the shoreline and beach top line before and after each of the three test runs. The close similarity of



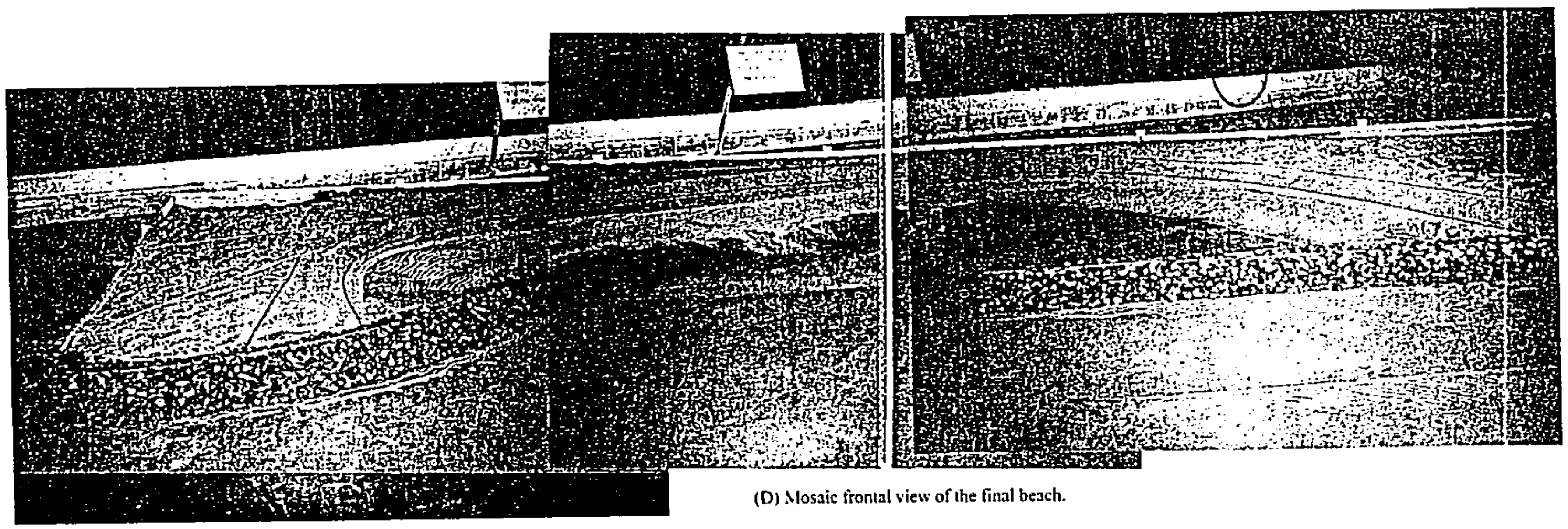


(A) Initial beach prior to testing.

(B) Final beach after testing as viewed from the south end of basin.



(C) Final beach after testing as viewed from the north end of the basin.



(D) Mosaic frontal view of the final beach.

Figure 2-5: Segmented Breakwater Configuration, tested with random waves, H_s = 3.6 feet and T_p = 8 seconds the final equilibrium shorelines is evident in Figure 2-4. Figure 2-5 shows photos of the initial and final planforms for the random wave test of the segmented breakwater concept.

Visual observations indicated that no significant sediment transport occurred out of the basin, particularly around the north breakwater segment.

It is interesting to note that in the lee of the north breakwater segment, the beach toe extends to the head of the breakwater as shown in the photographs in Figure 2-5. This would indicate that the shoreline in the lee of the north breakwater segment represents the most seaward extent that this equilibrium shoreline can exist. If more sand were added to the embayment with the present equilibrium shape shown in Figure 2-5, the entire shoreline would tend to move seaward and sand would then be transported around the north breakwater segment head and out of the basin, until the previous equilibrium shoreline shape is again reached.

3.0 NUMERICAL MODELING OF THE SEGMENTED BREAKWATER SHORELINE

3.1 Introduction

Numerical modeling techniques were applied to evaluate the equilibrium planform shape of the shoreline, using the physical model test results to calibrate the numerical models. Two numerical modeling techniques were applied: (1) "parabolic" shoreline model and (2) diffraction-dominant circular shoreline model. Both techniques are described by Silvester and Hsu (1993). The following describes the analytical evaluation of the segmented breakwater equilibrium shoreline using these two techniques.

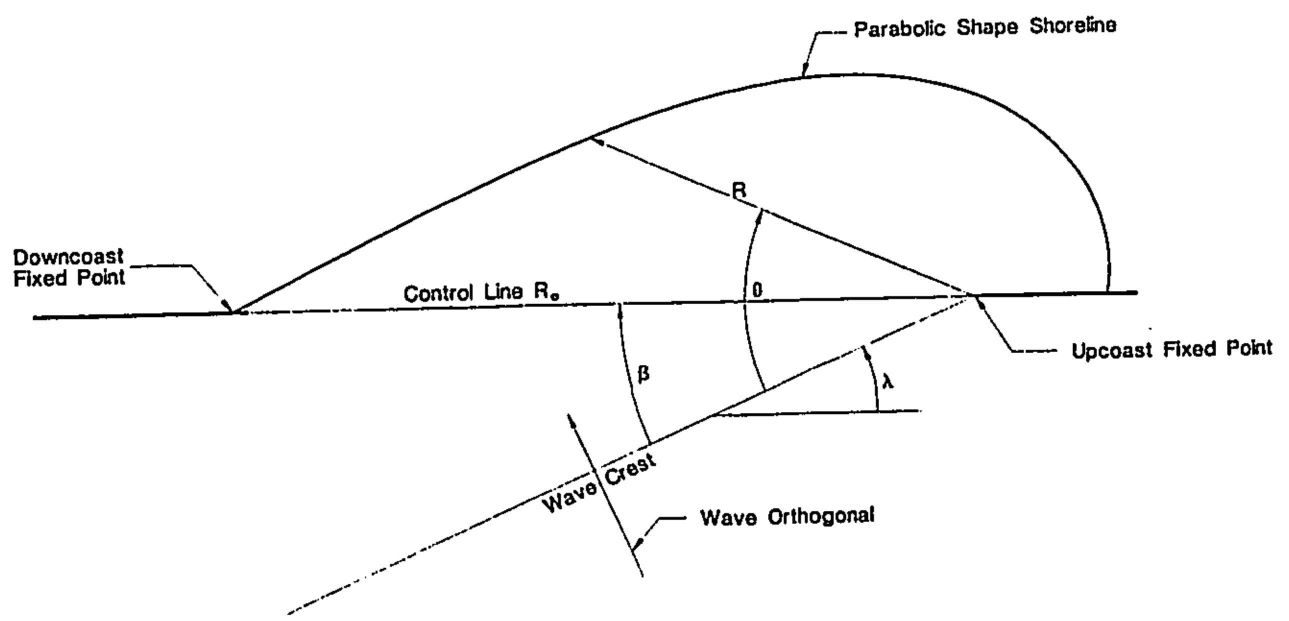
3.2 Parabolic Bay Shape Shoreline Model

Silvester and Hsu (1993) summarizes the modeling efforts for what Silvester describes as crenulate shaped bays, as schematically shown in Figure 3-1. Based on an extensive analysis using both model test shoreline data and actual bay shorelines, the following empirical polynomial equation for equilibrium shorelines has been derived (Hsu and Evans, 1989).

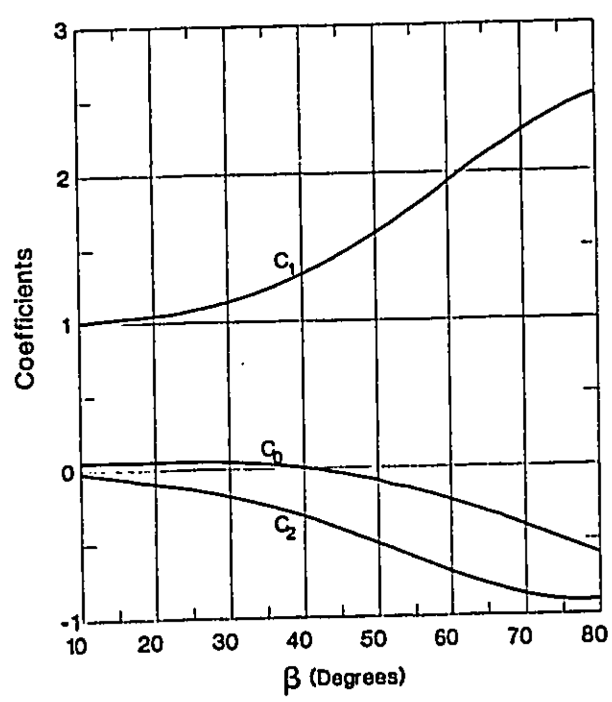
$$\frac{R}{R_o} = C_o + C_1\left(\frac{\beta}{\theta}\right) + C_2\left(\frac{\beta}{\theta}\right)^2 \qquad (1)$$

Coefficients C_o, C_1 and C_2 are described in Figure 3-2 and numerically summarized in Table 3-1. Note that Silvester and Hsu (1993) describe Eqn. 1 as a parabolic shaped shoreline, although it is more accurately a quadratic equation. In the following analysis, the parabolic term is used to describe Eqn. 1.

Examining the shoreline model test results shown in Figure 2-4 versus the Figure 3-1 variables, the equivalent upcoast headland or fixed point is represented by the head of the south breakwater segment, but the downcoast headland, represented by the north breakwater segment head, protrudes into the ocean and forms a small, protected water area in the lee of the downcoast fixed point. Silvester and Hsu (1993) provide Figure 3-3 which schematically describes a protruding downcoast fixed point where wave diffraction/refraction processes are at work in the protected lee. In this situation, a transition point between two parabolic shoreline shapes needs to be determined, to which the accepted wave orthogonal is perpendicular to the tangent to the shoreline. This transition point becomes the equivalent downcoast fixed point for the parabolic shoreline application.



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project Kuhio Beach Improvements | Definition Sketch Of Parabolic Shoreline Shape | FIGURE 3-1



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project Kuhio Beach Improvements | Parabolic Shape Shoreline Coefficients | FIGURE 3-2

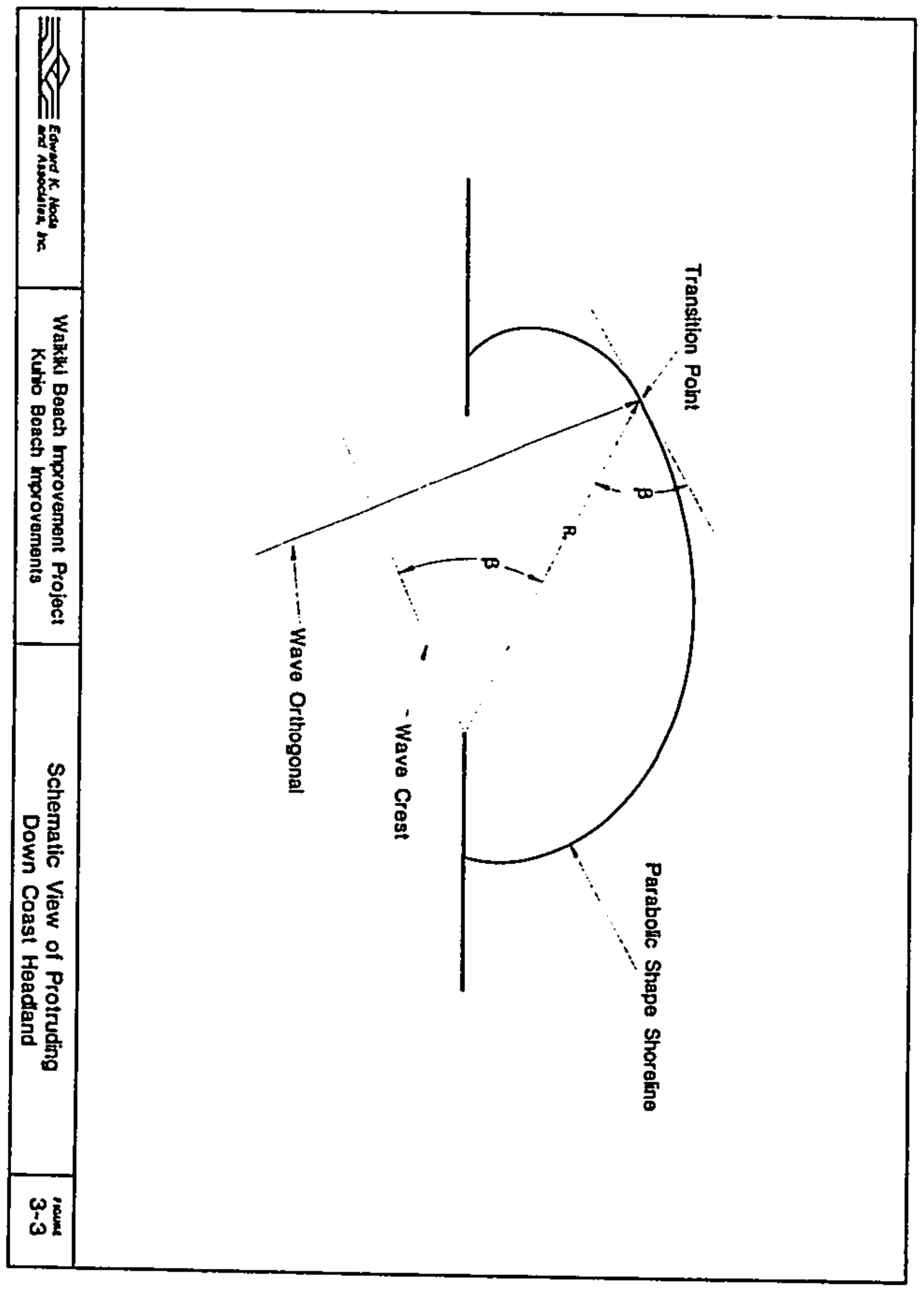
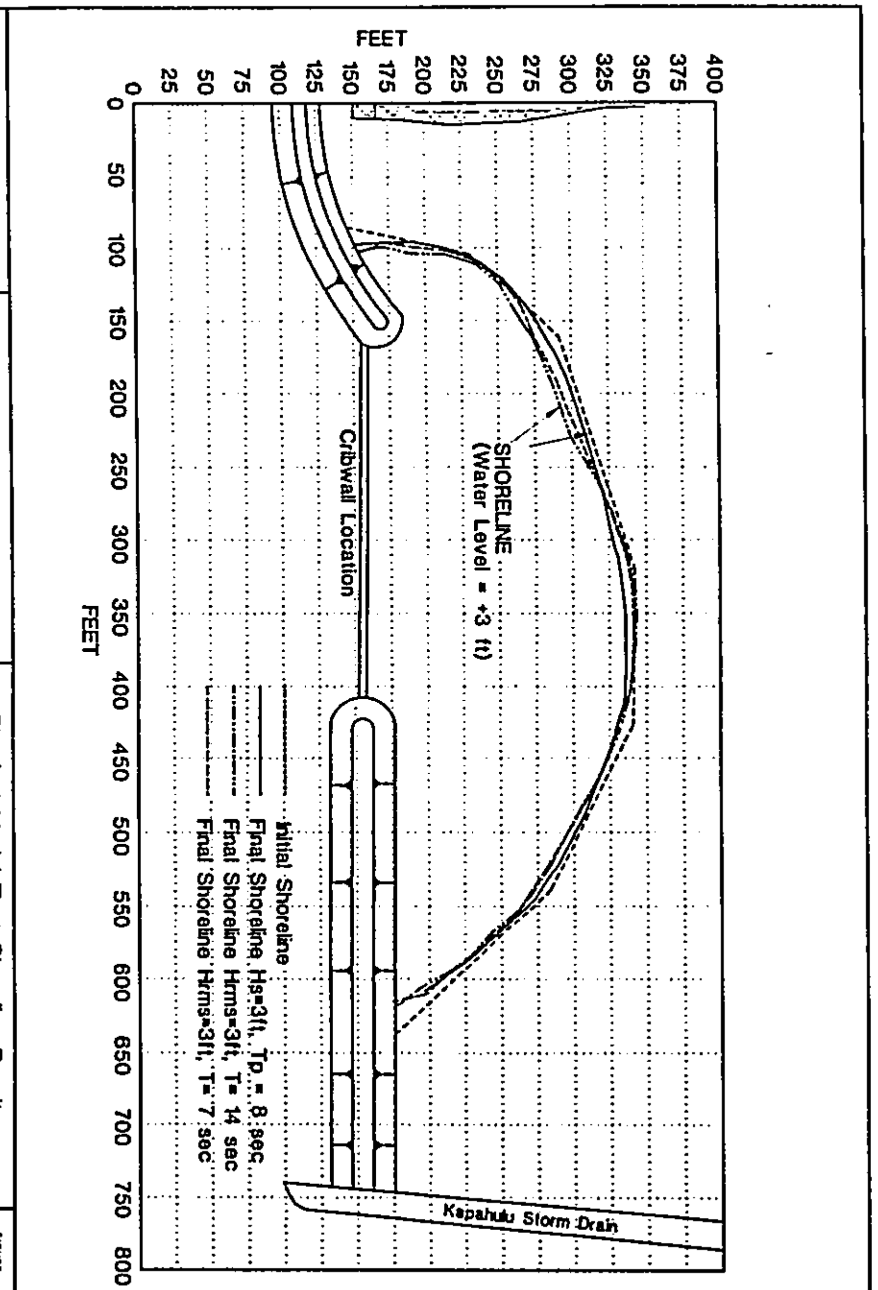


Table 3-1: Coefficients For Parabolic Shaped Shoreline Equation

β°	C_0	C_1	C_2
20	0.054	1.040	-0.094
22	0.054	1.053	-0.109
24	0.054	1.069	-0.125
26	0.052	1.088	-0.144
28	0.050	1.110	-0.164
30	0.046	1.136	-0.186
32	0.041	1.166	-0.210
34	0.034	1.199	-0.237
36	0.026	1.236	-0.265
38	0.015	1.277	-0.296
40	0.003	1.322	-0.328
42	-0.011	1.370	-0.362
44	-0.027	1.422	-0.398
46	-0.045	1.478	-0.435
48	-0.066	1.537	-0.473
50	-0.088	1.598	-0.512
52	-0.122	1.662	-0.552
54	-0.138	1.729	-0.592
56	-0.166	1.797	-0.632
58	-0.196	1.866	-0.671
60	-0.227	1.936	-0.710
62	-0.260	2.006	-0.746
64	-0.295	2.076	-0.781
66	-0.331	2.145	-0.813
68	-0.368	2.212	-0.842
70	-0.405	2.276	-0.867
72	-0.444	2.336	-0.888
74	-0.483	2.393	-0.903
76	-0.522	2.444	-0.912
78	-0.561	2.489	-0.915
80	-0.600	2.526	-0.910

It is somewhat difficult to locate the transition point, which is the selection of the "accepted orthogonal", particularly when the shoreline is a continuous curve. This requires accurate information on the direction of the wave ray as it just enters the embayment. Figure 3-4 shows the model test results for only the final shoreline shapes and it is noted that the shoreline area directly exposed to wave attack through the breakwater gap has formed a consistent orientation. If the shoreline orientation of the T = 7 and 14 second wave period tests are averaged, a normal



Waikiki Beach Improvement Project
Kuhio Beach Improvements

Physical Model Test Shoreline Results
Segmented Breakwater Concept

FIGURE 3-4

projection would represent the wave orthogonal. If this average shoreline orientation is moved such that it just becomes tangent to the shoreline from the random wave test, then this defines a logical transition point and the downcoast fixed points for both upcoast breakwater headlands. The resulting input parameters, R_o and β for each of the parabolic shorelines are shown in Figure 3-5 and the parabolic shoreline parameters for Eqn. 1 are also described.

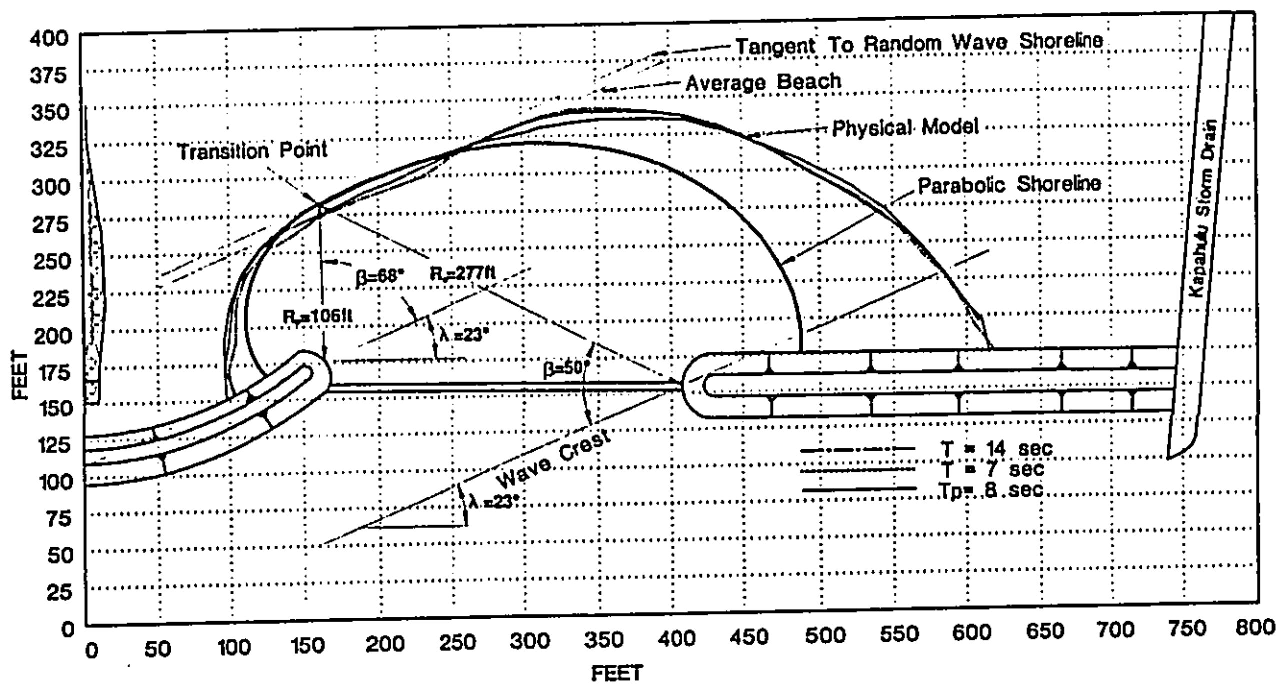
Examining Figure 3-5, it is noted that the parabolic shoreline is generally displaced seaward of the equilibrium shoreline obtained from the model tests. For the development of the parabolic shoreline equation, Eqn. 1, both model test results and a significant amount of actual embayment data were used. Thus, it can be expected that in the lee of the upcoast headland, wave refraction processes dominate over diffraction processes, leading to the non-circular shoreline shape in the lee of the headlands/breakwaters. Since the water depth within the Kuhio Beach basins are expected to be relatively constant, which was modeled in the Diamond Head basin, diffraction processes would be dominant, which could explain the differences between the parabolic shaped shoreline and the model test shoreline.

If the parabolic shape is indeed the final equilibrium shoreline, and if the initial shoreline is represented by the average of the model test results, then over time accretion would take place in the lee of both breakwater segments, particularly the upcoast or south breakwater segment. This situation may occur should sand be transported onto the flat basin areas, producing variable depth contours and increasing the influence of wave refraction processes. Assuming that no additional beach nourishment is provided and that the original volume of sand remains within the basin, the sand accretion in the lee of the breakwaters must be offset by shoreline erosion at other locations. If we further assume that the beach profile along the entire shoreline is generally similar, then the area of shoreline accretion would be approximately equal to the areas of erosion. Figure 3-6 describes a parabolic shaped beach where the area of shoreline accretion is about equal to the area of shoreline erosion, based on starting with the random wave model shoreline results. From the results shown in Figure 3-6, should the shoreline move towards a parabolic shaped bay, there would be erosion in the direction orthogonal to the persistent wave crests.

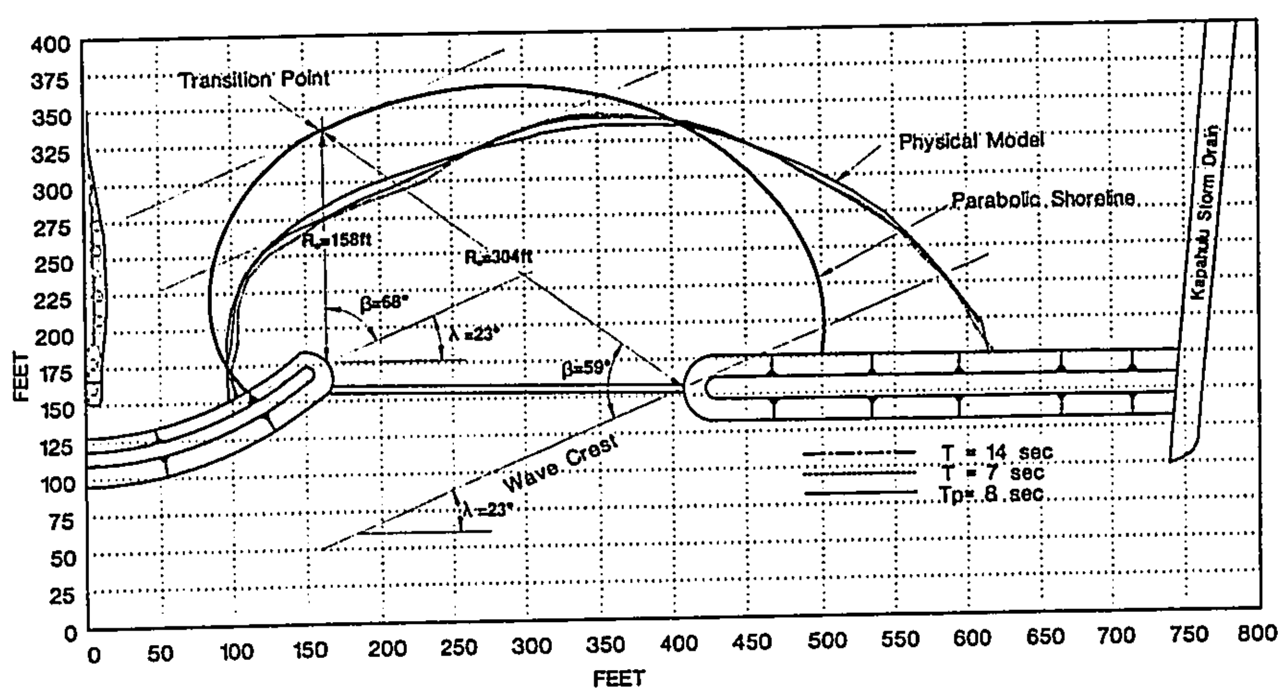
3.3 Diffraction-Dominant Circular Shoreline Model

Silvester and Hsu (1993) describe a situation when waves enter a small gap in a breakwater or reef and where wave diffraction is the dominant process as compared to wave refraction. In this situation, the water depth in the embayment is essentially constant. Thus, the incident wave proceeds through the breakwater gap, between the limiting orthogonals, unchanged in direction and simply reduced in wave height due to energy demands of the diffraction processes. The beach shoreline segment in the area of the non-diffracting waves will tend to be straight and aligned with the incoming wave crests. The shoreline segments on either side of this straight beach will tend to be circular arcs as shown in Figure 3-7.

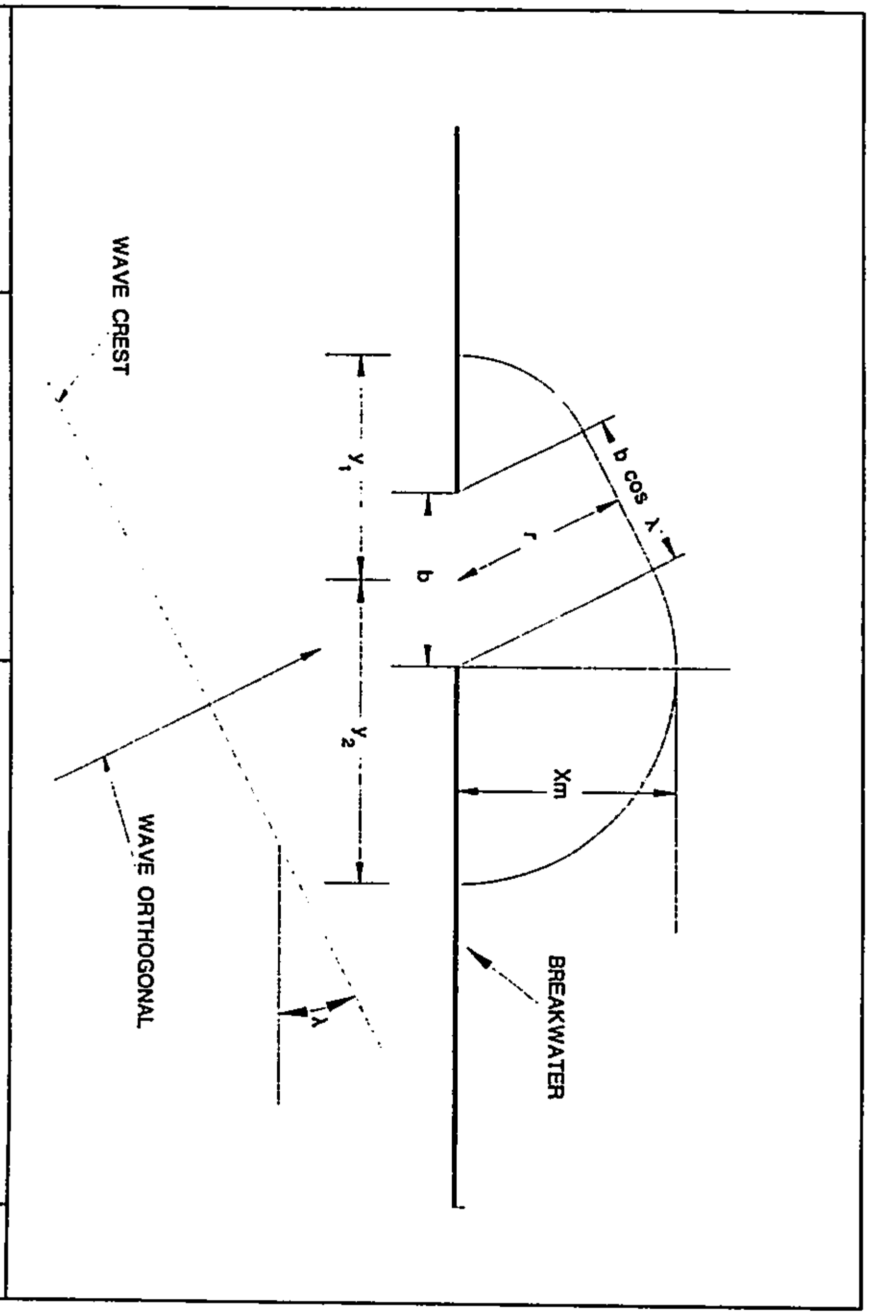
Examining the physical model test shoreline results shown in Figure 3-4, there is a clear similarity with the schematic drawing in Figure 3-7. Applying the above methodology to the



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	Parabolic Shoreline Analysis for the Segmented Breakwater Concept	FIGURE 3-5



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	Parabolic Shoreline Analysis Assuming Equivalent Sand Volume	FIGURE 3-6



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project Kuhio Beach Improvements | Definition Sketch of Diffraction-Dominant Embayment With Small Breakwater Gap | FIGURE 3-7

Kuhio Beach model shoreline data yields the results shown in Figure 3-8. Also included in Figure 3-8 is the parabolic shaped shoreline for comparison. It is interesting to note that the model test shoreline results are between the circular shoreline arcs and the parabolic shaped shoreline. The circular arc shoreline in Figure 3-8 more closely resembles the physical model results in the lee of the south breakwater segment (upcoast) than the parabolic shoreline. This shoreline reach would be expected to mimic a circular arc since the basin depth is constant over which the wave propagates. In the lee of the north breakwater segment, Figure 2-1 shows that the initial beach toe extends to the breakwater head and the photographs in Figure 2-5 show that final water depths are not constant. Thus, wave refraction and diffraction processes are at-work together, and a circular arc behind the north breakwater segment would not be expected.

Since the circular shoreline shape provides a reasonable comparison with the physical model test results, further analysis of the concept may provide useful predictive information. Considering the schematic description shown in Figure 3-7, a gap of width b allows waves angled λ to the breakwater to enter across a band width $b\cos\lambda$. The unrefracted waves then travel a distance r to the shoreline forming a beach normal to the wave orthogonals. The radius from the downcoast gap extremity is r_1 and the corresponding radius from the upcoast headland is r_2 which are given by the following.

$$r_1 = r - \frac{b\sin\lambda}{2} \quad , \quad r_2 = r + \frac{b\sin\lambda}{2} \qquad (2)$$

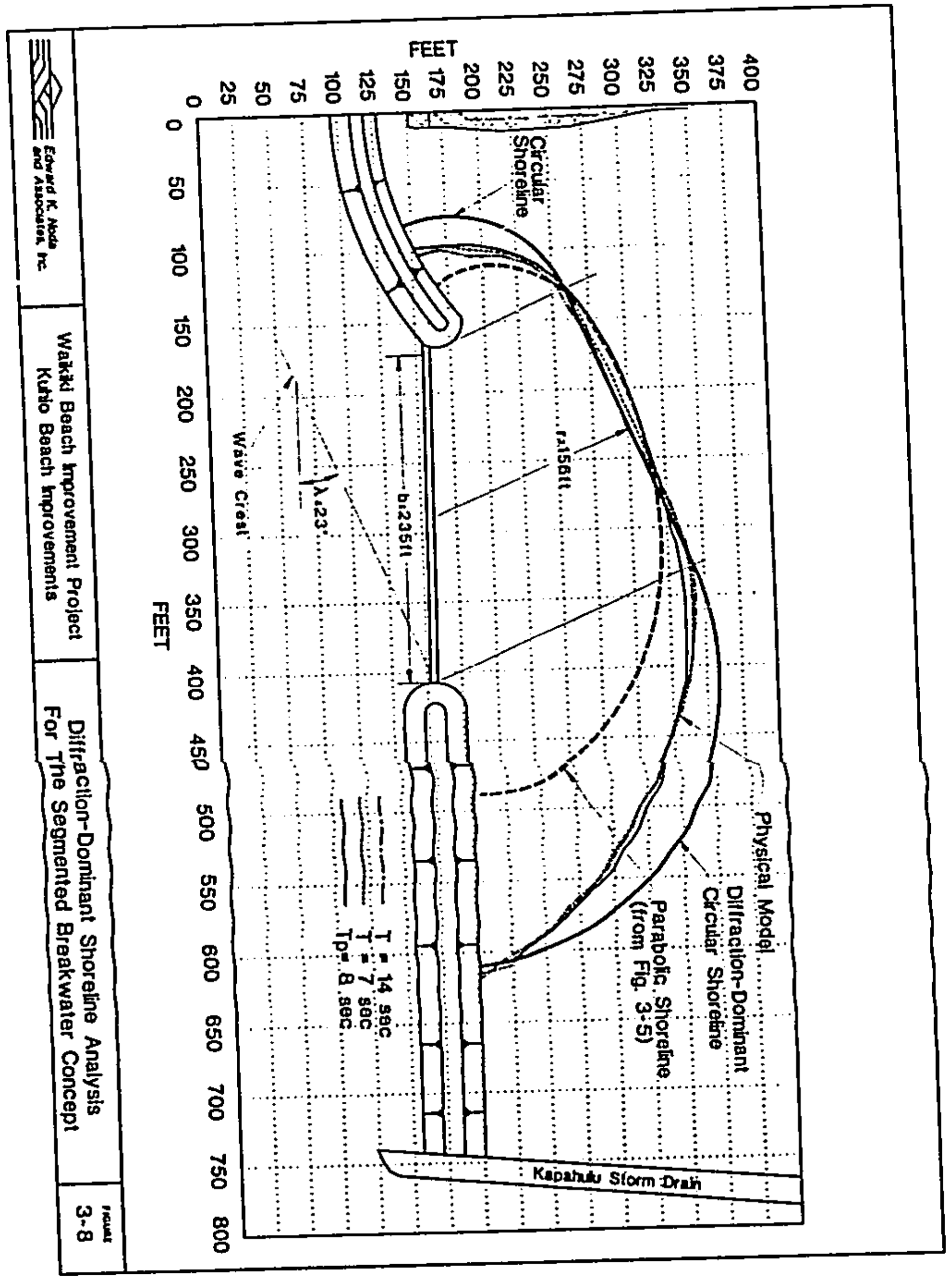
Where the circular arc shorelines reach the leeward side of the breakwater, the distances as measured from the center of the gap are

$$y_1 = r - \frac{b\sin\lambda}{2} + \frac{b}{2} \quad , \quad y_2 = r + \frac{b\sin\lambda}{2} + \frac{b}{2} \qquad (3)$$

The total distance $y_1 + y_2 = 2r + b$ which is independent of the wave angle, λ. As schematically described in Figure 3-7, the maximum indentation, x_m is given by

$$x_m = r + \frac{b\sin\lambda}{2} \qquad (4)$$

For the case shown in Figure 3-8, where $r = 156$ feet, the circular arc solution for the maximum indentation is $x_m = 202$ feet, while the physical model test results yield $x_m = 188$ feet, a difference of 14 feet. As shown in Figure 3-8, the assumption of circular shoreline arcs in the lee of the breakwater segments yields a conservative estimate of the maximum retreat of the equilibrium shoreline when compared with the model test results. Thus, the diffraction-dominant circular shoreline representation may serve as a conservative design shoreline.



Waikiki Beach Improvement Project
Kuhio Beach Improvements

Diffraction-Dominant Shoreline Analysis For The Segmented Breakwater Concept

FIGURE 3-8

If we do not preserve the beach area but instead vary the distance r, then Table 3-2 provides a listing of the maximum indentation, x_m as a function of distance r for the case shown in Figure 3-8 with $b = 235$ feet and $\lambda = 23$ degrees. In addition, the distance from the maximum indentation to the seawall, which defines the mauka extent of the Diamond Head basin, is provided in Table 3-2 assuming that the seawall is located parallel to and 250 feet from the center of the crib wall location. Figure 3-9 describes circular shoreline simulations for some of the cases described in Table 3-2.

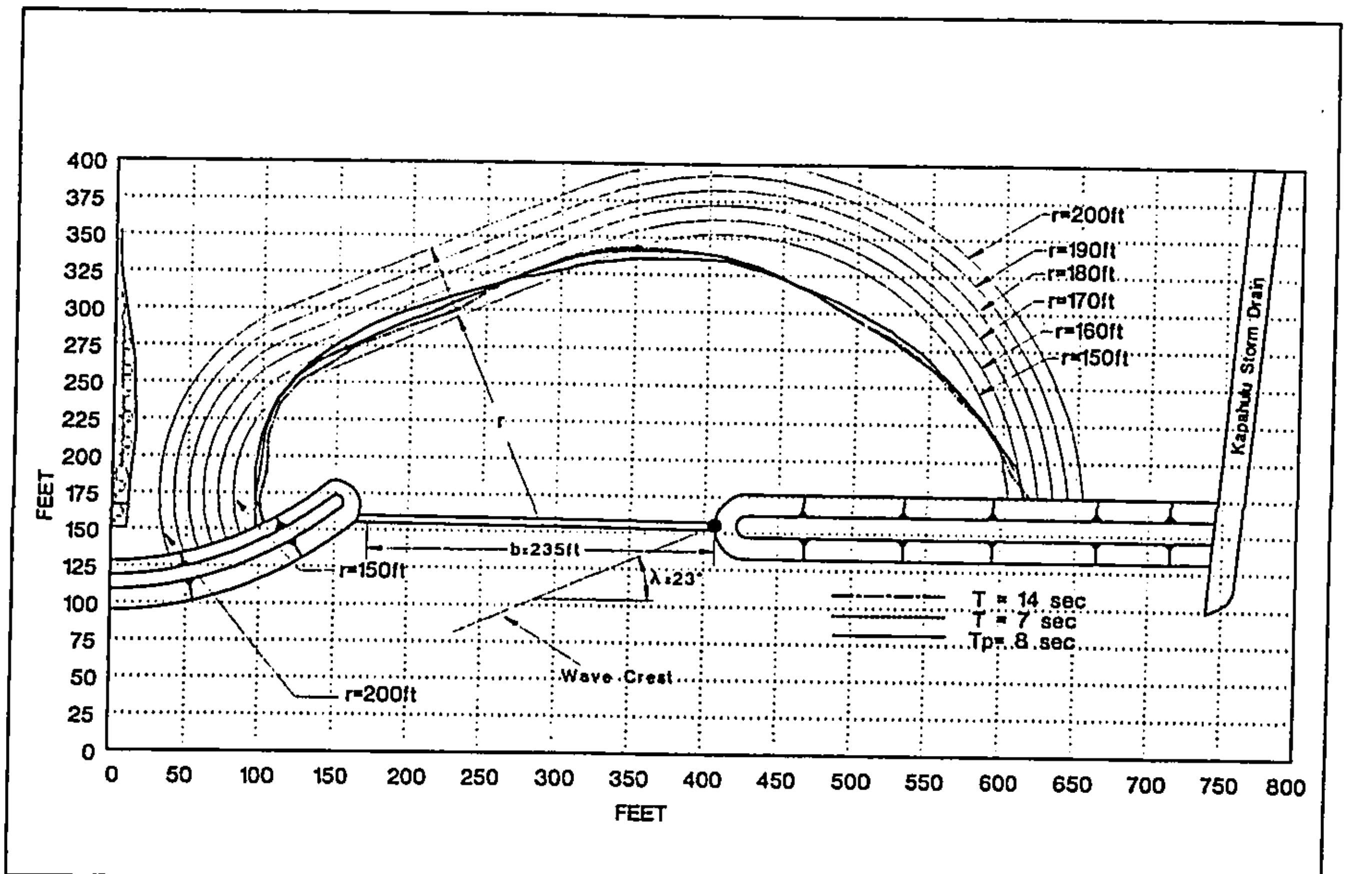
Table 3-2: The maximum indentation, x_m and the distance to the seawall from the maximum indentation versus the distance r, for $b = 235$ feet and $\lambda = 23$ degrees.

r (feet)	x_m (feet)	Distance To Seawall
150	196	54
155	201	49
160	206	44
165	211	39
170	216	34
175	221	29
180	226	24
185	231	19
190	236	14
195	241	9
200	246	4
205	251	-1

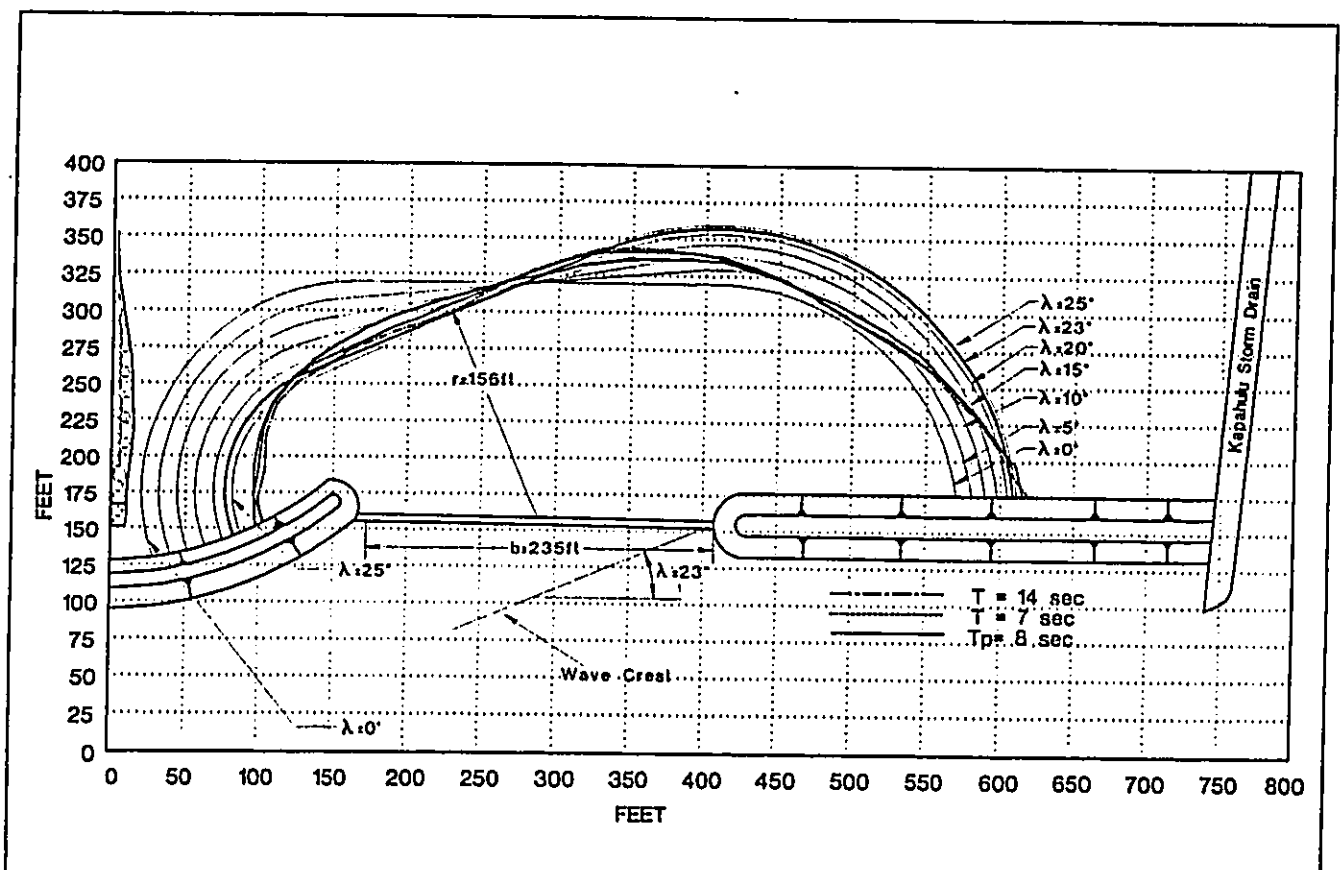
Based on the schematic representation of the circular shoreline shown in Figure 3-7, the water area within the embayment, bounded by the breakwater alignment, is given by

$$Area = \frac{\pi}{2} r^2 + (\lambda b \sin\lambda + b \cos\lambda) r + \frac{\pi b^2 \sin^2\lambda}{8} \qquad (5)$$

If it is assumed that a nominal equilibrium condition would be represented by $r = 156$ feet and $\lambda = 23°$, then the embayment water area is given by Eqn. 5. If we now assume that the embayment water area remains constant, based on $r = 156$ feet and $\lambda = 23°$, as wave direction λ varies, then for values of λ, the quadratic Eqn. 5 can be solved for r. In other words, based on the circular equilibrium shape of the beach with $r = 156$ feet and $\lambda = 23°$, we can solve for how the circular beach shape would change with varying wave directions assuming that the beach area remained constant within the embayment. Figure 3-10 provides the solutions for the circular shoreline for varying values of λ from $\lambda = 0°$ to $25°$ in $5°$ intervals including the $\lambda = 23°$ shoreline. Note that



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project, Kuhio Beach Improvements | Diffraction-Dominant Circular Shoreline Analysis With Variations In Shoreline Distance From Breakwater Gap | FIGURE 3-9



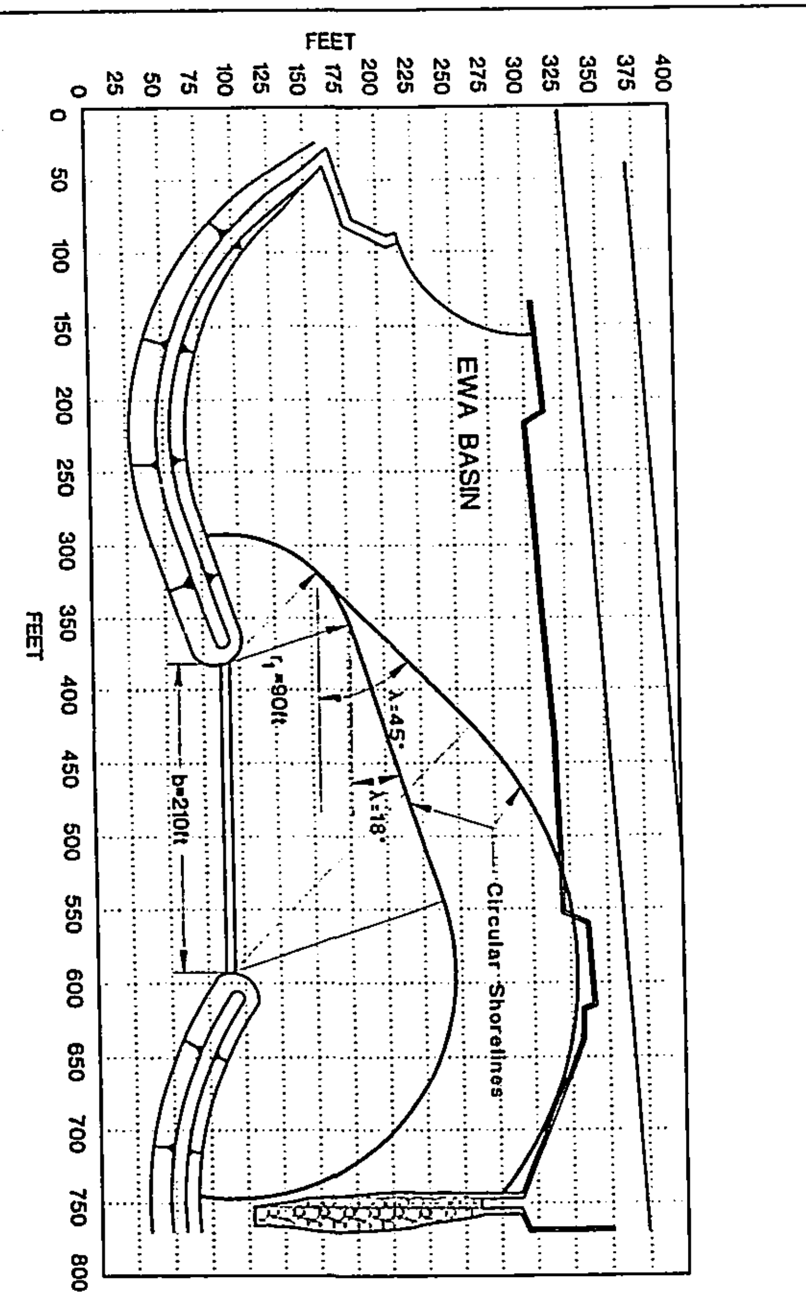
Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project, Kuhio Beach Improvements | Diffraction-Dominant Circular Shoreline Analysis With Variations In Incident Wave Direction Assuming Identical Beach Areas | FIGURE 3-10 based on the model test results, the actual shoreline location in the lee of the north breakwater segment is expected to be located seaward of the circular shoreline location.

3.4 Ewa Basin Equilibrium Shoreline Shapes

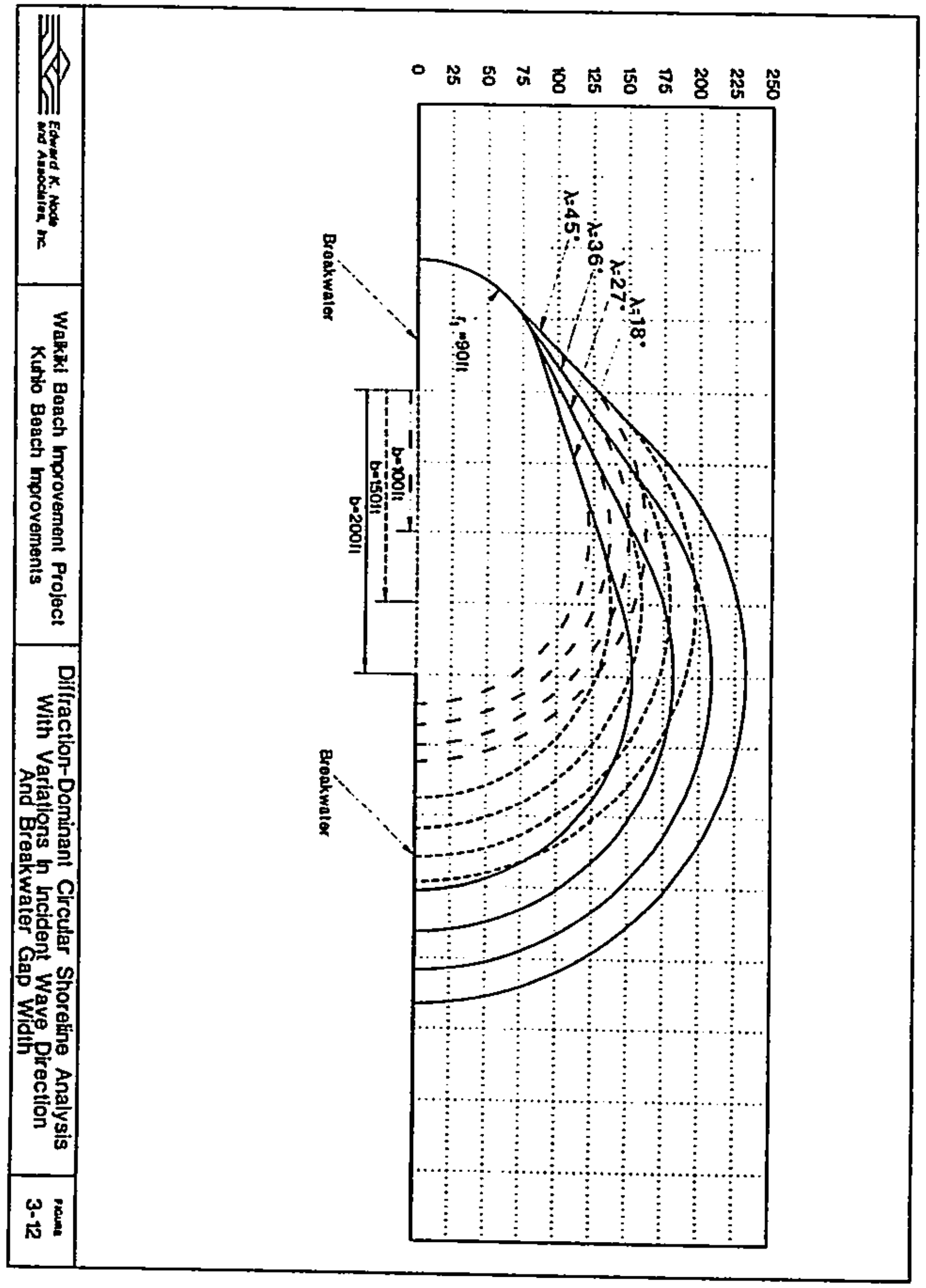
Based on the assumption that a conservative representation of equilibrium shoreline shapes for the Kuhio Beach basins are circular beach profiles, this theory has been applied to the prediction of the Ewa Basin shoreline.

Based on the equilibrium circular shoreline shape in the lee of the downcoast, north breakwater segment, as shown in Figure 3-8, the assumed minimum radius, r_1 is equal to 90 feet. From historic aerial photographs of the Kuhio Beach offshore area, it is noted that the wave approach angles are different for the Diamond Head and Ewa basins. In order to estimate the expected variability in wave directions at the Ewa basin proposed breakwater gap location, computer refraction results applicable to the Ewa Basin (Edward K. Noda and Associates, Inc., 1991) were examined. This evaluation indicated that wave directions relative to the crib wall varied from 18° to 29°. It is noted that the wave refraction calculations were terminated offshore of the crib wall, and additional wave direction changes can occur as the wave approaches the Ewa Basin breakwater segments. The same report describes wave crest orientations near the Ewa Basin as obtained from various aerial photographs. The wave crest directions from the aerial photographs were measured and wave approach angles at the Ewa Basin were estimated to range from $\lambda = 26°$ to 45°. Taking the extreme angles of $\lambda = 18°$ and 45°, and assuming that $r_1 = 90$ feet, Figure 3-11 provides the equilibrium circular shoreline beach shapes. Since it has been assumed that the radius $r_1 = 90$ feet represents the most seaward starting point for the circular beach shape, then the circular beach results shown in Figure 3-8 represent the most seaward locations of the shoreline for given λ.

To provide additional design information for both the Ewa and Diamond Head Basin shorelines, Figure 3-12 schematically shows the circular shoreline simulations for breakwater gap widths of $b = 100$, 150 and 200 feet, and for wave approach directions of $\lambda = 18°$, 27°, 35°, and 45° and assuming that the downcoast circular radius, $r_1 = 90$ feet represents the minimum radius. Figure 3-12 has been drawn to the same scale as other drawings showing the Kuhio Beach basin layouts and thus can be made into a transparency to evaluate optional breakwater gap designs and consequent equilibrium beach shoreline shapes.



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project Kuhio Beach Improvements | Diffraction-Dominant Circular Shoreline Analysis For The Ewa Basin | FIGURE 3-11



4.0 NUMERICAL MODELING OF THE BEACH PROFILE SHAPE

4.1 Introduction

In the previous section the numerical modeling of the Kuhio Beach planform shape of the shoreline was performed. In this section, a numerical modeling analysis of the profile shape of the beach is performed. The computer program selected for the beach profile analysis is the U.S. Army Corps of Engineers model SBEACH32 Version 2.0 (Rosati et al., 1993 and Wise et al., 1996). SBEACH is a numerical model used for simulating storm-induced beach change, including the formation and movement of major morphologic features such as longshore bars, troughs and berms under varying storm waves and water levels. It is being used herein to determine the profile fate of the proposed beach slope fill design. SBEACH32 is a two-dimensional model in that it only models cross-shore processes, while longshore (wave, current and sediment) transport processes are omitted. It is intended to calculate and predict short term, storm induced beach erosion.

A fundamental assumption in SBEACH32 is that any profile change is produced solely by cross-shore processes (onshore-offshore), resulting in a redistribution of sediment across the profile with no net gain or loss of material. Longshore processes are considered uniform and are neglected in the calculation process. The beach profile change is calculated from the cross-shore sediment transport produced by breaking waves and changes in water level. Water level changes are calculated from the storm surge, tide and wind. SBEACH32 is an empirically-based model developed for sandy beaches with uniform representative grain sizes in the range of 0.2 mm to 0.42 mm.

As developed by the U.S. Army Corps of Engineers, the primary application of SBEACH32 is in the design of beach fills. It is used to calculate the beach profile response of alternative design configurations to storms of varying intensity.

SBEACH32 accepts as input, varying water levels as produced by storm surge and tide, varying wave height and period, and an arbitrary grain size in the fine to medium sand range. Input waves can be chosen as monochromatic or irregular. Monochromatic waves are characterized by a single offshore wave height and period, and when propagated shoreward they break at a common point on the profile corresponding to the breaking depth. Irregular waves are characterized using statistical relationships such that as a single representative wave height is transformed across the nearshore zone, the fractions of broken, unbroken and reformed waves are determined and used in the calculation to represent random wave properties. This provides a realistic description of random waves while at the same time requires only a single wave input and transformation. The random wave field is characterized at some point offshore by a probability density function (*pdf*) for the wave height, a peak spectral wave period and a mean incident wave angle. The offshore point where the wave height *pdf* is defined is assumed to be at a depth where wave breaking is negligible. The wave height variation is assumed to follow a Rayleigh distribution.

Additionally the wave height, wave period and water depth can be chosen to be a constant or a time varying value. If chosen as a constant, then a constant value is input at each time step calculation. If a time varying value is chosen, a table of values at a set time stepping is required to be input. If the time step of the varying quantity is longer than the time step of the calculation, then waves will be linearly interpolated from one wave to the next. If this time step is much longer than the time step of calculation, then some variation of wave height may be desired to more realistically simulate randomness in the wave field. This can be accomplished by specifying a percent of variability about the linearly interpolated value when using the Wave Height Randomization option in the Storm Information input screen.

4.2 SBEACH Simulations of Kuhio Beach Physical Model Test Runs

The focus of this numerical modeling effort is on the beach segment that is directly exposed to the incoming waves through the breakwater gap. It is expected that this beach segment would exhibit the greatest profile changes in response to incoming wave attack. In order to provide comparison data between the Kuhio Beach Phase 2 physical model tests and the SBEACH numerical modeling results, the initial beach profile used in the model study, as shown in Figure 2-1, was also used as the initial beach profile for the SBEACH runs. This profile is represented by a constant berm height of +6 feet MLLW and a beach slope of 1V:8H down to a toe elevation of -4 feet MLLW. To complete the initial offshore bathymetry profile, from the toe of the initial beach profile to the crib wall location, the profile was set at a constant -4 feet MLLW, and beyond the crib wall the existing bathymetry data was used. (Note that the crib wall was removed in the model to elevation -2 feet MLLW. The -4 feet MLLW depth in the basin landward of the crib wall is the original depth of dredging at the time of construction of Kuhio Beach.) The initial beach profile horizontal distances were referenced to a zero point at the top of the beach slope, at the initial Beach Line location.

Additionally SBEACH includes a provision to provide a "hard bottom" profile which is not subject to erosion or accretion. Thus, a hard bottom was established at -4 feet MLLW extending under the initial beach and seaward to the crib wall location. Seaward of the crib wall, the hard bottom coincided with the offshore bathymetry profile. The implementation of a hard bottom is to realistically model the actual presence of the coral bottom offshore of Kuhio Beach.

Wind speed and direction options were not implemented and the wave approach angle was set as normal to the beach (angle = 0). The total time period for calculations was set at 1,500 minutes with a numerical calculation time stepping of 1 minute. The sand grain size was input as 0.3 mm for most runs, but was changed to 0.5 mm to evaluate the sensitivity of the results. The transport rate coefficient was kept at the default value of 1.75×10^{-6} m^4/N; the coefficient for the slope dependent term was kept at the default value of 0.0020 m^2/s, and the transport rate decay coefficient multiplier was also set to the default input of 0.50. Water temperature for all runs was set at 25°C. The grid used to define the beach profile had 760 calculation cells with a constant cell width of 2 feet. The total starting water surface elevation was set to a constant value of +3 feet MLLW, which was the same water level used in the Phase 2 model study. No

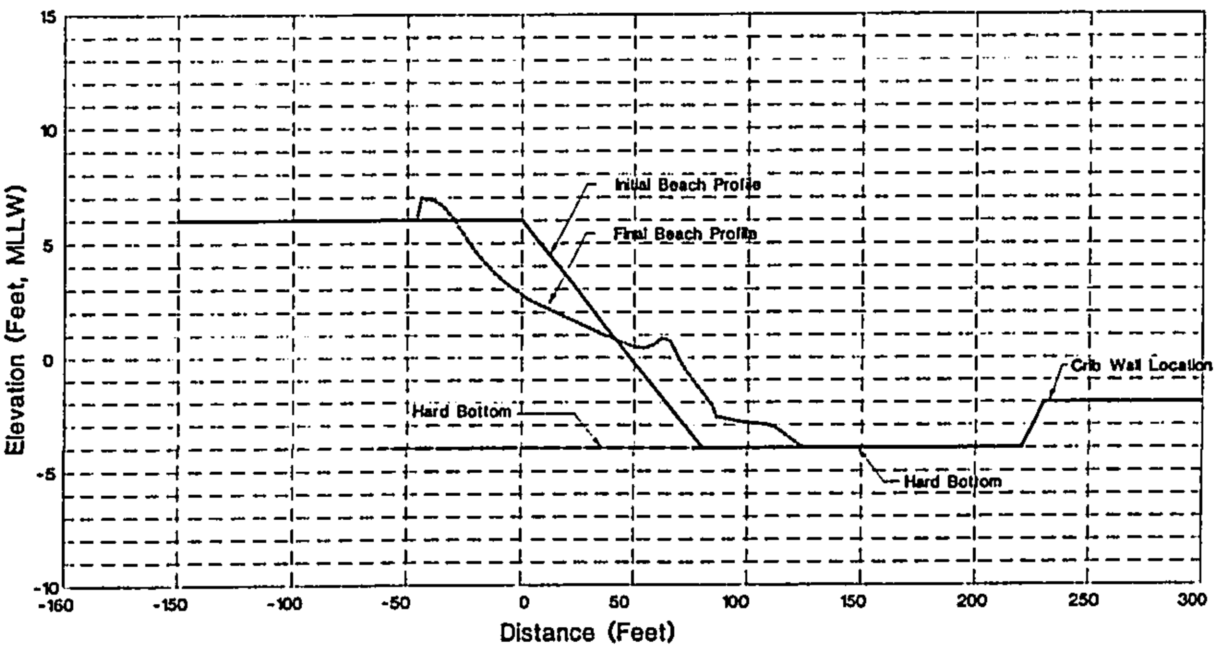
beach fill or seawall options were considered.

Wave heights and wave periods were set at constant values for each run. For monochromatic waves (regular), computations were performed for a significant wave height (H_s) of 4.2 feet and wave periods (T) of 7 and 14 seconds. Note that for consistency with the Phase 2 physical model tests whose wave height was based on H_{rms}, the equivalent significant wave height is given by $H_s = \sqrt{2}H_{rms}$. Since the Phase 2 physical model tests were referenced to wave heights measured at a location fronting the Diamond Head basin in a water depth of -6 feet MLLW, this shallow water location was also used as the starting point for the SBEACH computations. Since the input wave heights and periods were set at constant values instead of variable values, there was no Wave Height Randomization input required.

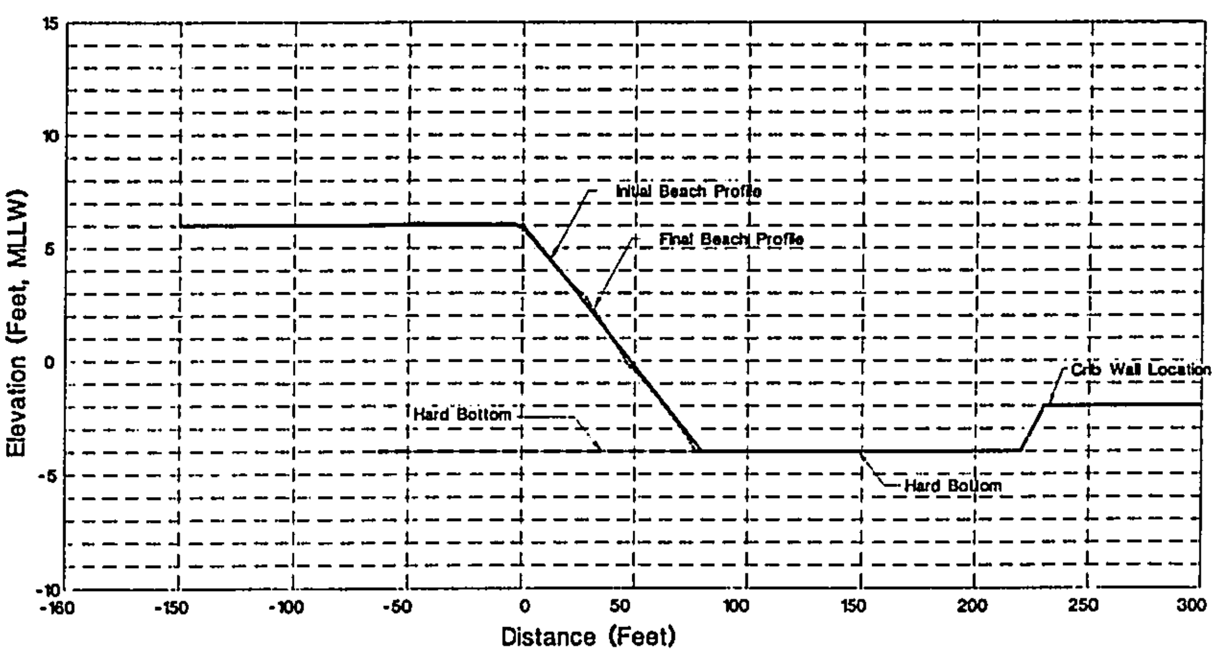
Figures 4-1 and 4-2 show the SBEACH computer model results for H_s = 4.2 feet and wave periods of T = 7 and 14 seconds, respectively. There is clear difference in the beach profile response between these two wave periods. Figure 4-1 indicates that the T = 7 second waves significantly flattens the initial 1V:8H beach slope, while Figure 4-2 shows that the T = 14 second waves have very little effect on the initial beach slope. Visual observations during the segmented breakwater physical model tests indicate that there was a general flattening of the initial beach slope for both monochromatic wave tests, but with the shorter period waves having a greater effect. Figure 4-1 indicates that the final SBEACH simulated beach profile has a slope of about 1V:15.5H from the top of the berm to the toe of the beach at -4 feet MLLW.

The SBEACH program numerically simulates wave set up as part of the wave transformation process as the waves propagate towards the beach. Since SBEACH is a 2-D program, where transverse wave energy transfer is not allowed, it is likely that SBEACH will over predict the total wave set up at the beach as compared to the 3-D physical model study which allows diffraction through the breakwater gap resulting in reduced wave height, wave energy and wave set up at the directly impacted shoreline. In an attempt to compensate for this difference, the SBEACH model was run for an input water level of +2 feet MLLW and the same regular wave simulation parameters as described above. Figures 4-3 and 4-4 provides the simulation results with the reduced input water level. Comparing Figure 4-3 with Figure 4-1, there is a general similarity in the shape of the beach profile although the beach slope from Figure 4-3 is steeper (about 1V:13.8H). Comparing Figure 4-4 with Figure 4-2, both show very little change from the initial beach slope.

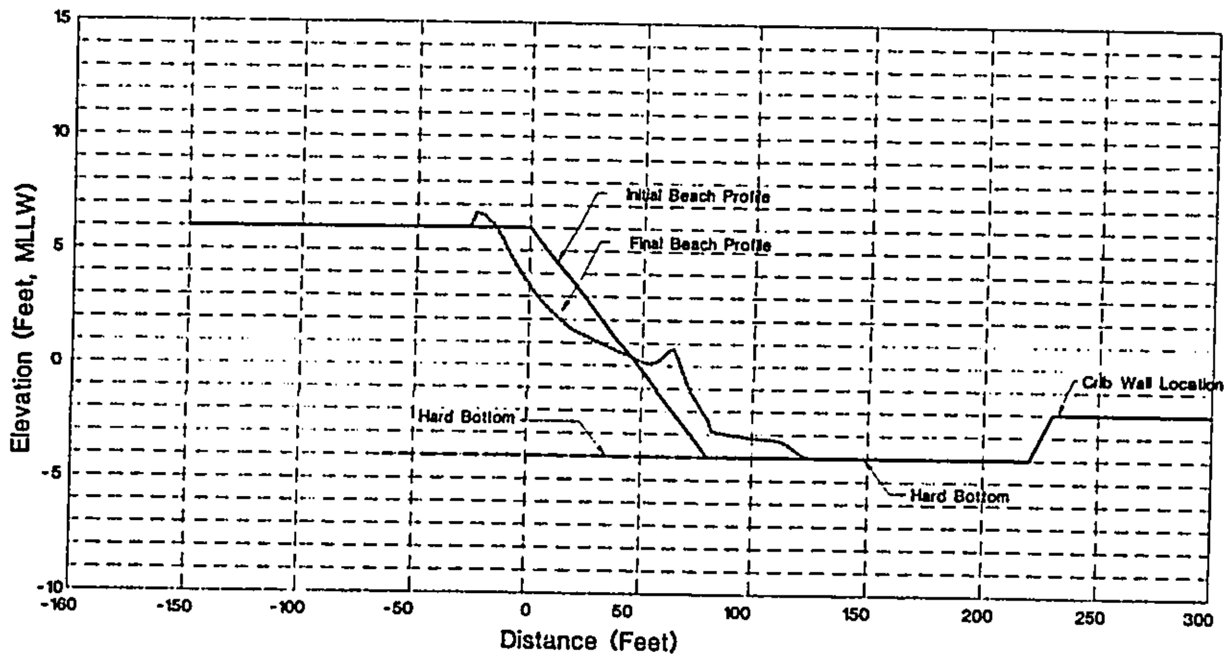
To provide comparison results for the random wave test performed in the Phase 2 physical model tests, irregular waves were run in the SBEACH model with H_s =3.6 feet and T= 8 seconds with no randomization applied. In a similar manner to the previous regular wave runs, the starting point for the SBEACH computations was at a shallow water offshore location with a depth of -6 feet MLLW. Figure 4-5 provides the SBEACH results for this irregular wave case for an input water level of +3 feet MLLW and Figure 4-6 provides the similar results for an input water depth of +2 feet MLLW. The simulation results shown in Figure 4-5 indicate that the initial beach profile has been transformed more significantly in comparison to the previous regular wave



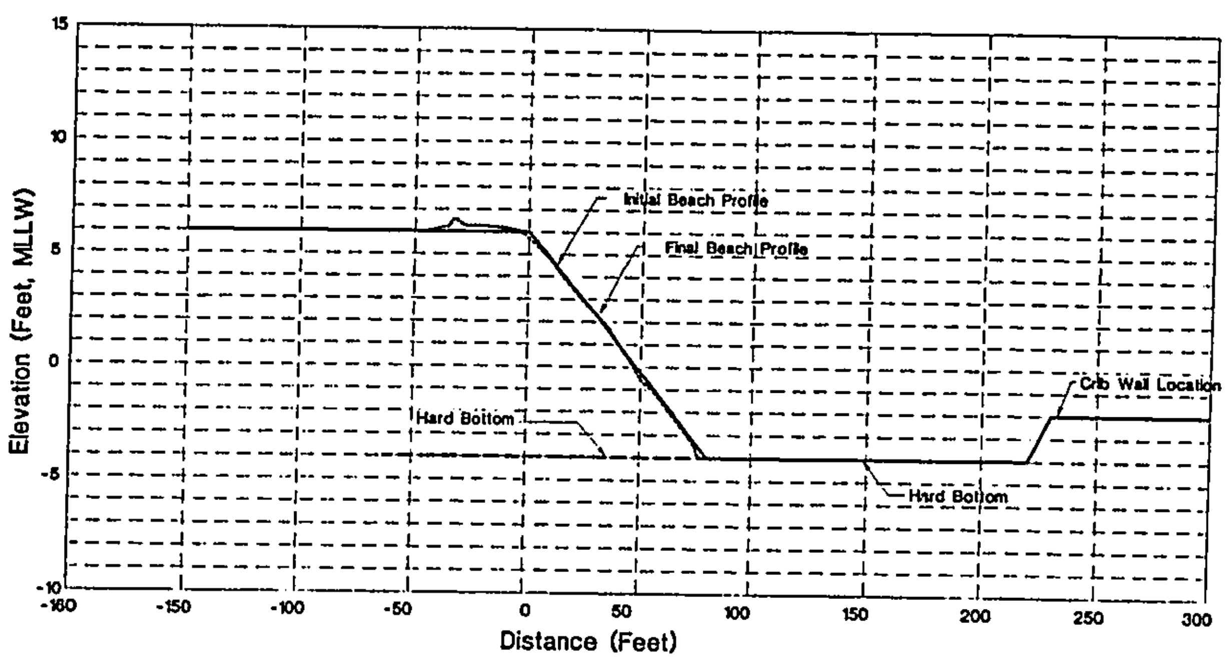
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Regular Waves, Shallow Water H_s=4.2ft, T=7sec, Input Water Level=3ft, Sand=0.3mm	FIGURE 4-1



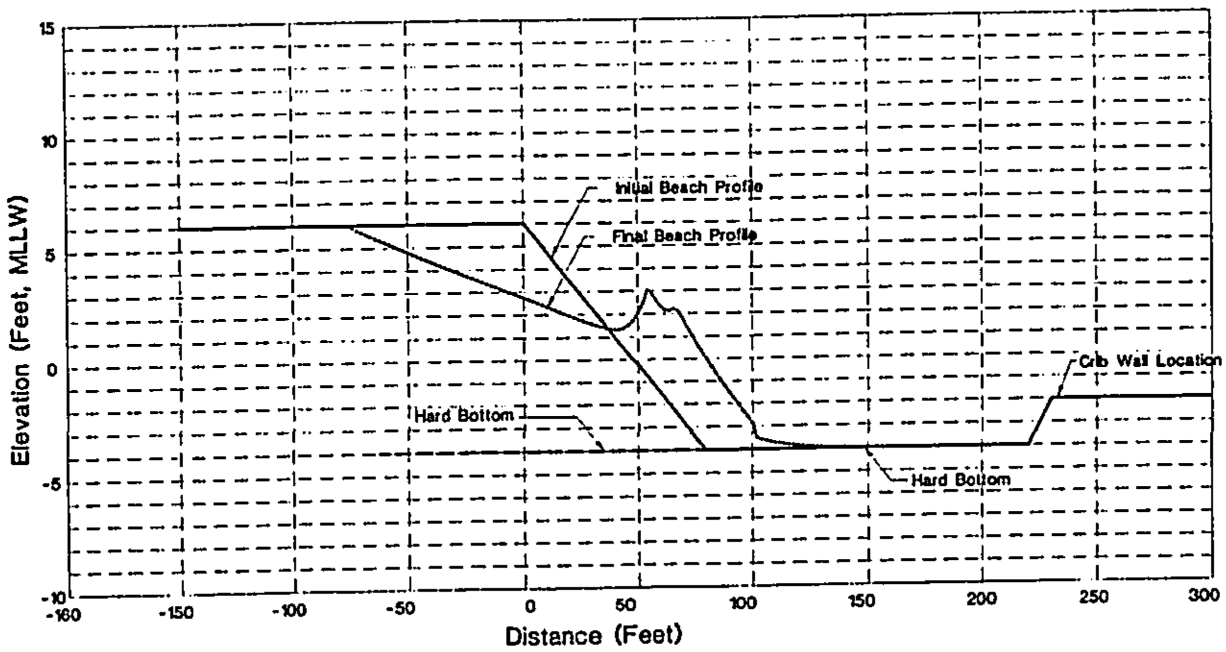
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Regular Waves, Shallow Water H_s=4.2ft, T=14sec, Input Water Level=3ft, Sand=0.3mm	FIGURE 4-2



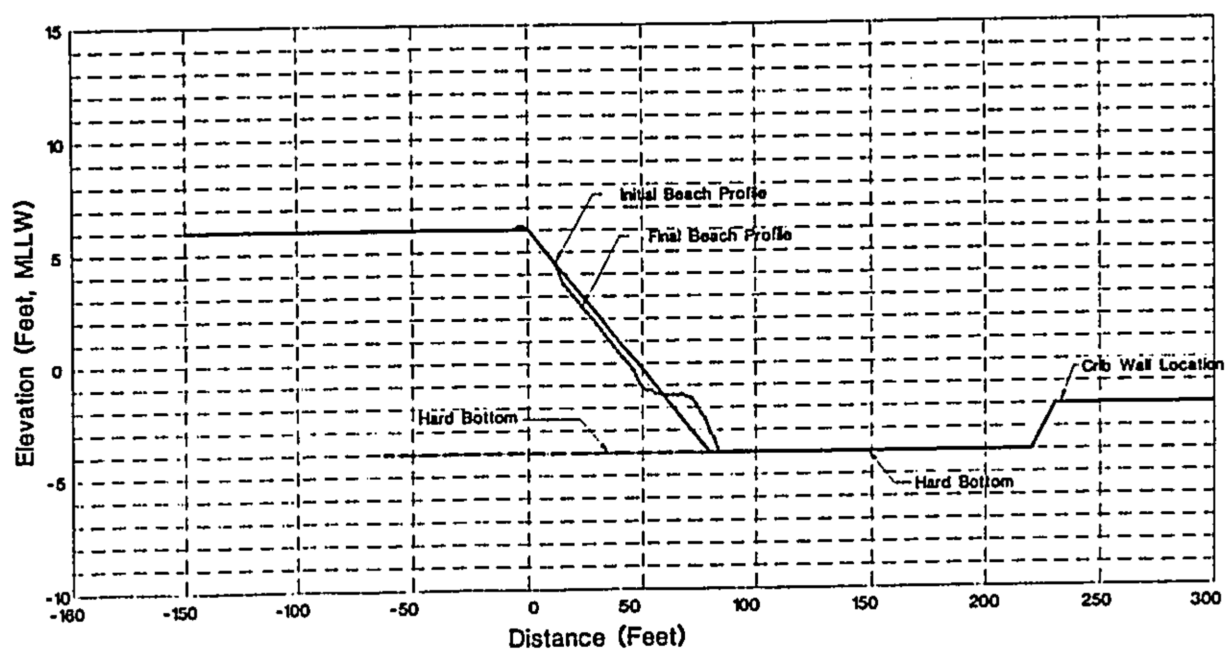
Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Regular Waves, Shallow Water H_s=4.2ft, T=7sec, Input Water Level=2ft, Sand=0.3mm	FIGURE 4-3



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Regular Waves, Shallow Water H_s=4.2ft, T=14sec, Input Water Level=2ft, Sand=0.3mm	FIGURE 4-4



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Irregular Waves, Shallow Water H_s=3.6ft, T=8sec, Input Water Level=3ft, Sand=0.3mm	FIGURE 4-5



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Irregular Waves, Shallow Water H_s=3.6ft, T=8sec, Input Water Level=2ft, Sand=0.3mm	FIGURE 4-6

simulations. There is a 75 feet erosion of the beach berm line and the creation of a foreshore berm whose height is above mean sea level. These profile features were not as visually pronounced in the physical model test results although a series of time lapse photographs were obtained at different water levels during water draining and these showed some of the SBEACH simulated morphological features. Figure 4-6 shows a very different beach profile as compared to Figure 4-5, where the Figure 4-6 results show a minimal flattening of the initial beach slope with a overall slope of 1V:8.3H.

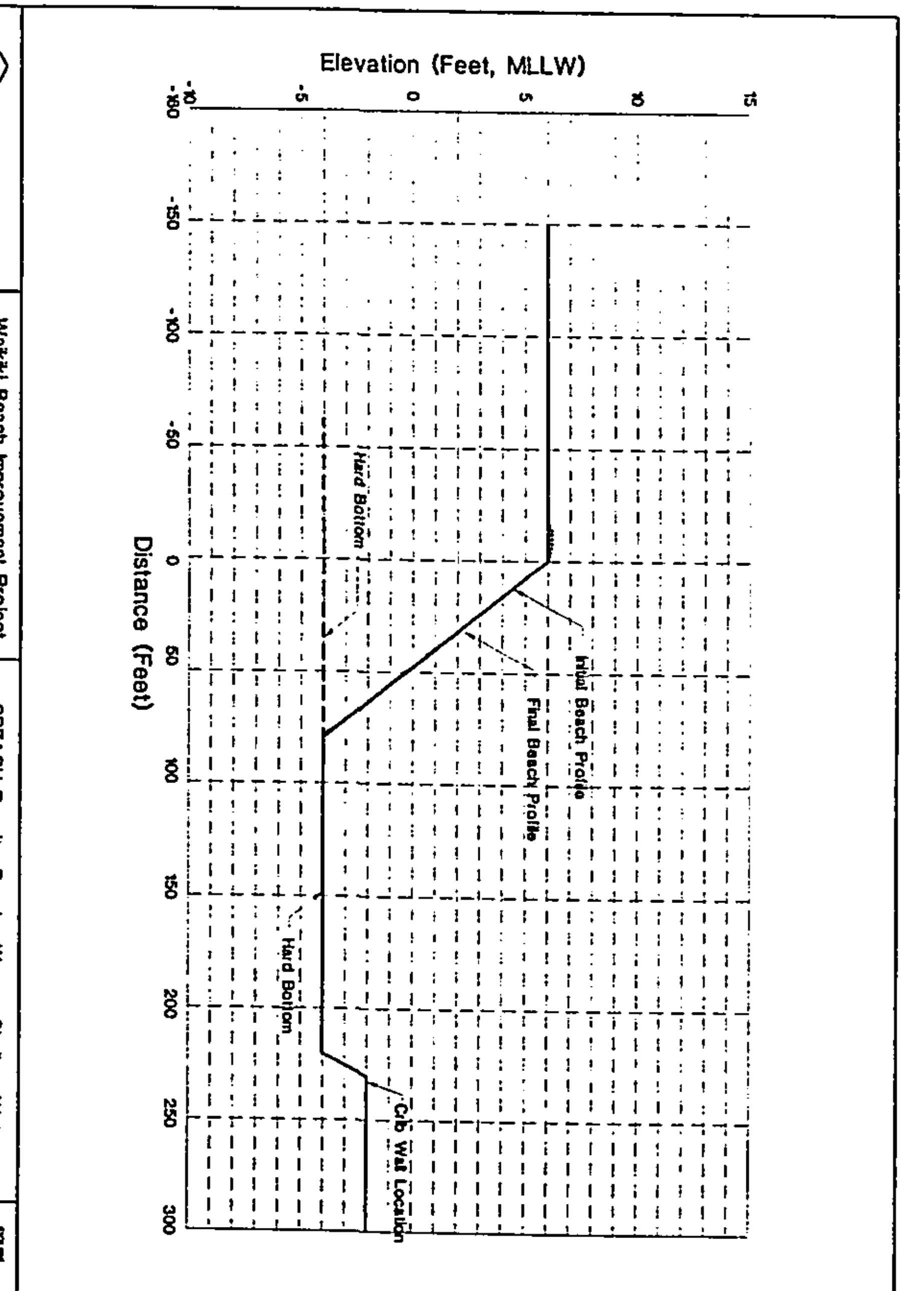
The above SBEACH model simulation results for Kuhio Beach, under "normal" wave conditions, indicate that the beach profile is very sensitive to wave period, where the shorter period waves may have a more significant impact on flattening the profile with a consequent effect of producing erosion of the berm line. The above results also indicate that the beach profile can be very sensitive to water level. If the wave runup does not overtop the berm height then water level changes may not have a great influence on the beach profile development. Conversely, when overtopping occurs, the resulting beach profile can show dramatic changes as compared to the non-overtopping situation for the same wave input event.

Examining Figures 4-1 to 4-6 at the +3 feet or +2 feet MLLW still water level, it is noted that all the figures indicate either that the resulting profiles have eroded (moved mauka) from the initial shoreline position or remained at the initial position. Conversely, the physical model test results as shown in Figure 3-4 indicate that the shorelines accreted (moved makai) for all three model test results, possibly indicating a contradiction. It is believed that a contradiction may not exist. In the physical model study, both longshore and cross shore processes are simultaneously occurring, while SBEACH only models the cross-shore processes where the gain and loss of profile materials are balanced with a net change equal zero. Moreover, it should be noted again that the SBEACH model was developed for open beaches under storm wave attack, but it is being applied in the above analysis to a partially protected embayment under relatively reduced wave height attack.

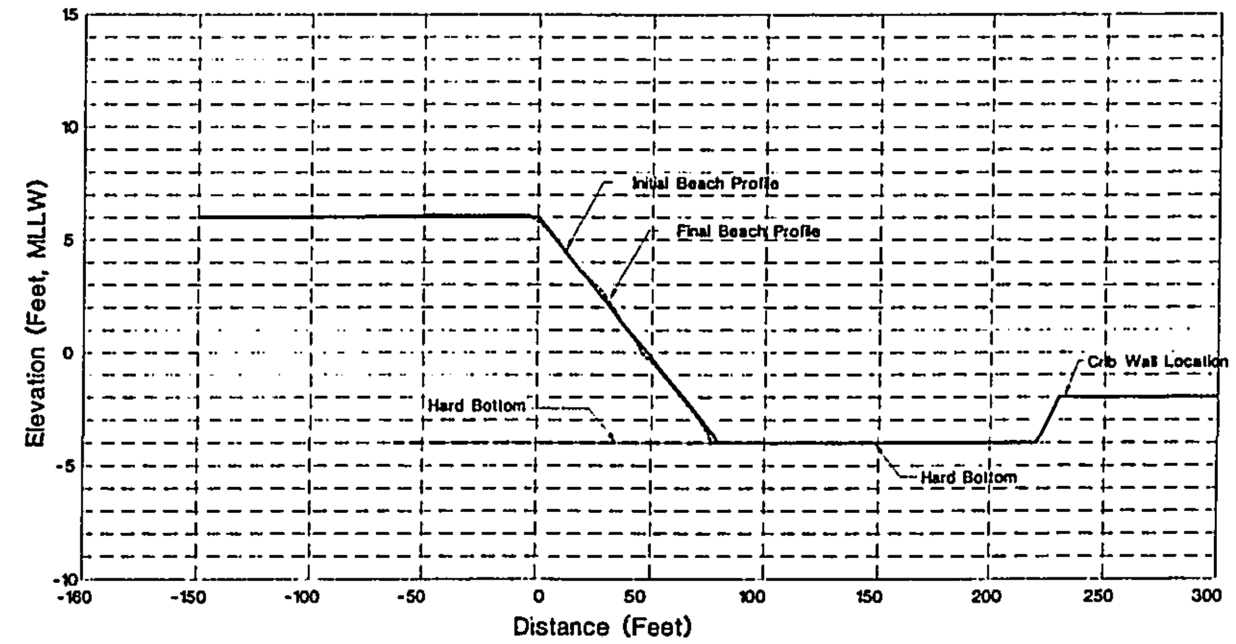
To evaluate the sensitivity of the SBEACH simulation results for a different sand grain size, the representative sand size was changed to 0.5 mm and all other parameters remained the same as the initial runs, including an input water level of +3 feet MLLW. Figures 4-7, 4-8 and 4-9 describe the SBEACH results for regular waves of T = 7 and T= 14 seconds and irregular waves, respectively. The interesting item of note in Figures 4-7 and 4-9, when compared with Figures 4-1 and 4-5, is that the beach profile results are very sensitive to the sand grain size.

4.3 SBEACH Simulations of Extreme Seasonal Wave Conditions

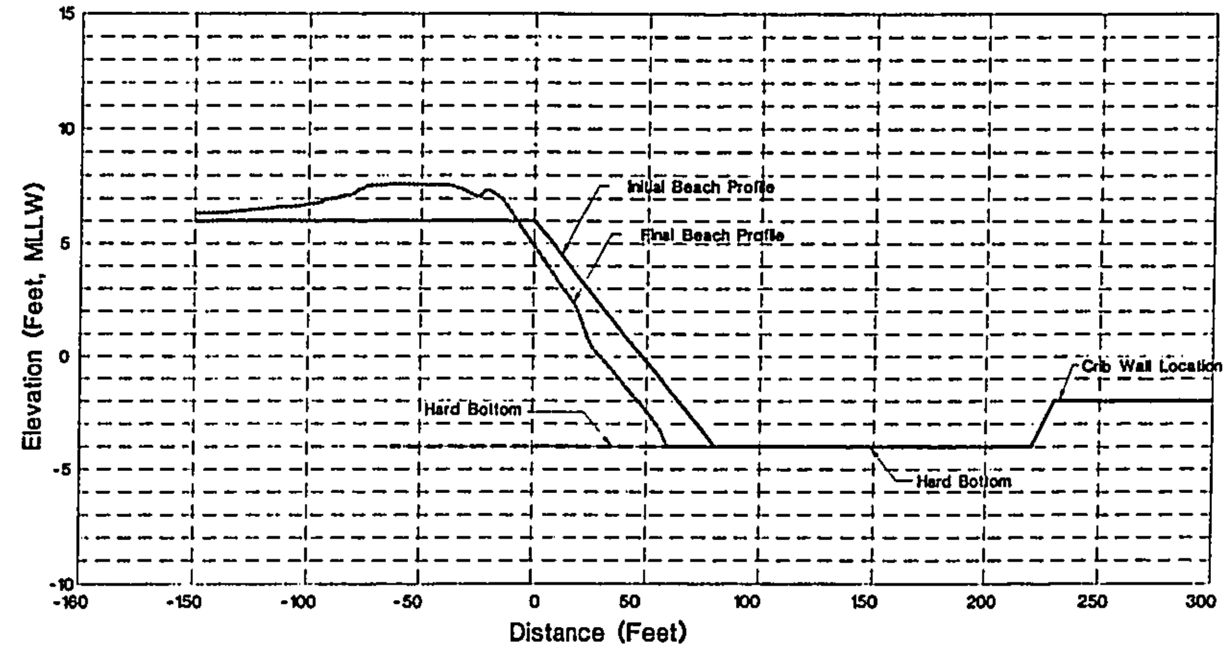
To evaluate the types of seasonal changes that could affect the Kuhio Beach shoreline profile, the SBEACH computer model was run for various extreme seasonal wave conditions that were measured offshore of Waikiki Beach. The field measured wave data (Edward K. Noda and



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project, Kuhio Beach Improvements | SBEACH Results, Regular Waves, Shallow Water H_s=4.2ft, T=7sec, Input Water Level=3ft, Sand=0.5mm | FIGURE 4-7



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Regular Waves, Shallow Water H_s=4.2ft, T=14sec, Input Water Level=3ft, Sand=0.5mm	FIGURE 4-8



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Irregular Waves, Shallow Water H_s=3.6ft, T=8sec, Input Water Level=3ft, Sand=0.5mm	FIGURE 4-9

Associates, Inc., 1992) represents wave conditions measured over a 15 month period from July 1990 to October 1991 with the wave sensor located about 1 mile from shore in a water depth of 50 feet. From the wave data, four specific extreme seasonal wave events were extracted as described in Table 4-1.

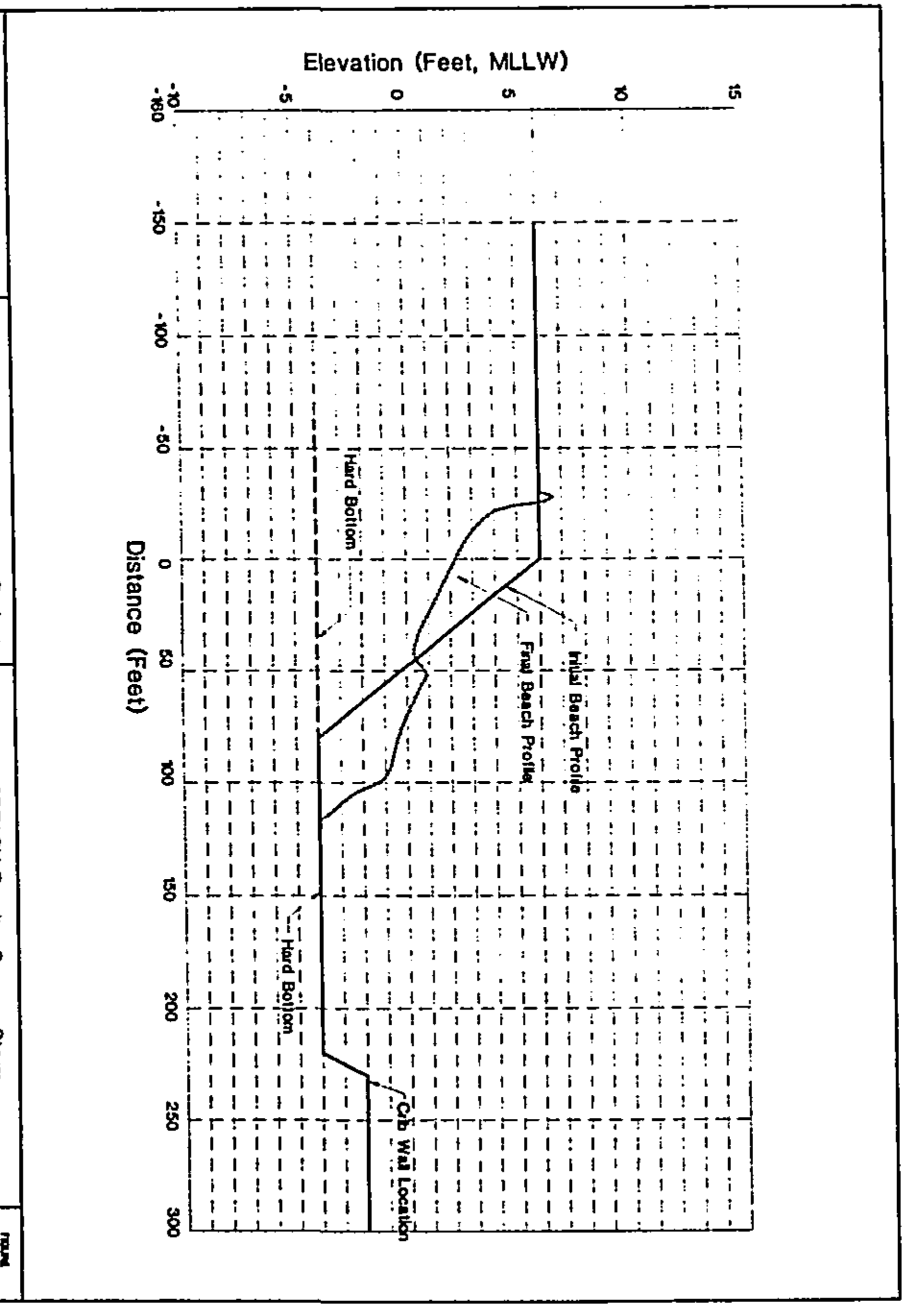
Table 4-1: Extreme Seasonal Wave Conditions For Kuhio Beach, As Measured In An Offshore Water Depth Of 50 feet.

Wave Type	Extreme Wave Characteristics
Summer Storm	H_s = 7 feet, T = 8 seconds
Extreme Summer Swell	H_s = 6 feet, T = 18 seconds
Winter Storm	H_s = 10 feet, T = 8 seconds
Extreme Winter Swell	H_s = 5 feet, T = 18 seconds

The SBEACH program was initiated in "deep water", the water level was set at +2 feet MLLW, the irregular wave option was utilized, the sediment size was set at 0.3 mm and the initial beach profile used in the model study was utilized, represented by a +6 feet MLLW flat berm and a beach slope of 1V:8H.

Figure 4-10 describes the SBEACH results for the Summer Storm conditions and indicates that in comparison to the initial beach profile, the beach berm has eroded about 25 feet, the beach toe has moved seaward about 36 feet and the end point beach slope is about 1V:14H. The Extreme Summer Swell simulation results from SBEACH are shown in Figure 4-11 and indicates that the beach profile has become only slightly flatter from the initial beach profile, with about 7 feet erosion of the berm and accretion at the toe, and an overall beach slope of about 1V:9.5H. For comparison purposes, Figures 4-2 and 4-4 provide SBEACH profile results for "normal" summer swell conditions with wave heights of H_s = 4.2 feet. It can be imagined that following a Summer Storm or Extreme Summer Swell event, normal summer swell conditions could rebuild the beach profile to a configuration generally similar to the initial beach slope.

Figure 4-12 describes the SBEACH simulation results for Winter Storm conditions where the beach berm has eroded about 27 feet, the beach toe has accreted about 34 feet and the overall beach slope is about 1V:14H. It is interesting that the resulting SBEACH profiles for the Summer Storm, Figure 4-10, and the Winter Storm, Figure 4-12 are very similar, even with a 3feet difference in wave height. Figure 4-13 describes the Extreme Winter Swell SBEACH results, which basically shows that there is no change as compared to the initial beach profile, and which is similar to Figure 4-2 and 4-4 for "normal" swell conditions. Similar to the summer analysis, the winter swell waves could rebuild the Winter Storm profile to almost initial conditions.



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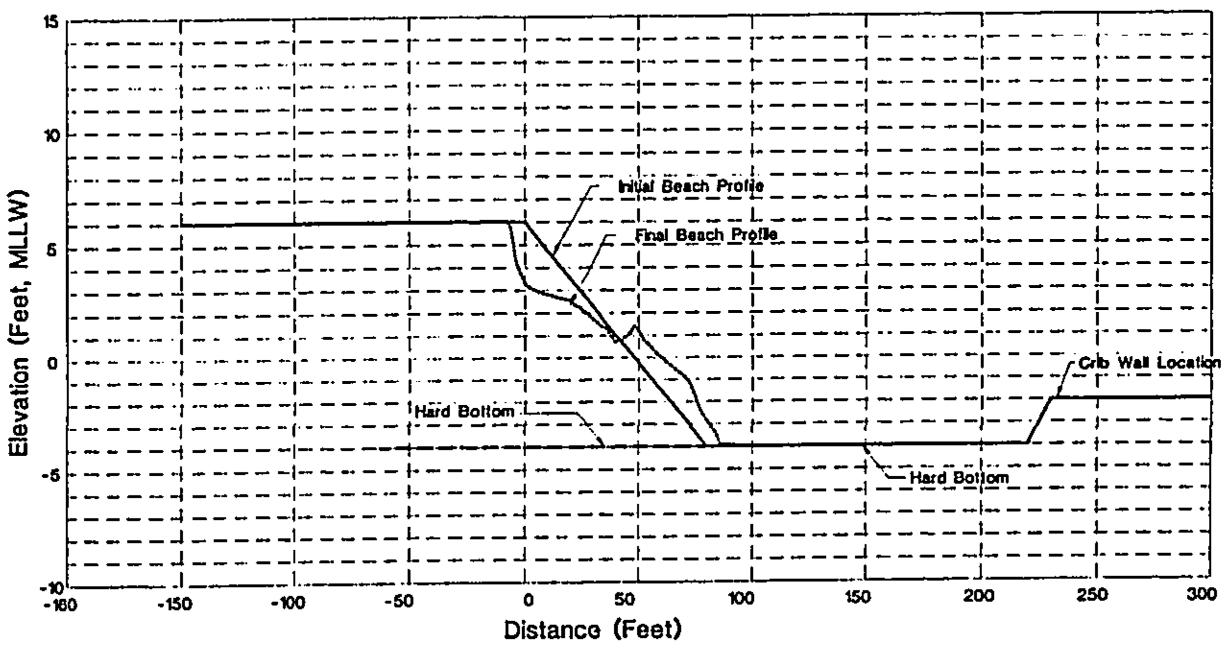
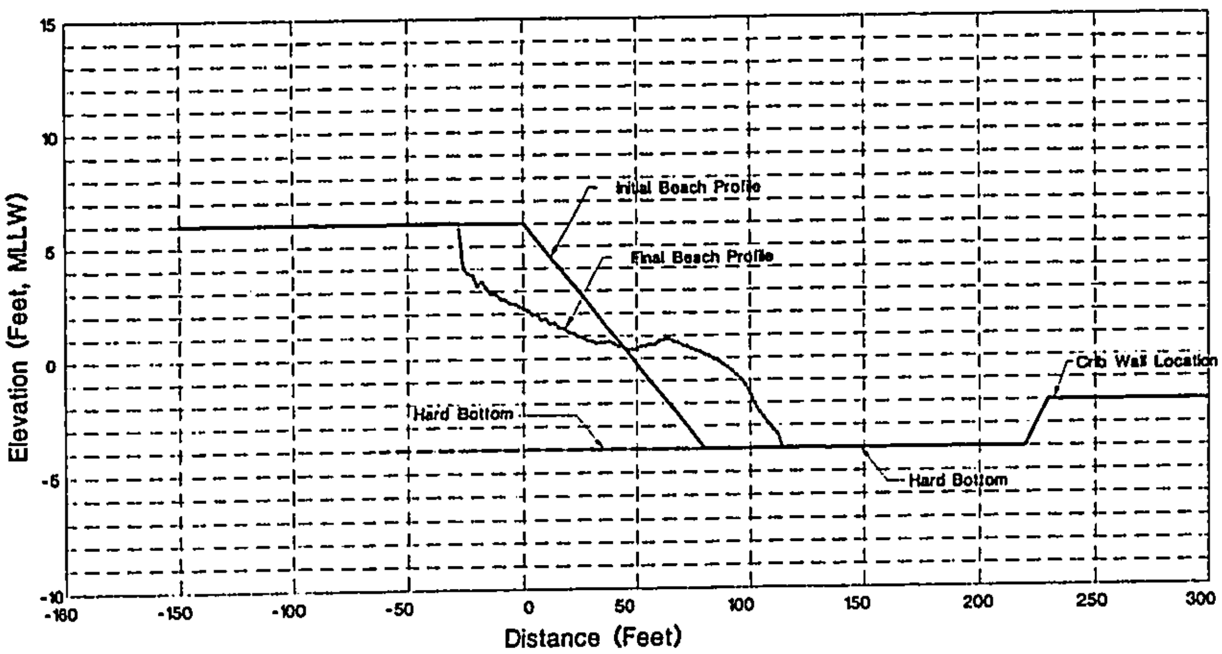
Waikiki Beach Improvement Project
Kuhio Beach Improvements

SBEACH Results, Summer Storm
H_s=7ft, T=8sec, Input Water Level=2ft, Sand=0.3mm

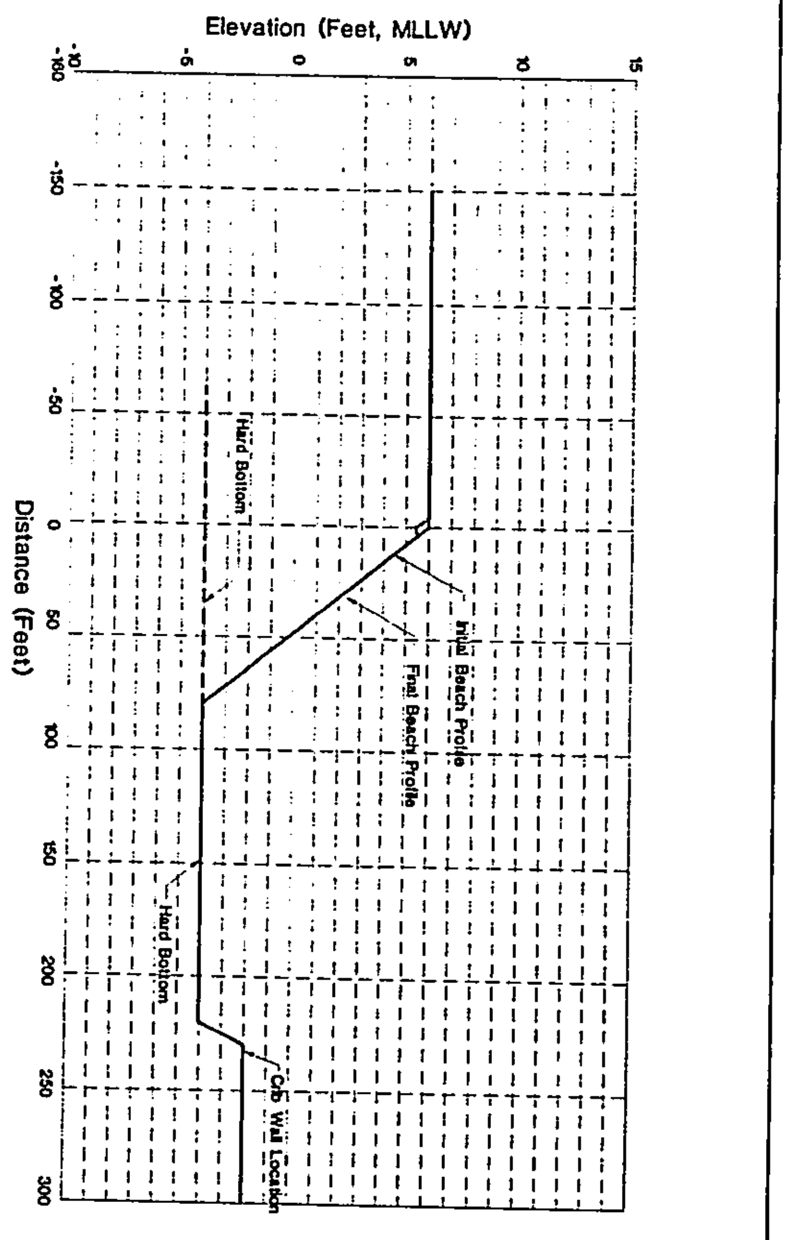
FIGURE 4-10



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Extreme Summer Swell H_s=6ft, T=18sec, Input Water Level=2ft, Sand=0.3mm	FIGURE 4-11



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	SBEACH Results, Winter Storm H_s=10ft, T=8sec, Input Water Level=2ft, Sand=0.3mm	FIGURE 4-12



Edward K. Noda and Associates, Inc.

Waikiki Beach Improvement Project
Kuhio Beach Improvements

SBEACH Results, Extreme Winter Swell
H_s=5ft, T=18sec, Input Water Level=2ft, Sand=0.3mm

FIGURE 4-13

4.4 Summary

To provide information on the profile shape of the equilibrium beach design for the Kuhio Beach improvements, the U.S. Army Corps of Engineers' SBEACH computer model has been run for the equivalent cases as were tested during the Phase 2 physical model study. While the SBEACH beach profile results show variability as a function of wave period, the general flattening of the resulting beach profiles was confirmed by visual and photographic observations during the model tests. For design purposes, it is proposed that a 1V:10H beach slope be utilized for the initial design of the Kuhio Beach beach profile.

To evaluate the potential dynamic beach profile seasonal changes at Kuhio Beach, the SBEACH model was run for a series of extreme seasonal wave conditions consisting of a Summer Storm, Extreme Summer Swell, Winter Storm and Extreme Winter Swell events. The resulting beach profiles indicate the expected variability of the beach profiles, with seasonal storm events producing erosion of the berm of the order of 25 feet, and with subsequent seasonal swell events returning the beach profile to near initial conditions.

Based on the numerical modeling results, it should be recognized that extreme wave events can result in offshore movement of sand, and a "flattening" of the beach slope. This erosion of the backshore berm will be most pronounced along the beach segment exposed to direct wave approach through the breakwater gaps. However, "normal" swell activity will help to rebuild the beach slope by moving sand from the foreshore toe portion of the beach to the backshore portion of the beach berm. A "transition" zone of about 30 feet mauka of the "equilibrium" planform shoreline should be expected in the breakwater gap, normal to the direction of wave approach.

5.0 NUMERICAL MODELING OF THE EXTENDED GROIN SHORELINE

5.1 Introduction

Section 2 described the Phase 2 physical model tests for the segmented breakwater concept. While this concept is the recommended alternative, the model tests were also carried out for an extension of the center groin dividing the Diamond Head and Ewa basins of Kuhio Beach and without breakwater protection of the basins. In this section, a numerical modeling evaluation of this extended groin concept was performed in order to provide general design alternatives, should this concept alternative be considered.

5.2 Physical Model Test Description and Results

Figure 5-1 describes the Extended Groin concept and the initial beach profile that was tested in the Phase 2 physical model study. The groin extension was constructed over the existing center groin location that divides the Diamond Head and Ewa basins, having a crest elevation of +7 feet MLLW and a total groin length of 350 feet, representing a 150 feet extension beyond the existing crib wall alignment. In a similar testing schedule to that performed for the segmented breakwater concept, 3 different wave conditions were tested as shown in Table 5-1.

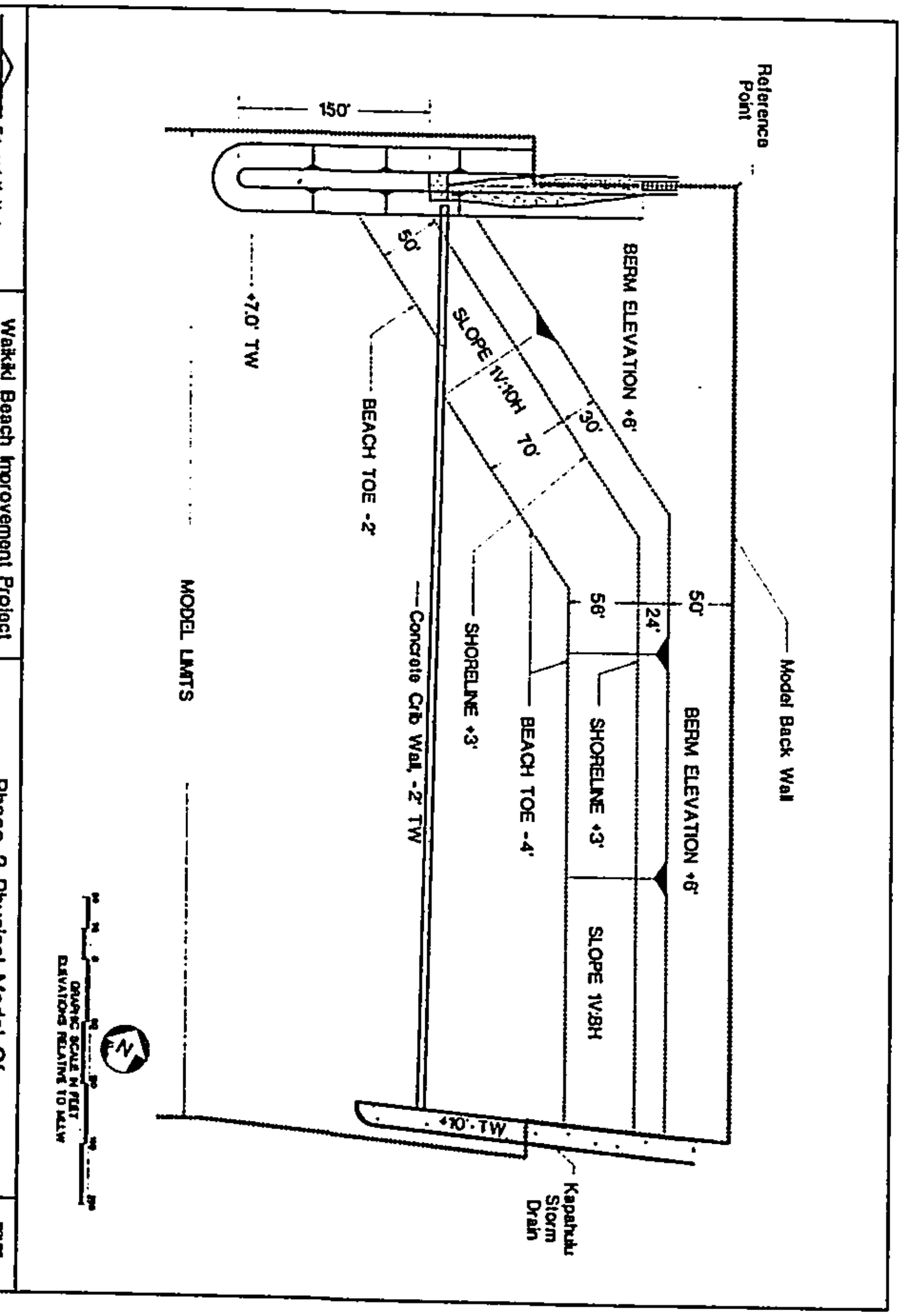
Table 5-1: Extended Groin Wave Test Conditions

Regular Waves, H_{rms} = 3 feet, T = 7 seconds
Regular Waves, H_{rms} = 3 feet, T = 14 seconds
Random Waves, H_s = 3.6 feet, T_p = 8 seconds

Figure 5-2 describes the plan view shoreline shape at the +3 feet MLLW still water level for all three physical model test runs, and Figure 5-3 provides photographs of the initial beach configuration prior to the wave attack and the final beach results for the random wave test. The shoreline model test results shown in Figure 5-2 indicate that all three final shoreline shapes are very similar.

5.3 Parabolic Shoreline Shape Numerical Modeling

The parabolic shape shoreline analysis described in Section 3.1 (Silvester and Hsu, 1993) is also applicable to the extended groin equilibrium shoreline. To determine the orientation of the incoming wave crest, the model test shorelines in the region of the groin extension were measured and the average value of $\alpha = 24°$ was utilized as the wave crest orientation at the downcoast fixed point, which is located at the tip of the Kapahulu storm drain. The downcoast fixed point is located at the point where the shoreline meets the groin, thereby defining the



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Phase 2 Physical Model Of Extended Groin Concept

FIGURE 5-1

reference line and distance R_n = 717 feet and β = 30.6°. The resulting parabolic shaped shoreline is shown in Figure 5-4. The calculated parabolic shoreline provides a reasonable representation of the model test results for about half the basin length from the groin location. For the south half of the basin, the parabolic shoreline is located on the order of 25 feet mauka of the model test results.

5.4 Diffusion Equation Numerical Modeling

In this section, another mathematical shoreline evolution theory, referred to as the diffusion equation shoreline, is used to model the extended groin concept. Due to the relatively simple beach geometry shown in Figure 5-1, the classical shoreline evolution mathematical model developed by Pelnard-Considere (1956) and described by Le Mehaute and Soldate (1977), is applied in this section. Since the above references may not be widely available, the theoretical development is reproduced herein.

Pelnard-Considere (1956) assumed the following:

1. The beach profile remains similar and determined by an equilibrium profile. This implies that all contour lines are parallel and the solution only need be developed for a single contour line.
2. The wave direction is constant and makes a small angle with the shoreline.
3. The longshore transport, Q, is linearly related to the tangent of the angle of incidence, α, (i.e. $Q \propto \tan\alpha$).
4. The beach has a fixed depth, D, which is the depth of the beach under motion as shown in Figure 5-5.

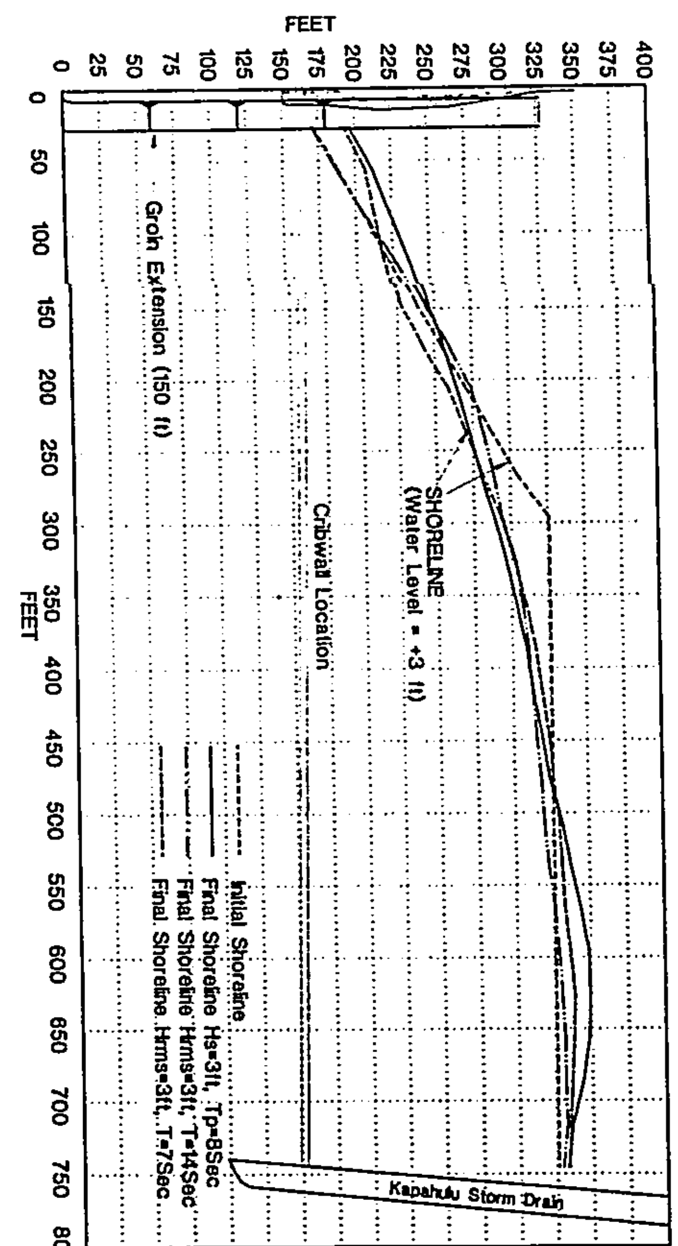
Now consider the orthogonal coordinate system defined in Figure 5-6 where the x-axis is along the shoreline and the y-axis is in the seaward direction. The incoming wave crest direction relative to the x-axis is given by α_o. The local angle of the wave at the shoreline, α, is assumed to be small and therefore,

$$\alpha = \alpha_o - \tan^{-1}\left(\frac{\partial y}{\partial x}\right) \approx \alpha_o - \frac{\partial y}{\partial x} \qquad (6)$$

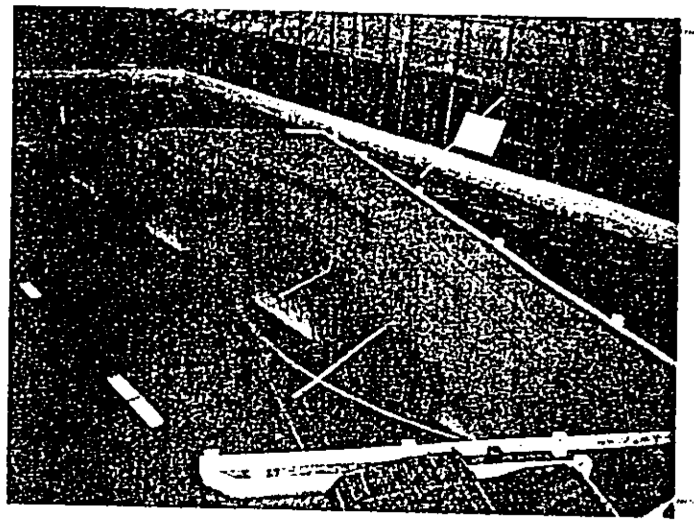
yielding

$$\alpha - \alpha_o = -\frac{\partial y}{\partial x} \qquad (7)$$

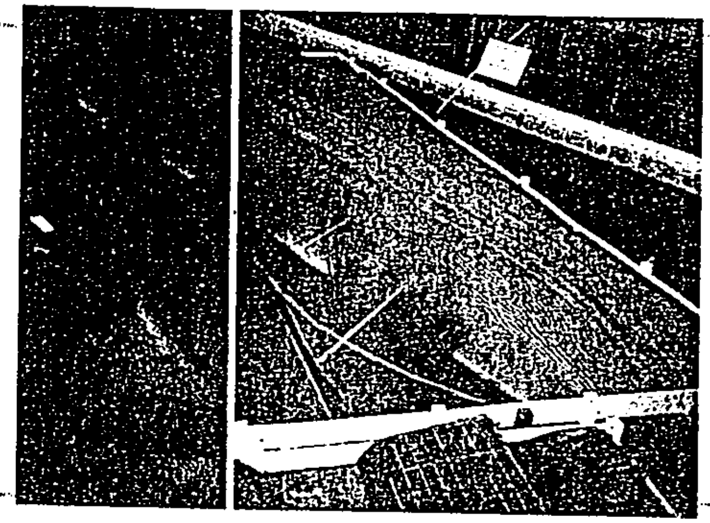
where $y = f(x,t)$ describes the shoreline as a function of x and time t. The littoral drift Q is a function of the angle of incidence α and can be expanded in a Taylor series given by



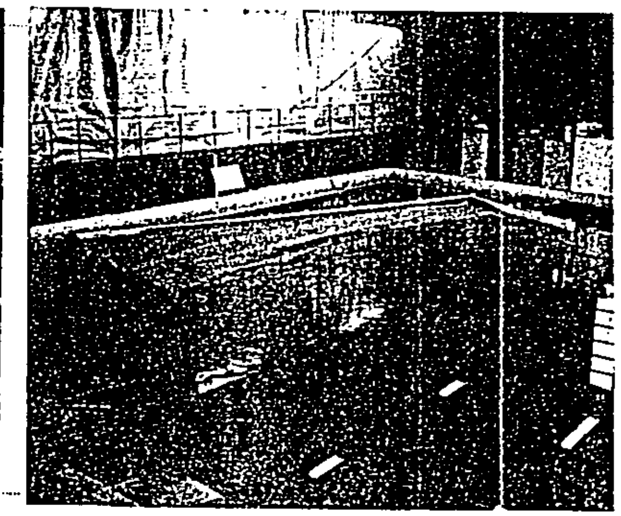
Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project, Kuhio Beach Improvements | Physical Model Test Results, Extended Groin Concept | FIGURE 5-2



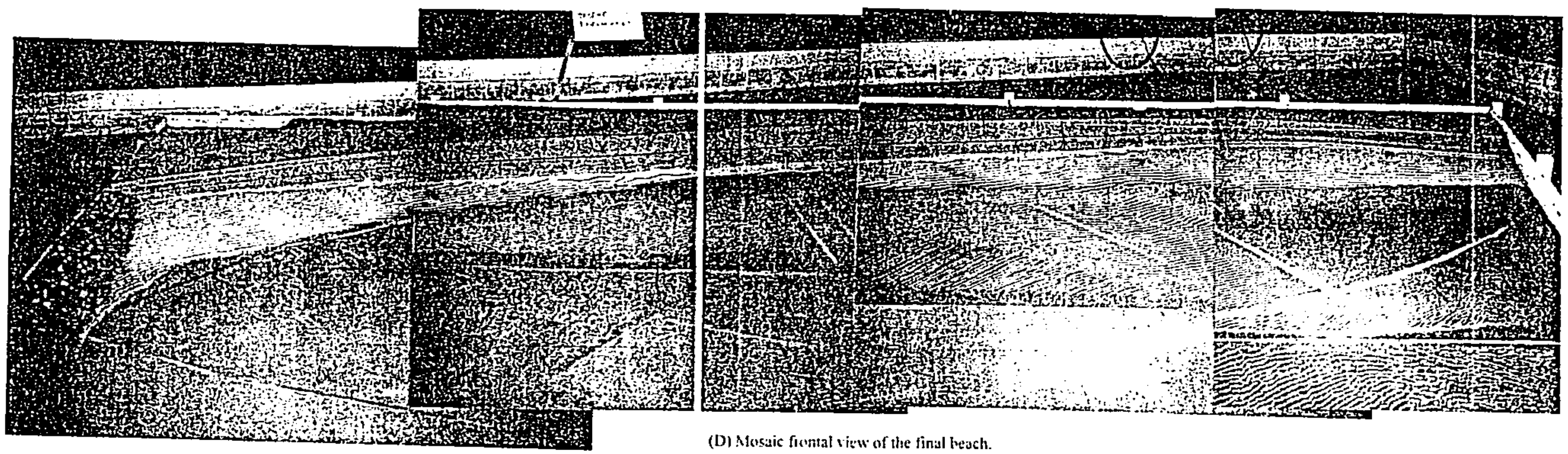
(A) Initial beach prior to testing.



(B) Final beach after testing, as viewed from the south end of basin.

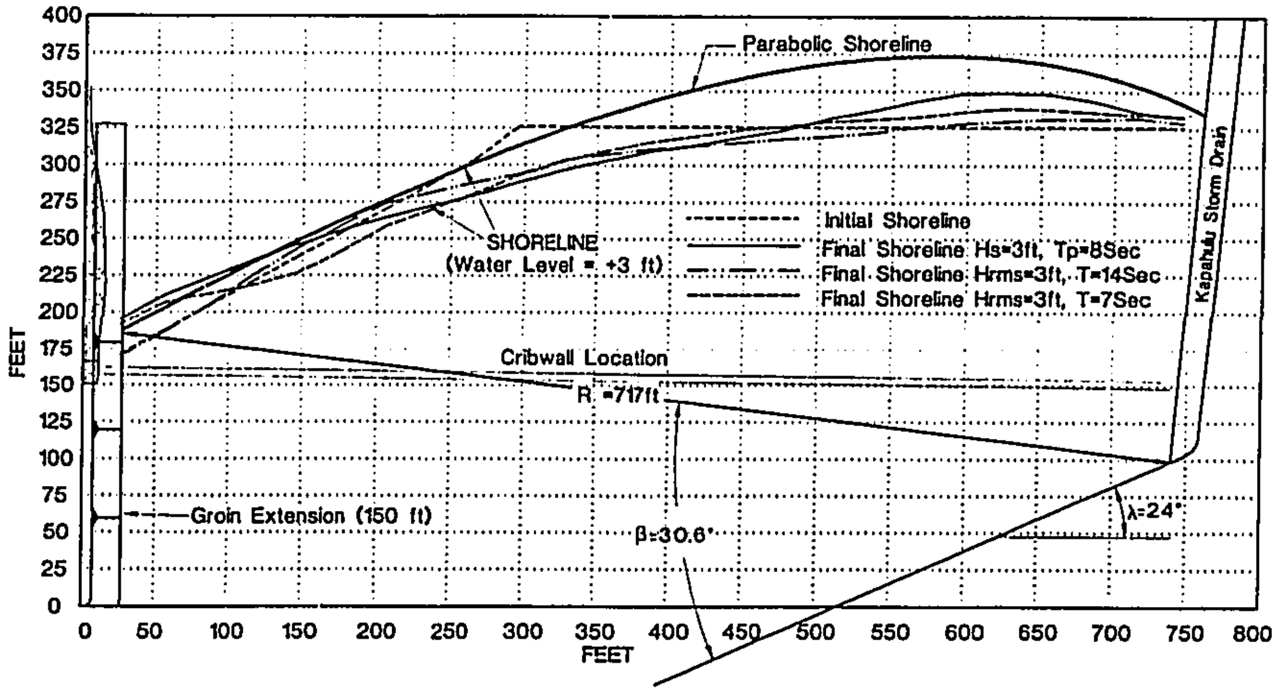


(C) Final beach after testing as viewed from the south end of the basin.

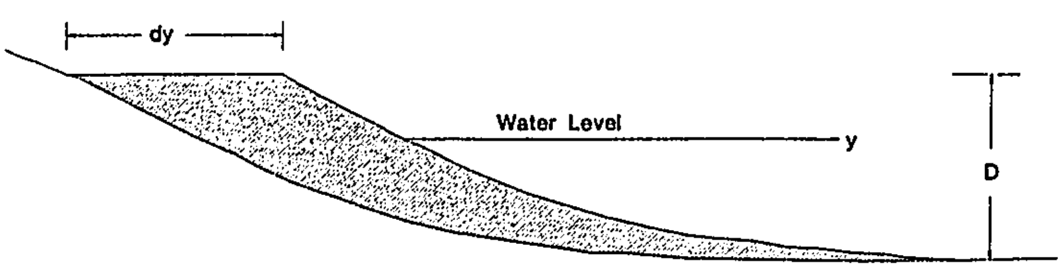


(D) Mosaic frontal view of the final beach.

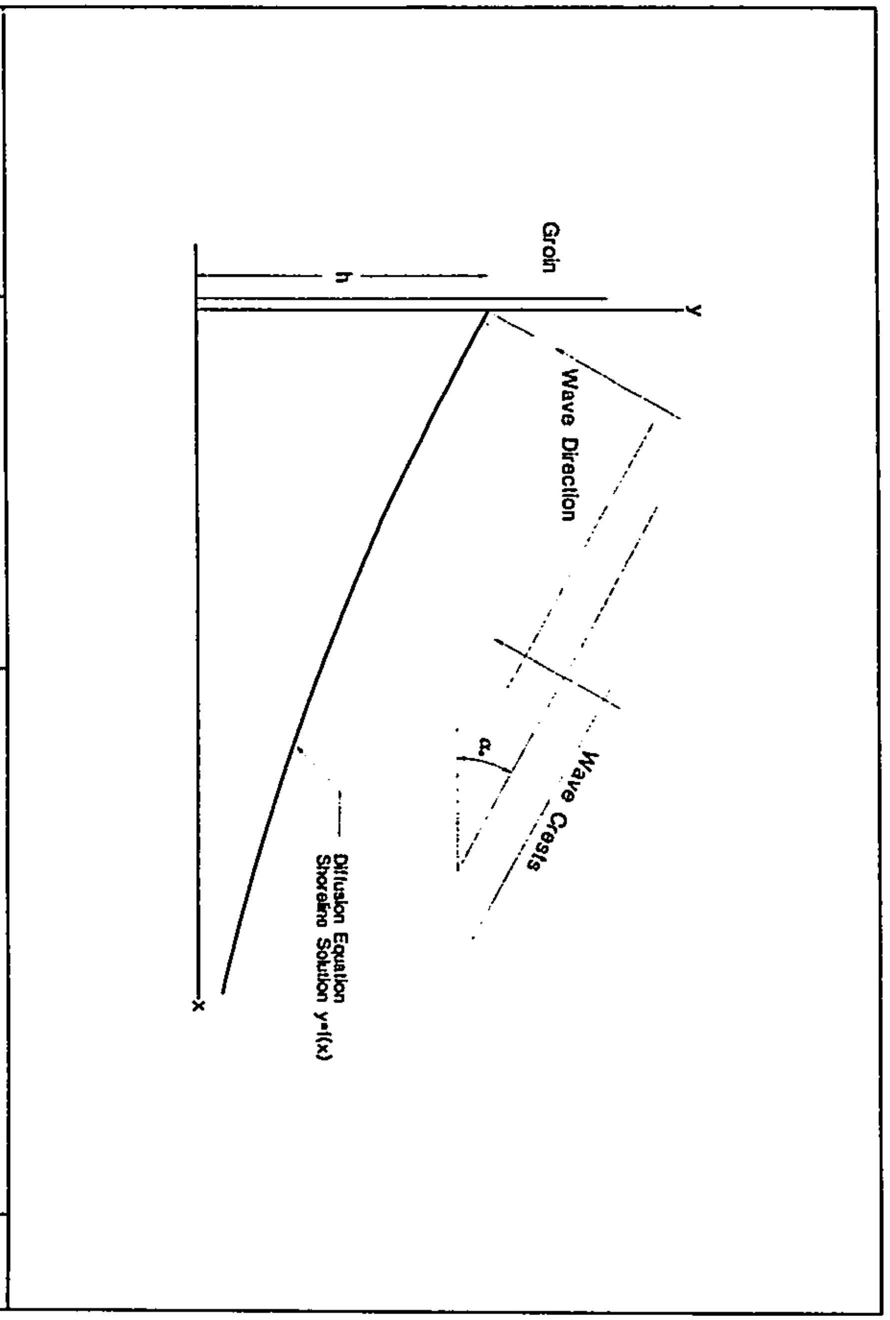
Figure 5-3: Extended Groin Configuration, tested with random waves, H_s = 3.6 feet and T_p = 8 seconds.



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	Model Test Results, Extended Groin Concept With Parabolic Shoreline Simulation	FIGURE 5-4



Edward K. Noda and Associates, Inc.	Waikiki Beach Improvement Project Kuhio Beach Improvements	Beach Depth Definition For Diffusion Equation Shoreline	FIGURE 5-5



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project Kuhio Beach Improvements | Diffusion Equation Shoreline Coordinate System | FIGURE 5-6

$$Q = Q_o + \frac{\partial Q}{\partial \alpha}\bigg]_{\alpha=\alpha_o} (\alpha - \alpha_o) + \cdots \qquad (8)$$

in which Q_o is the longshore transport Q when the angle of the incident wave at the shoreline is α_o. Substituting Eqn. 7 into Eqn. 8 and evaluating the dominant term yields:

$$Q = Q_o - \left(\frac{\partial Q}{\partial \alpha}\bigg]_{\alpha=\alpha_o} \right) \frac{\partial y}{\partial x} \qquad (9)$$

During the interval of time, dt, the shoreline recedes (or accretes) by a quantity dy. Thus, the volume of sand which is removed (or deposited) over a length of beach, dx, is $D\,dx\,dy$. This quantity is equal to the difference in the longshore transport during time, dt, and between locations x and $x + dx$, between the quantities $Q\,dt$ and $(Q + \frac{\partial Q}{\partial x} dx)\,dt$, yielding $\frac{\partial Q}{\partial x} dt$.

Therefore,

$$D\,dx\,dy = \frac{\partial Q}{\partial x} dx\,dt \qquad (10)$$

or

$$\frac{\partial y}{\partial t} = \frac{1}{D} \frac{\partial Q}{\partial x} \qquad (11)$$

Substituting Eqn. 9 for Q into Eqn. 11 and defining

$$K = \frac{1}{D} \frac{\partial Q}{\partial \alpha}\bigg]_{\alpha=\alpha_o} \qquad (12)$$

yields

$$K \frac{\partial^2 y}{\partial x^2} = \frac{\partial y}{\partial t} \qquad (13)$$

which is the well known diffusion equation.

Now consider the case of the longshore transport rate along a straight and long beach that is suddenly interrupted by the construction of a long groin built perpendicular to the shoreline as schematically shown in Figure 5-6, and with the following boundary conditions.

a. $y = 0$ for all x when time $t = 0$, which describes an initial straight shoreline.
b. At the groin, $x = 0$, the longshore transport rate $Q = 0$, which requires the shoreline to be parallel to the incoming wave crest such that

$$\frac{\partial y}{\partial x} = -\tan\alpha_o \quad \text{at } x = 0.$$

c. $\frac{\partial y}{\partial x} = 0$ and $Q = Q_o$ at a large updrift distance represented by $x = \infty$.

The solution to Eqn. 13 with the above boundary conditions is

$$y = \frac{\tan\alpha_o}{\sqrt{\pi}}\left[\sqrt{4Kt}\, e^{-u^2} - x\sqrt{\pi}\, erfc(u)\right] \qquad (14)$$

where $u = \frac{x}{\sqrt{4Kt}}$ and $erfc(u)$ is the Error Function given by

$$erfc(u) = \frac{2}{\sqrt{\pi}}\int_u^{\infty} e^{-u^2}\,du \qquad (15)$$

Tabulated values of the $erfc(u)$ or more typically $erf(u)$, whose integral extends from 0 to u rather than the compliment, from u to ∞, are available such as in Abramowitz and Stegun (1965). Also, rational approximations are available for the error function.

For the present mathematical modeling of the Kuhio Beach shoreline, our interest is not in the time dependent evolution of the shoreline due to steady longshore transport, but rather the final equilibrium shape of the shoreline with no longshore transport occurring along the shoreline. Consider Eqn. 14 at $x = 0$, i.e. at the groin, for $t > 0$, and define the shoreline location at the groin to be h, yields

$$y_{at\,x=0} = h = 2\tan\alpha_o\sqrt{\frac{Kt}{\pi}} \qquad (16)$$

Solving Eqn. 16 for t yields

$$t = \frac{h^2\pi}{4K\tan^2\alpha_o} \qquad (17)$$

and utilizing Eqn. 17 yields the following:

$$\sqrt{4Kt} = \frac{h\pi^{1/2}}{\tan\alpha_o} \qquad (18)$$

and

$$u = \frac{x\tan\alpha_o}{h\sqrt{\pi}} \qquad (19)$$

Thus, the independent variables for Eqn. 14 only include the incoming wave direction α_o and the shoreline location along the groin and do not include time t, the beach depth D or any reference to the longshore transport Q. In other words, once the location of the shoreline at $x = 0$ is known, the shoreline is completely defined for a given wave direction.

Figure 5-7 describes the application of Eqn. 14, herein called the diffusion solution, to the Kuhio Beach Phase 2 physical model test results, where the shoreline is located at $h = 144$ feet along the groin axis from the equivalent straight shoreline and the incident incoming wave direction is $\alpha_o = 30°$. This wave angle, $\alpha_o = 30°$, was determined by averaging the measurements of the shoreline angle at the groin. Figure 5-7 also includes the parabolic shaped shoreline for reference. Note that in selecting the value of h, which is referenced to the straight shoreline at long distances from the groin, the average of the model test shoreline maximum mauka locations was used. The diffusion solution provides a good approximation to the physical model test results.

While the physical model tests used only a single incident wave direction, the mathematical modeling results can now be used to extend the physical model test results to other incident wave directions. By integrating Eqn. 14, the area between the shoreline and the x-axis is approximately given by

$$Area = 0.78\,\frac{h^2}{\tan\alpha_o} \qquad (20)$$

Now consider that wave events have resulted in the diffusion equation shoreline solution shown in Figure 5-7. If the sand is confined to the Diamond Head basin, what would be the resulting equilibrium shoreline shape if the incident wave direction were to vary? If the reference shoreline has $h = 144$ feet and $\alpha_o = 30°$, then for a new wave direction, the new shoreline distance at the groin, h, is given by

$$h(ft) = 150\sqrt{\frac{\tan\alpha_o}{\tan 30°}} \qquad (21)$$

Based on the dimensions shown in Figure 5-7, the straight shoreline is located about 67 feet from the mauka seawall in the Diamond Head basin, and thus the shoreline at the groin is located about 211 feet from the seawall. Based on these dimensions, Table 5-2 describes the seaward extent of the shoreline for different incident wave angles based on Eqn. 21.

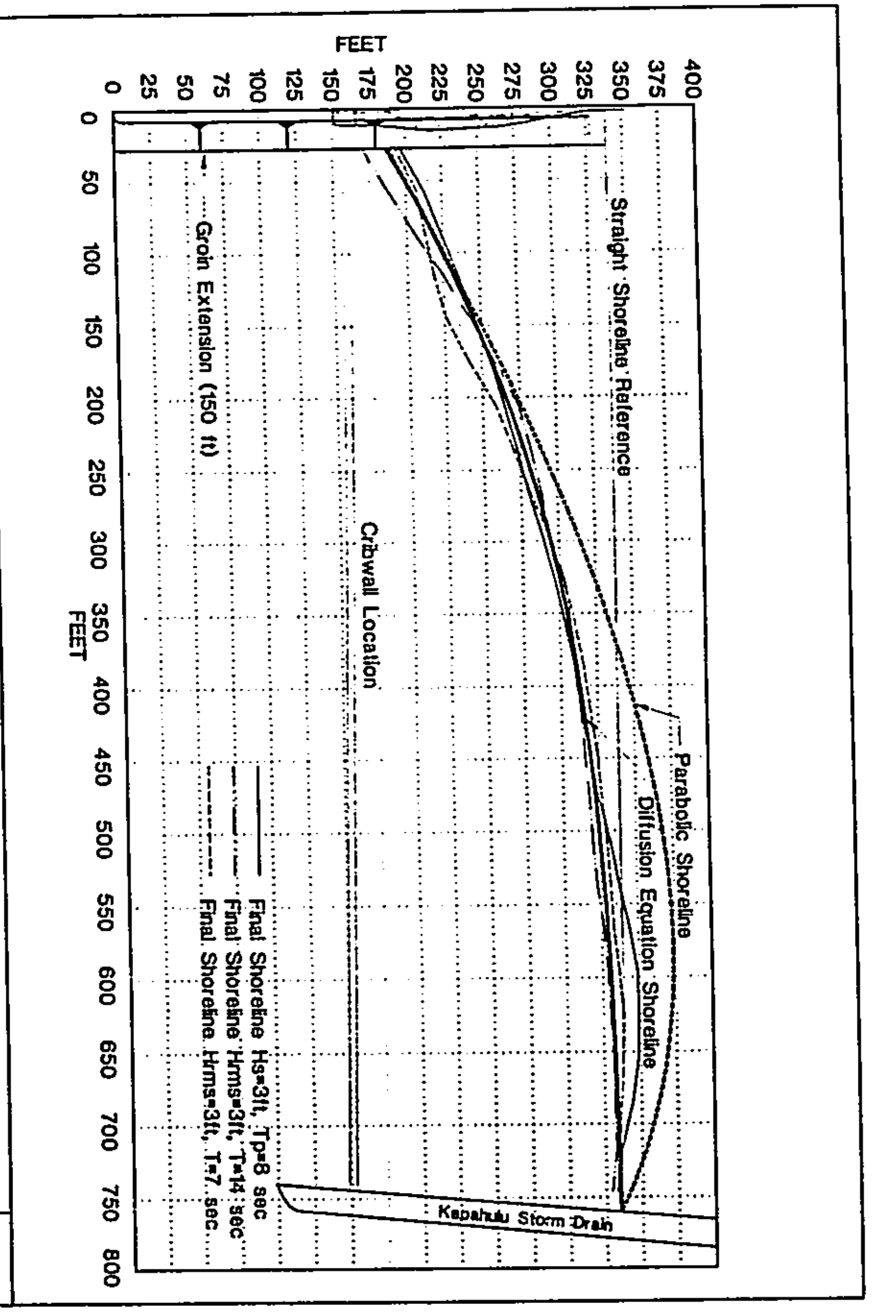
Table 5-2: Seaward Extent of the Shoreline at the Groin for Varying Incoming Wave Directions.

Wave Angle α_o	h (feet)	Distance From Seawall
10°	83	145
15°	102	164
20°	119	181
25°	135	197
30°	150	212
35°	165	227
40°	181	243

Figure 5-8 describes the family of curves for α_o = 10° to 40° assuming that the planform area of sand within the embayment remains constant.

Based on the assumptions used to develop the diffusion equation for shoreline evolution, the solutions that have been provided are based on the volume (planform area) of sand within the basin. Thus, if it is desired to create additional beach area, adding sand would simply move the shoreline seaward, but the shapes provided by the diffusion equation solution would be identical as long as the toe of the beach profile did not extend beyond the groin head.

Based on the beach profile analysis in Section 4, the maximum storm beach profile slope is about 1V:14H. Therefore, to prevent sand from being transported around the groin head, the shoreline at the groin should be at least 100 feet mauka of the tip of the groin (i.e. beach berm location about 140 feet mauka of the groin tip).



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project Kuhio Beach Improvements | Model Test Results For Extended Groin Concept With Diffusion Equation Shoreline | FIGURE 5-7

6.0 SUMMARY AND RECOMMENDATIONS

Numerical modeling was performed of the proposed Kuhio Beach improvements to better understand the equilibrium behavior of the beach protected by the segmented breakwater system. Both the planform shape and the profile shape of the beach was modeled. The Phase 2 physical model test results were used to calibrate and validate the numerical models. The numerical modeling results can be used to determine the probable equilibrium beach shapes for both the Diamond Head Basin and Ewa Basin.

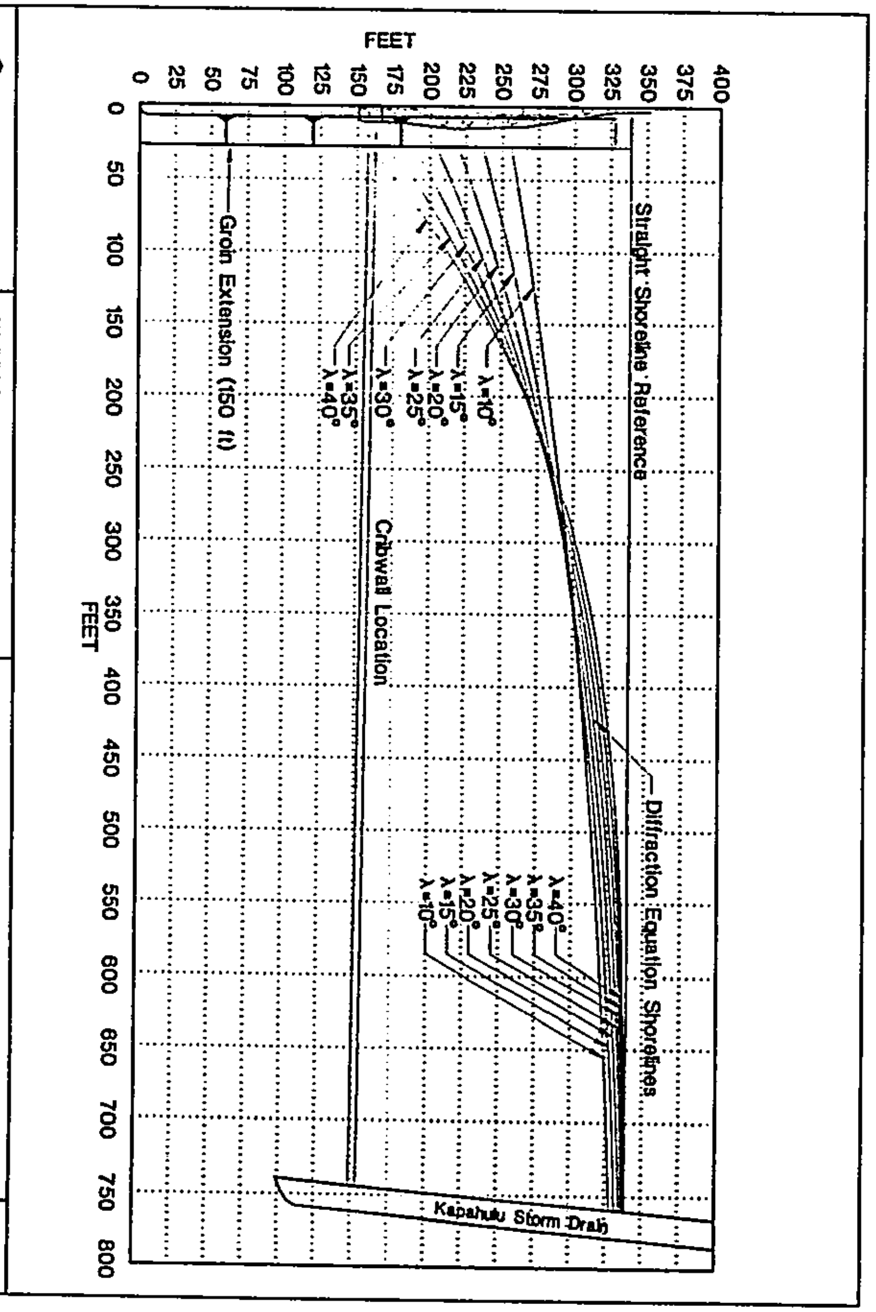
In general, the results of the numerical modeling effort indicate that:

- The equilibrium beach planform shape resulting from the segmented breakwater system can best be approximated by using a diffraction-dominant circular shoreline model. This technique predicts that the beach exposed to undiffracted waves entering the breakwater gap will align itself parallel with the incoming wave crests, while the adjacent beach segments in the lee of the breakwater will tend to be circular arcs conforming to the diffracted wave patterns.

- The equilibrium beach planform shape is primarily dependent on the wave approach direction at the breakwater gap and the breakwater gap width. The total volume of sand within each basin will dictate the minimum dry beach width that can be expected, assuming that the given volume of sand will distribute itself within the basin in accordance with the equilibrium planform shape.

- The beach profile (beach slope) is sensitive to the wave period, water level, and sand grain size. Assuming sand grain size of 0.3 mm, it is recommended that the initial beach slope be constructed no steeper than 1V:10H. Storm waves and extreme swell waves can result in offshore movement of sand (erosion of sand from the backshore with subsequent deposition at the toe of the beach). For the beach segment exposed to direct wave approach through the breakwater gap, a 30-feet transition distance landward of the initial top-of-beach-slope alignment is recommended to accommodate possible mauka movement of the shoreline due to extreme wave events. Normal seasonal swell activity will be expected to rebuild the beach berm by moving sand from the foreshore portion of the beach slope to the backshore portion of the beach.

- The final design should consider the nature of the backshore improvements planned by the City and County of Honolulu. The breakwater gaps should be adjusted as necessary (width and location) to minimize potential storm wave damage to the backshore improvements.



Edward K. Noda and Associates, Inc. | Waikiki Beach Improvement Project Kuhio Beach Improvements | Diffusion Equation Shorelines, Extended Groin Concept, Varying Wave Directions | FIGURE 5-8

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Appendix C

Baseline Surveys of Nearshore Water Quality and Coral Reef Communities at Waikiki, Oahu, Hawaii

Baseline Surveys
of Nearshore Water Quality
and Coral Reef Communities
at Waikiki, Oahu, Hawaii

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January, 1991

PREFACE

The beach and nearshore areas of Waikiki have been subjected to dredging and filling since at least the 1920s (Chave et al., 1973). Reef areas have been dredged to improve swimming conditions and to increase boat access to the shoreline. Sand fill from offshore sites or remote beaches has repeatedly been placed on Waikiki beaches. Much of this material has apparently been removed by wave action, since the high tide line has continued to encroach upon hotels and seawalls, particularly between Fort DeRussy and the Royal Hawaiian Hotel (Fig. 1).

In recent years, sand for Waikiki beach replenishment has become more difficult to obtain, and offshore sources (such as sand banks seaward of the Honolulu Airport reef runway) have been considered. These dredged sands would be cleaned, sorted, and placed upon the berm and intertidal areas of Waikiki Beach.

These actions could potentially alter marine water quality and biological communities in the Waikiki area. To address these potential impacts, this report provides baseline data on water quality and marine community structure offshore of Waikiki, from the Hilton Hawaiian Village to the Natatorium.

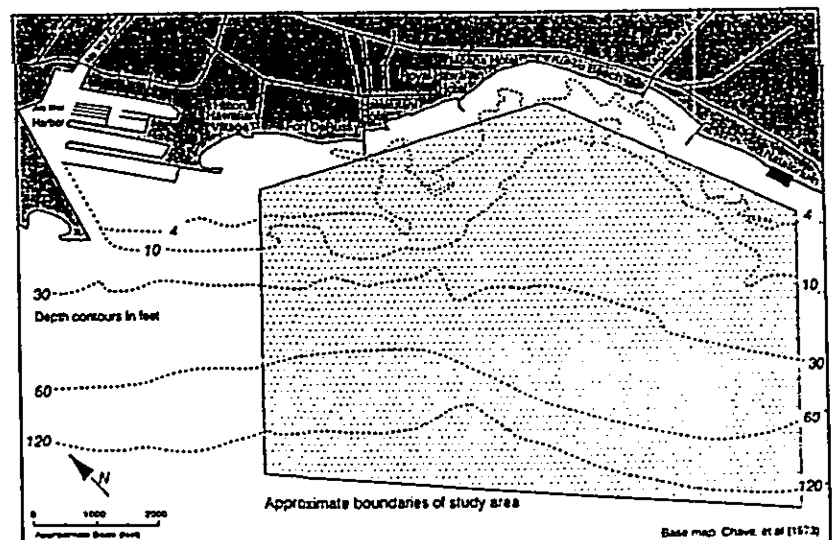

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FIGURE 1.
MAP OF STUDY AREA
WAIKIKI BEACH RESTORATION SITE

EXECUTIVE SUMMARY

Part I - Water Quality Survey

Water quality samples were taken at 20 stations along five transects seaward of the Waikiki area. The stations were located in water depths of 1, 3, 10, 20, and 40 m; multiple samples (at various depths) were taken at the deeper stations. All samples were collected on 3 August 1990, a day of light trade winds and small waves.

Water temperature and salinity were generally higher near shore, as were concentrations of nutrients, pigments, and total filterable solids. These data suggest that circulation is relatively poor in many nearshore areas. An exception may be the area between the Royal Hawaiian Hotel and Kapahulu Avenue, where lower parameter levels suggest a greater degree of mixing with offshore waters, perhaps due to the presence of a gap in the offshore reefs and deeper water near the beach.

Elevated levels of nutrients, pigments, and total dissolved solids were observed along the nearshore portions of transects A and D. The slightly lower salinity measured in these areas suggests that nutrient levels were elevated because of freshwater discharges from the Ala Wai Harbor (near transect A) and from an unknown source (possibly the Kapahulu storm drain) near transect D. However, the highest turbidity levels were observed further from shore, near wave-break areas along the offshore reef platforms.

Considerable variation was observed in water quality at the offshore stations, especially those closer to Diamond Head. Mixing between water masses from several sources and at several depths complicate the analysis of water quality patterns in this area.

The geometric mean levels of several parameters measured in the Waikiki area were less than or equal to the State of Hawaii's Water Quality Criteria for discharges in "dry" open coastal areas. However, mean concentrations of dissolved nutrients (especially ammonium) exceeded the state criteria, as did mean turbidity levels. In analyzing these baseline data, it is important to remember that parameter concentrations and overall trends in water quality are likely to be affected by variations in wind strength and direction, rainfall and runoff, solar heating, and wave activity.

EXECUTIVE SUMMARY (continued)

Part II - Survey of Coral Reef Communities

Corals, exposed invertebrates, and fishes were surveyed at 16 stations off Waikiki on 6-9 August 1990. Sampling stations were located along four transect lines extending perpendicular to shore, at the 10, 20, 40, and 60 foot depth contours. This offshore area can be divided into two main physiographic zones. From the shoreline to the 25-foot contour are extensive sand flats with few exposed marine animals. However, protruding through the sand are numerous rounded limestone ridges, upon which benthic organisms can settle without being subjected to the scouring action of wave-driven sand. Offshore, at depths below 25 feet, is a flat limestone surface with scattered rubble and sand. Like the sand flats near shore, the limestone platform is also rather barren of benthic animals. However, those few areas of substantial vertical relief harbor comparatively dense aggregations of benthic animals and fish.

The dominant coral species at Waikiki are *Porites lobata* and *Pocillopora meandrina*, which together account for about 96 percent of all measured coral coverage. Average coral coverage is highest at the mid-depth (20 and 40 m) stations along the northwest transects (III and IV). Coral diversity showed few clear spatial trends. However the highest diversity was observed along transect IV, near the Hilton channel. The exposed limestone ridges are more abundant along the northwest transects and provide a greater degree of vertical relief and more solid substrate for coral growth. Areas of shifting sand were more prevalent along transects I and II. This sand apparently limits colonization by corals and other sessile organisms.

Of the algae surveyed, the blue-green alga *Lyngbya majuscula* and the brown alga *Sargassum echinocarpum* were most common. The former dominated the deep limestone flats and the latter was common on shallow limestone ridges, especially along transect II. The abundance of reef fish varied in proportion to coral coverage, with areas of little vertical relief having lower coral coverage and fewer fish. The lack of larger, older individuals of fish species preferred by fishermen suggests considerable fishing pressure in this area.

In summary, it appears that the dominant environmental factor shaping the nearshore benthic and reef fish communities off Waikiki is the movement of sand, much of which could have been deposited during prior beach replenishment projects. The proposed sand replenishment project is not likely to qualitatively alter these conditions, and hence will probably result in no identifiable changes to biotic structure.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PART I

Baseline Water Quality Survey at Waikiki, Oahu, Hawaii

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INTRODUCTION

This report describes a baseline survey of marine water quality in the Waikiki area. This data will be used to assess the impacts of a proposed beach replenishment project. Based on the types of impacts possible, thirteen water quality parameters were selected for this study. These are described below.

Perhaps the most obvious possible effect of a beach replenishment project would be to release small particulate materials into the water column. This could cause increases in turbidity and/or total filterable solids. Poorly-washed sands could also release significant quantities of nutrients (nitrate, ammonium, phosphate, silicate, total nitrogen, or total phosphorus). These nutrients could stimulate the growth of macroalgae and/or phytoplankton. Chlorophyll concentrations provide a direct indication of phytoplankton biomass, and thus could be used to identify such an increase in algal growth. Pheopigment levels, on the other hand, indicate the rate at which phytoplankton are dying and/or being consumed by herbivores.

Dissolved oxygen concentrations reflect a balance between oxygen introduced by photosynthesis and physical mixing and oxygen consumed by biological and chemical processes. Salinity and temperature measurements were used to assess patterns of mixing and circulation and sources of freshwater discharge in the marine environment.

METHODS

Samples were taken at 20 stations (Fig. I-1). These stations were located along five transects extending perpendicular to the shoreline. Transects A, D, and E each had five stations in water depths of approximately 1, 3, 10, 20, and 40 m. Transects B and C had fewer stations, and extended only to the 10 m and 3 m depth contours, respectively.

Water quality measurements were taken offshore of Waikiki Beach on 3 August 1990, between about 0900 hr and 1200 hr. The tide (at Honolulu Harbor) was rising from a low of 0.1 ft at 0711 hr to a high of 2.3 ft at 1449 hr. The five transects were sampled from north to south (starting at transect A) and along each transect, sampling progressed from shallow to deep water. Tradewinds were light (10-15 kt), the waves were small (0.5 ft), and no significant surface currents were observed.

Samples were collected using a 5-liter Niskin bottle (General Oceanics Model 1010-5). At the 1 m stations (e.g. A1, B1, etc.) a single water sample was taken at 0.5 m below the surface. At mid-depth stations (e.g. A2, A3, B2, B3, etc.) samples were taken 0.5-1 m below the surface and 2-2.5 m above the bottom. At the 20 and 40 m stations, three samples were obtained: 1 m below the surface; 5 m above the bottom; and midway between the surface and bottom. For each water sample, 13 water quality parameters were measured.

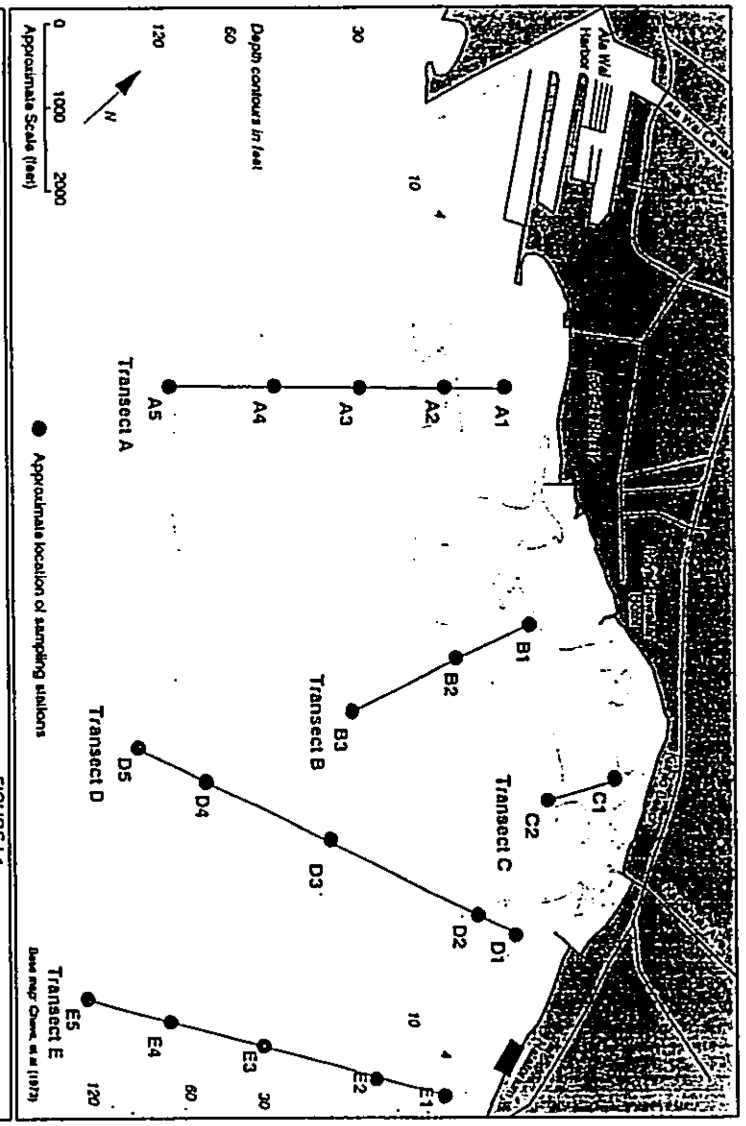

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FIGURE I-1.
WATER QUALITY SAMPLING STATIONS
WAIKIKI BEACH RESTORATION SITE

Water temperature and dissolved oxygen were measured *in situ*, the latter using an YSI-model 58 dissolved oxygen meter. Subsamples used for the analyses of the other eleven parameters were placed in clean 2-liter polyethylene bottles and stored in coolers for transport to the laboratory. In the laboratory, salinity was determined with a Grundy Environmental Systems Inc. Model 6230N salinometer. Turbidity was measured on a Turner Designs Nephelometer. Suspended solids samples were filtered onto tared GF/C glass fiber filters that were dried at 60°C for 24 hours to a constant weight (American Public Health Association, 1975).

Samples for inorganic nutrients (nitrate/nitrite, ammonium, phosphate and silicate) were filtered through Whatman GF/C glass fiber filters and analyzed on a Technicon AutoAnalyzer II system according to methods for automated analyses (general: Armstrong et al., 1976; Hager et al., 1968; nitrate/nitrite: Technicon, Inc., 1977; ammonium; Solorzano, 1969; phosphate: Murphy and Riley, 1962; silicate: Strickland and Parsons, 1972). Total nitrogen concentrations were measured using the alkaline persulfate digestion method (D'Elia et al., 1977) and total phosphorus was measured using the acid persulfate digestion method (Grasshoff et al., 1983). Pigment samples were collected on 0.4 um Nucleopore polycarbonate filters, and extracted in acetone in the dark at -5°C. Chlorophyll and pheopigment concentrations were determined via the fluorometric method for acetone-extracted samples (Holm-Hansen et al., 1965; Strickland and Parsons, 1972), and measured with a Turner Designs fluorometer.

RESULTS & DISCUSSION

Water Quality Analyses

Waikiki water quality data for 3 August 1990 are presented in Table I-1. Each sample is numbered according to the station and depth at which it was taken. For example, sample A-1-M is the mid-water sample at station A1 and sample E-5-B is the bottom sample at station E5.

Water temperatures were generally highest near shore, at stations B1, C1, and E1 (Fig. I-2). Station E1, near the Natatorium, had the warmest water (28.0°C, compared with a geometric mean of 26.5°C for all samples). In contrast, water at nearshore stations A1 and D1 was about 0.2°C cooler than the overall average. Offshore stations (20 and 40 m stations) averaged 0.2 to 0.4°C cooler than the average, with the coldest water (25°C) observed in the bottom sample at Station E5.

Salinity averaged 34.98 parts per thousand (ppt) among all the samples, and ranged from 34.91 to 35.12 ppt - typical for marine waters. Within this narrow range, small but systematic variations were observed (Fig I-3). A zone of lower than average salinity (34.93 to 34.96 ppt) extended seaward along transect D

Table I-1. Water quality at stations off Waikiki Beach - 3 August 1990. For station locations, see Fig. I-1. S - surface sample, M - mid-depth sample, and B - bottom sample; "-" indicates data not available.

SAMPLE	DEPTH (m)	TEMP. (deg C)	SAL-INITY (ppt)	DIS-SOLVED OXYGEN (mg/l)	NO_3 AND NO_2 (ug/l)	NH_4 (ug/l)	TOTAL NITRO-GEN (ug/l)	PO_4 (ug/l)	TOTAL PHOS-PHORUS (ug/l)	SILICA (ug/l)	CHLORO-PHYLL (ug/l)	PHEO-PIGMENT (ug/l)	TURBI-DITY (NTU)	TOTAL FILT. SOLIDS (mg/l)
A-1-M	0.5	26.3	35.03	6.80	10.36	39.62	99.3	5.76	15.36	206.4	0.19	0.18	0.4	5.92
A-2-S	0.5	26.3	35.04	5.64	9.94	78.82	171.6	6.08	12.16	125.2	0.22	0.22	1.8	7.90
A-2-B	2.0	26.5	35.04	5.80	3.92	9.80	111.6	4.80	12.16	206.4	0.18	0.23	1.6	6.47
A-3-B	9.0	27.2	34.99	6.60	8.54	24.22	92.0	7.04	15.36	80.9	0.10	0.09	1.4	4.06
A-4-S	0.5	26.3	34.91	6.15	11.06	42.42	104.0	8.96	13.12	140.0	0.10	0.03	0.1	3.34
A-4-M	10.0	26.3	34.97	6.38	2.66	15.12	182.1	5.44	10.24	117.9	0.08	0.03	2.0	3.55
A-4-B	18.0	26.3	34.96	6.47	3.36	32.20	105.8	4.80	11.52	427.3	0.10	0.03	2.6	-
A-5-S	0.5	26.3	34.91	6.50	1.96	13.72	78.8	4.80	18.88	235.8	0.10	0.01	0.2	3.26
A-5-M	20.0	26.2	34.96	6.80	9.38	15.96	85.1	7.04	10.24	449.4	0.07	0.02	0.0	3.34
A-5-B	35.0	26.3	34.97	6.52	6.02	10.22	73.6	8.00	10.56	302.1	0.10	0.03	0.6	3.04
B-1-M	0.5	27.3	35.04	6.14	4.76	28.70	144.2	4.80	12.16	140.0	0.20	0.15	1.0	5.57
B-2-S	0.5	26.6	35.01	5.50	4.90	26.88	179.5	5.44	10.56	103.0	0.12	0.09	3.4	3.89
B-2-B	2.0	26.2	34.99	6.35	8.40	35.28	119.1	7.04	13.44	257.9	0.18	0.06	0.8	3.51
B-3-S	0.5	26.4	34.95	6.19	4.62	23.24	80.4	4.80	11.20	154.8	0.08	0.03	0.4	3.57
B-3-B	8.0	26.2	34.97	6.55	8.12	41.02	122.5	8.96	14.08	177.0	0.10	0.04	0.8	3.05
C-1-M	0.5	27.0	35.00	6.10	3.64	29.40	127.3	5.12	10.56	626.4	0.11	0.05	0.6	3.74
C-2-S	0.5	26.4	35.01	6.30	2.94	19.46	141.8	4.80	13.12	117.9	0.10	0.05	2.0	3.39
C-2-B	2.0	26.4	34.97	6.49	7.14	17.64	133.8	6.08	14.40	243.0	0.07	0.07	1.4	3.66
D-1-M	0.5	26.4	34.94	6.63	7.98	16.94	128.2	6.08	18.24	213.6	0.19	0.24	1.6	6.96
D-2-S	0.5	26.5	34.94	6.28	6.16	13.72	114.9	5.12	16.32	449.4	0.14	0.09	0.4	3.94
D-2-B	2.5	26.6	34.93	6.53	3.08	22.40	108.6	4.80	14.08	169.4	0.15	0.06	0.7	3.80
D-3-S	0.5	26.5	34.94	6.21	1.96	11.48	108.9	4.80	21.76	95.8	0.09	0.03	0.5	3.44
D-3-B	9.0	26.4	34.95	6.74	9.10	5.18	80.4	7.04	12.48	184.2	0.11	0.03	0.3	3.78
D-4-S	0.5	26.4	34.95	6.31	1.82	10.50	113.4	4.80	21.12	220.9	0.08	0.02	0.2	4.25
D-4-M	10.0	26.4	34.95	6.69	14.56	21.56	108.6	5.44	12.48	1260.0	0.05	0.01	0.2	3.13
D-4-B	18.0	26.2	34.97	6.81	1.40	8.68	95.1	4.80	11.20	88.5	0.09	0.01	0.4	2.91
D-5-S	0.5	26.4	34.95	6.45	4.48	24.50	150.2	5.12	19.20	117.9	0.13	0.02	0.1	2.58
D-5-M	20.0	26.3	34.96	6.62	7.00	5.04	137.6	7.36	11.52	589.4	0.07	0.01	0.0	3.83
D-5-B	35.0	26.0	35.00	6.63	15.40	17.78	92.0	5.76	11.52	1105.2	0.12	0.03	0.4	3.11
E-1-M	0.5	28.0	35.12	7.72	4.76	17.08	109.9	4.80	13.12	213.6	0.11	0.11	1.2	4.42
E-2-S	0.5	26.9	35.07	6.60	4.90	18.90	143.6	4.80	11.20	346.4	0.13	0.12	1.3	4.40
E-2-B	2.5	26.9	35.09	6.76	3.36	12.04	133.3	4.80	11.20	95.8	0.18	0.12	1.2	4.78
E-3-S	0.5	26.4	34.97	6.50	7.28	48.30	106.5	5.76	19.84	103.0	0.11	0.04	0.0	3.63
E-3-B	9.0	26.6	34.99	7.05	4.06	18.48	91.4	4.80	11.20	110.6	0.10	0.06	0.5	2.96
E-4-S	0.5	26.3	34.96	6.31	7.42	6.30	83.9	4.80	10.24	147.3	0.09	0.01	0.1	3.52
E-4-M	10.0	26.2	34.95	6.38	3.36	1.40	104.9	5.12	10.24	265.2	0.10	0.02	0.0	3.03
E-4-B	19.0	26.2	34.98	6.60	3.22	17.36	83.4	4.80	11.20	390.6	0.14	0.01	0.0	3.65
E-5-S	0.5	26.3	34.95	6.32	4.90	20.16	128.8	5.76	11.20	154.8	0.08	0.04	1.4	3.46
E-5-M	20.0	26.2	34.97	6.59	3.64	26.46	79.9	5.44	25.60	88.5	0.10	0.03	0.0	3.29
E-5-B	35.0	25.0	35.07	6.80	2.66	24.78	92.5	4.80	12.16	199.1	0.14	0.04	0.9	3.61
MINIMUM:		25.0	34.91	5.50	1.40	1.40	73.6	4.80	10.24	80.9	0.05	0.01	0.0	2.58
MAXIMUM:		28.0	35.12	7.72	15.40	78.82	182.1	8.96	25.6	1260.0	0.22	0.24	3.4	7.90
GEOMETRIC MEAN:		26.5	34.98	6.46	5.00	17.71	110.6	5.57	13.25	205.5	0.11	0.04	0.7	3.67
State Water Quality Standards (for "open coastal waters" along "dry" coastlines) Geometric mean:					3.50	2.00	110.0	5.00	16.00		0.15		0.2	10.00

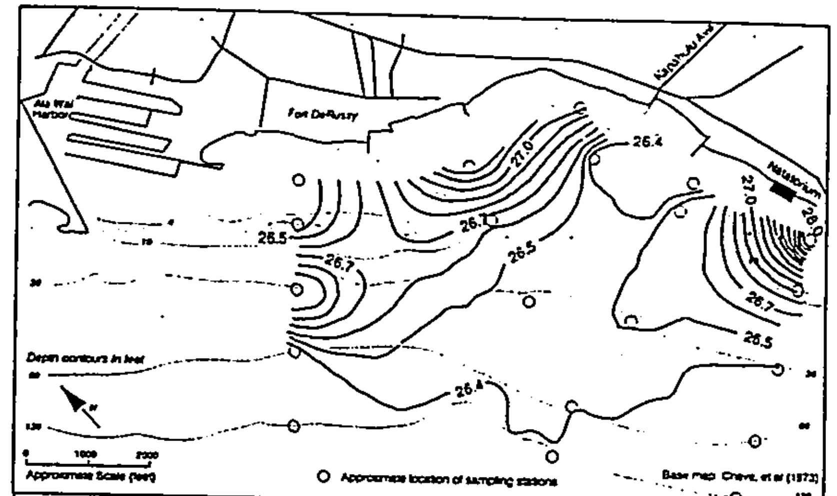

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FIGURE I-2.
SURFACE TEMPERATURE CONTOURS (DEG. C)
WAIKIKI BEACH RESTORATION SITE

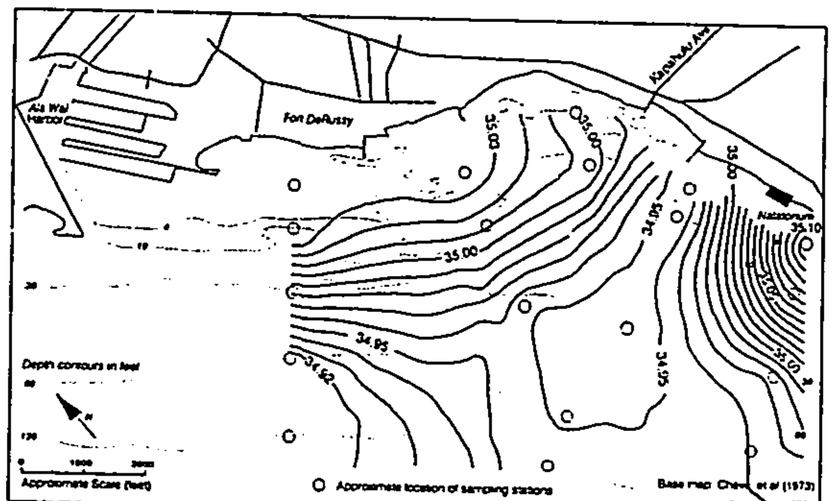

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FIGURE I-3.
SURFACE SALINITY CONTOURS (PPT)
WAIKIKI BEACH RESTORATION SITE

and appeared to spread laterally toward the south. Within this zone, the least saline water was near shore, at stations D1 and D2. These data suggest the presence of a freshwater source near the north end of Queen's beach, and subsequent seaward transport of a "plume" of slightly lower salinity water. One possible freshwater source could be the storm drain seaward of Kapahulu Avenue; however, surface salinity at stations C1 and C2 were near the overall average. After a heavy rainstorm, Chave et al. (1973) documented a plume of low salinity water (30-33 ppt) originating at the Kapahulu storm drain and moving toward Diamond Head and offshore. At stations A4 and A5, a second area of lower salinity surface water was observed during the 1990 survey. This may be related to fresh or brackish water discharged through the Ala Wai Canal. Such low-salinity plumes would probably be more noticeable and more extensive following local rainstorms.

A region of slightly higher salinity water was observed near the Natatorium, at stations E1 and E2. The warm, high-salinity water in this area and at station B1 probably resulted from solar heating and evaporation of nearshore waters in areas of reduced circulation and mixing.

Nitrate and phosphate concentrations averaged 5.0 and 5.6 ug/l, respectively. Generally low concentrations of these nutrients were observed near shore along transects B, C, and E (see Fig. I-4 for nitrate concentrations). Elevated levels along transect A

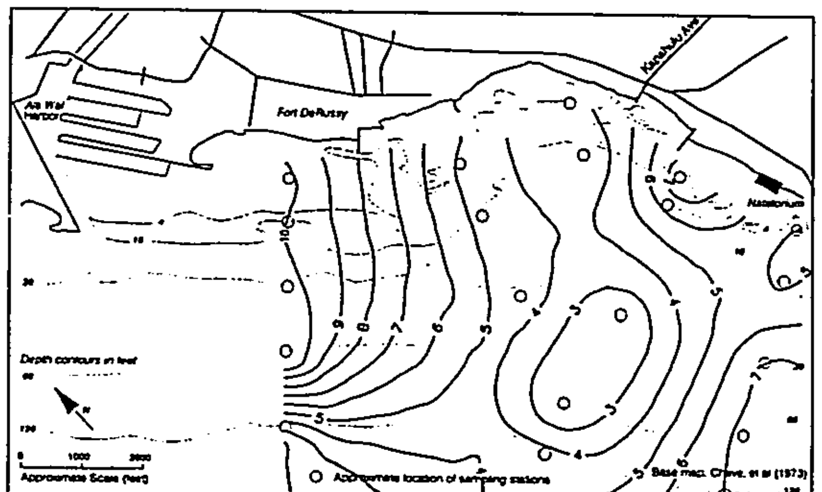

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FIGURE I-4.
SURFACE NITRATE CONCENTRATION (ug/l)
WAIKIKI BEACH RESTORATION SITE

may reflect discharge from the Ala Wai Canal and Harbor. Nitrate concentrations were high and phosphate levels were slightly elevated at station D1 (8.0 and 6.1 ug/l, respectively) perhaps in response to the apparent freshwater discharge in this area.

The highest ammonium concentrations (40-80 ug/l) were observed in surface waters at stations A1, A2, and A4 (no data were available for the surface waters at station A3). From these stations, a region of elevated ammonium levels (25-40 ug/l) extended toward Diamond Head, and was detectable at stations B1, B2, B3, and C1. Like the elevated nitrate and phosphate levels observed along transect A, these high ammonium concentrations may originate in water discharged through the Ala Wai Harbor channel.

Total nitrogen and total phosphorus showed less distinct spatial trends, and varied greatly among stations and depths. Along with turbidity, total nitrogen levels were highest at the 3 m stations (except along transect D). In contrast, some of the highest total phosphorus concentrations were observed in surface water along transect D. Samples taken at similar locations in September 1972 (Chave et al., 1973) show similar spatial distributions for total nitrogen and total phosphorus. However, due to differences in analytical technique, the actual concentrations are not directly comparable.

Silicate concentrations were high (> 300 ug/l) in most of the mid-depth and bottom samples from offshore (10 and 20 m) stations. The highest silicate concentrations (1100 to 1260 ug/l) were measured in samples D-4-M and D-5-B, which also had the highest nitrate concentrations.

As might be expected, chlorophyll and pheopigment concentrations followed similar spatial trends, although chlorophyll concentrations were higher at most stations. Concentrations of both pigments generally decreased with distance from shore, but relatively low concentrations were observed near shore along transect C (Fig I-5). Higher pigment concentrations were measured in surface samples from stations A1, A2, A3, and B1. The increased algal biomass in this area probably results from elevated nutrient concentrations and/or high algal biomass in water from the Ala Wai Harbor region. Locally high pigment concentrations were also observed at station D1, another area of elevated nutrient levels.

Concentrations of total filterable solids (TFS) averaged 3.7 mg/l but tended to be higher (5.5 to 7 mg/l) near shore, with highest levels at Stations A1, A2, B1, and D1 (Fig. I-6). TFS concentrations in surface samples followed the same spatial trend as did the pigment concentrations (see Figs. I-5 and I-6). Furthermore, there were statistically significant correlations between TFS, chlorophyll, and pheopigments. These correlations suggest that microalgae and/or macroalgal detritus may contribute significantly to TFS levels in the Waikiki area.

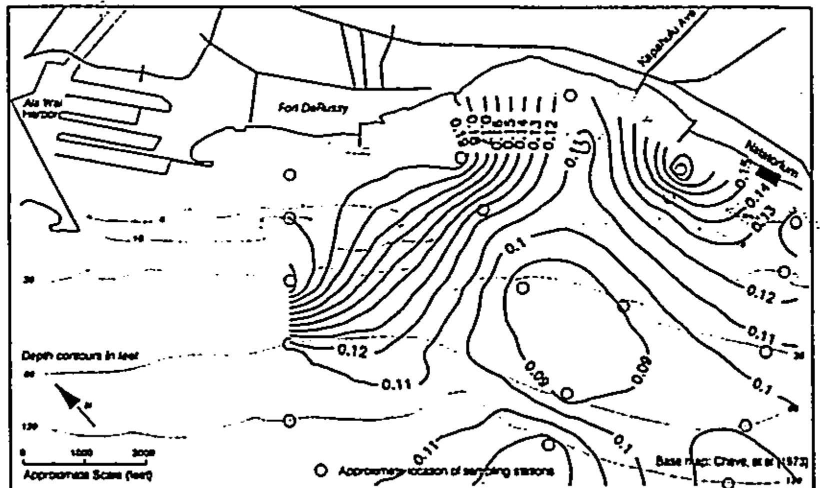

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FIGURE I-5.
SURFACE CHLOROPHYLL CONCENTRATIONS (ug/l)
WAIKIKI BEACH RESTORATION SITE

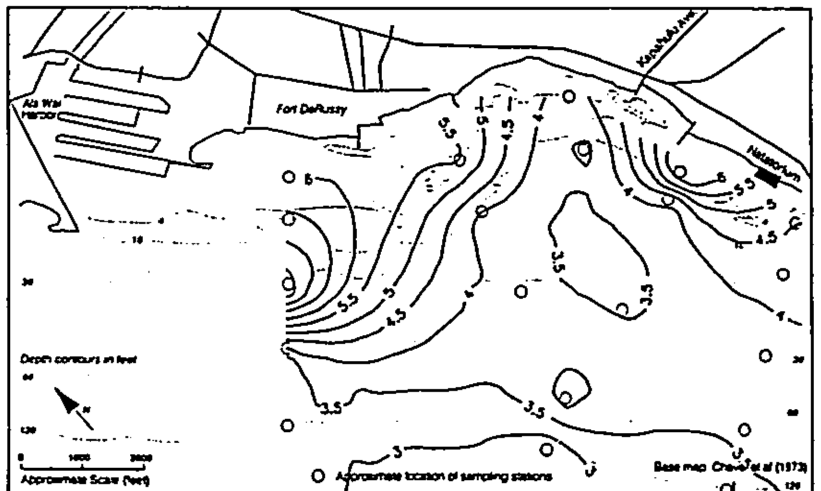

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FIGURE I-6.
SURFACE TFS LEVELS (mg/l)
WAIKIKI BEACH RESTORATION SITE

Somewhat surprisingly, turbidity followed a different spatial trend than did TFS levels. Except along transect D, the highest turbidity levels (1.6 to 2.1 NTU) were observed at the 3 m stations (A2, B2, C2, and E2) rather than at the stations closest to shore. This band of high turbidity lies just seaward of the normal wave break point, along the edge of the shallow reef platform, about 0.25 to 0.5 mile offshore. The lack of correlation between TFS and turbidity suggests that turbidity off Waikiki is controlled by the presence of dissolved or colloidal material rather than algae or particulates. Turbidity was significantly correlated with concentrations of total nitrogen, but not with nitrate or ammonium.

Comparison with Hawaii Water Quality Standards

The State of Hawaii has established Water Quality Standards (WQS) for nine of the thirteen water quality parameters measured in this study. These standards must be met by any effluent discharged into state waters, and are assumed to represent typical "ambient conditions" within various aquatic environments. For discharges into the waters off Waikiki, the standards for "open coastal waters" along a "dry" coastal area would apply. On 3 August 1990, the observed geometric means for temperature, salinity, total filterable solids, chlorophyll, and total phosphorus were all below the WQS for dry coastal waters (Table I-1). Mean total nitrogen levels were essentially equal to the WQS and phosphate and nitrate concentrations exceeded WQS levels by 11 and 43 percent, respectively. In contrast, mean ammonium and turbidity levels were, respectively, 2.5 and 7.9 times higher than the state criteria. All except one of the samples exceeded the state criterion for ammonium (2 ug/l), and many exceeded this level by an order of magnitude or more.

Overall Water Quality Trends

The survey of 3 August 1990 identified several general trends in water quality within the Waikiki study area. Levels of many water quality parameters (e.g. temperature, pigments, and nutrients) were generally higher at the shallower stations. However, lower levels were observed near shore along transect C, where channels cut through the offshore reefs and deeper water lies closer to the beach.

As described previously, water quality near shore along transect D appears to be affected by a source of nutrient-rich fresh water, perhaps the Kapahulu storm drain. The salinity and temperature data also suggest that the nearshore waters between the Royal Hawaiian Hotel and Kapahulu Avenue are more actively mixed with water from offshore, perhaps due to the presence of the deep channels described above. Chave et al. (1973) observed a net seaward current flow near Kapahulu and near the Natatorium during low-wave conditions. During large waves, they observed a strong seaward flow originating nearshore between the Royal Hawaiian Hotel and Kuhio Beach.

Surface water quality in nearshore samples along the northeastern transects (A and B) appeared to be strongly influenced by a water mass having lower salinity and elevated concentrations of nutrients, pigments, and suspended materials. The most likely source of this water is the Ala Wai Canal and Harbor. However, other sources cannot be ruled out.

In general, the deeper, offshore samples had low levels of TFS, turbidity, nutrients, and pigments, probably reflecting a greater influence of oceanic water. However, anomalously high levels of some parameters (e.g. turbidity, nitrate, silicate) were observed in mid-depth and bottom samples from some offshore stations, especially along transects D and E. Presumably, these anomalies result from mixing of offshore and nearshore waters, perhaps transported from the Diamond Head area. However, the overall trends in water quality from the mid-depth and bottom samples are complex and difficult to assess.

In closing, it should be noted this water quality survey was conducted on a hot summer day with light trade winds and very little wave action. Both parameter concentrations and overall trends in water quality are likely to be affected by variations in solar heating, wind strength and direction, rainfall and runoff, and wave activity. Such factors must be considered in comparing these baseline water quality data with the results of previous or subsequent surveys.

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PART II

Baseline Survey of
Coral Reef Communities
at Waikiki, Oahu, Hawaii

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INTRODUCTION

For the purpose of this study, the marine community off Waikiki was analyzed in terms of the abundance, diversity, and distribution of stony and soft corals, motile benthos such as sea urchins, and pelagic species such as reef fish. In using repeated observations to assess environmental impacts on subtidal marine communities, benthic (bottom-dwelling) organisms are most useful. Because these organisms are generally long-lived, immobile, and intimately affected by exogenous input of sediments and other potentially deleterious materials, they must either tolerate the surrounding conditions within the limits of adaptability or die.

As members of the benthos, stony corals are of particular importance in nearshore Hawaiian environments. Corals compose a large portion of the reef biomass and their skeletal structures are vital in providing a complex of habitat space, shelter, and food for other species. Because corals serve in such a keystone function, coral community structure is considered the most "relevant" group in evaluating past and potential impacts of land-use changes on reef communities. For this reason, and because alterations in coral communities are easy to identify, observable change in coral population parameters is a practical and direct method for obtaining the information that is required to meet existing environmental regulations. In addition, because they comprise a very visible component of the nearshore environment, detailed investigations of reef fish assemblages were undertaken as well.

METHODS

Marine Community Structure

All fieldwork was carried out on 6-9 August 1990, using a 21-foot boat. Descriptive and quantitative information was obtained regarding the benthic (bottom dwelling) communities inhabiting the nearshore area between the shoreline and the 20 meter (~60 foot) depth contour. We first performed a qualitative reconnaissance survey of the offshore area from the Natatorium to the Hilton Channel. This reconnaissance survey was useful in making relative comparisons between areas, identifying any unique or unusual biotic resources, and providing a general picture of the physiographic structure and benthic assemblages occurring throughout the region of study.

Following the preliminary survey, four sampling transects were selected offshore of Waikiki (see Fig. II-1). Transect I was located just west of the Natatorium; transect II was located seaward of the Moana Hotel; transect III was located seaward of the Halekulani Hotel near the eastern part of Fort DeRussy; and transect IV was located just to the east of the Hilton Channel. Transects I, II, and III are located offshore of the sand replenishment area.

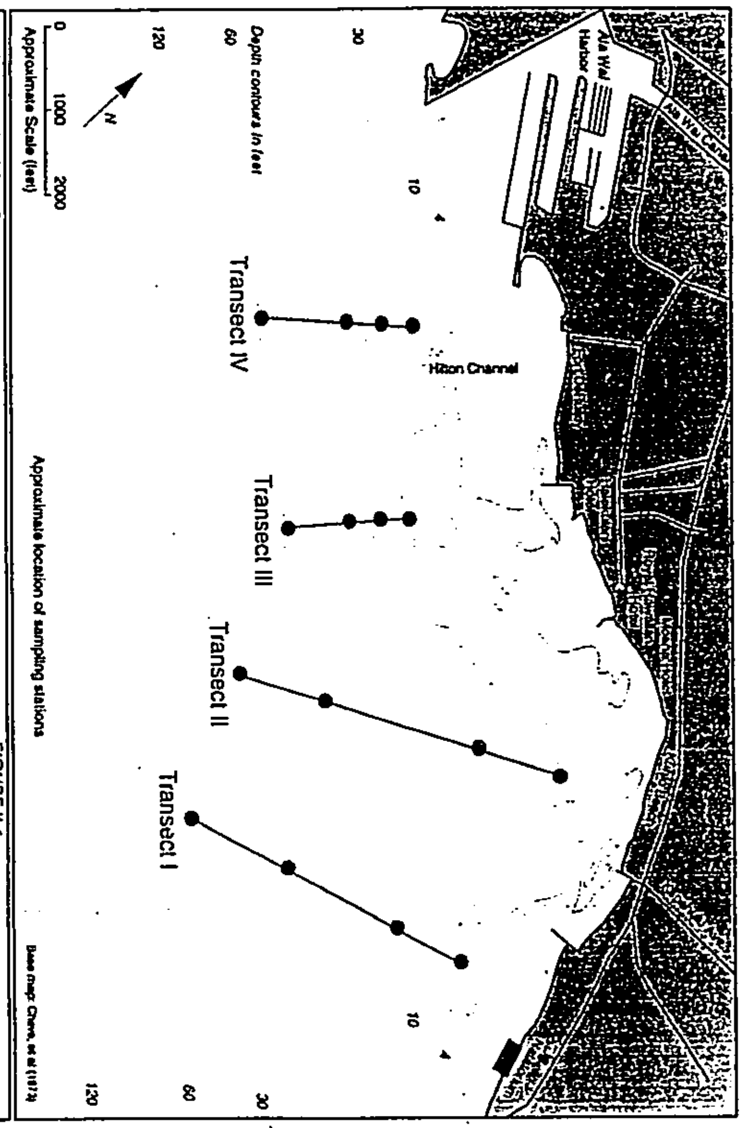

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FIGURE II-1.
BIOLOGICAL SURVEY TRANSECT STATIONS
WAIKIKI BEACH RESTORATION SITE

Along each transect, sampling stations were established at four representative depths (10, 20, 40, and 60 feet). These depths were selected to cover the dominant physical and biological zonation scheme of the nearshore environment. Each sampling station consisted of a 160-foot transect line parallel to depth contours, and bisecting a single reef zone. It is important to note that all sampling stations were located in areas of hard substrata, rather than sandy areas. Therefore, the locations of these stations were not completely random, and were biased toward areas of peak benthic community structure.

Quantitative benthic surveys were conducted by stretching a 160-foot long surveying tape in a straight line over the reef surface. An aluminum quadrat frame, with dimensions of 3 feet by 2 feet, was sequentially placed over 10 random marks on the tape so that the tape bisected the long axis of the frame. A color photograph was taken of the reef area enclosed by each quadrat frame. In addition, a diver knowledgeable in the taxonomy of resident species visually estimated the percent cover and occurrence of organisms and substratum type within each quadrat. No attempt was made to disturb substrata to observe organisms, and no attempt was made to identify and enumerate cryptic species dwelling within the reef framework. Only macrofaunal species greater than approximately 2 centimeters were noted.

Following the fieldwork, quadrat photographs were projected onto a grid and units of bottom cover for each benthic faunal species and bottom type were recorded. Results of the photo-quadrats were combined with the in-situ cover estimates and community structure parameters (percent cover, species diversity) were calculated. The photo-quadrat transect method is a modification of the technique described in Kinzie and Snider (1978), and has been employed in numerous field studies of Hawaiian reef communities (e.g. Dollar, 1979; Grigg and Maragos, 1974). This method has proven to be particularly useful for quantifying coverage of attached benthos such as corals and large epifauna (e.g., sea urchins, sea cucumbers). Although this methodology provides reliable, quantitative results for the larger exposed fauna, it does not provide data for the many coral reef invertebrates that are small, cryptic and/or nocturnal. In fact, quantitative assessment of these groups requires methodologies that are beyond the scope of the present assessment program.

A quantitative assessment of reef fish community structure was conducted in conjunction with the benthic surveys. As the transect tape was being laid along the bottom, all fish observed within about three feet on either side of the tape were identified and enumerated. Care was taken to conduct the fish surveys so that the minimum disturbance was created by divers, ensuring the least possible dispersal of fish. Only readily visible individuals were included in the census. No attempt was made to seek out cryptic species or individuals sheltered within coral. This method is an adaptation of techniques described in Hobson (1974).

The areal coverage of various biotopes within the Waikiki area was determined using data from the transect surveys and from aerial photographs.

RESULTS AND DISCUSSION

Physical Structure

Table II-1 presents a brief description of the physical environment at each of the sixteen sampling stations. In general, the marine environment offshore of Waikiki can be characterized into two major zones. A nearshore zone, extending from the shoreline to approximately the 25-foot depth contour, is characterized by expansive sand plains. Owing to the nearly constant movement of the sands by waves, few attached or epibenthic organisms occupy this biotope.

Between the sandy areas in the nearshore zone are numerous limestone (calcium carbonate) projections that could be described as "finger knolls". These structures are elongated ridges, generally oriented parallel to the shoreline, that rise several feet off the sandy bottom. The sides of the knolls are generally gently sloping rather than vertical. As a result of their elevation above the sand flats and the solid substratum they provide, the surfaces of the finger knolls serve as preferred settling sites for attached benthos.

The second major zone, occurring in water depths from approximately 25 feet to the limits of the qualitative survey (approximately 80 feet), can be described as a "hardpan" bottom. This region consists of an extremely flat, calcium carbonate surface covered by a veneer of sandy sediment and rubble fragments. Vertical relief in this zone is restricted to shallow indentations and channels lined with sand. Colonization by attached benthos is ubiquitously low over the hardpan surface, and is generally restricted to small corals and benthic algae. In the few locations having structural relief, solid substratum that extended above the surrounding reef surface was colonized by comparatively dense aggregations of attached benthos and fish.

Several exceptions to this general pattern were observed. Along transect I, the shallowest sampling station was located in an old structural coral reef. The solid limestone reef surface was cut by numerous fissures and cracks. This area was not characterized by the sand flats that typified the rest of the survey area at the shallowest depths. In other areas, particularly off the Halekulani Hotel, continuous sand channels extended from the beach out to the limits of the survey.

Table II-1. Physical settings at transect stations used in Waikiki reef community survey. For transect station locations, see Figure II-1.

TRANSECT	Depth (ft)	DESCRIPTION
I	10	Old carbonate structural reef; numerous fissures, cracks and channels filled with coarse sand and rubble. Abundant large colonies of P. meandrina.
	20	"Hardpan" bottom composed of flat calcium carbonate platform. Interspersed with numerous small crevices and channels filled with sand. Sediment-bound layer over entire surface. Large heads of P. meandrina and flat encrustations of P. lobata dominant coral cover.
	40	Hardpan interspersed with sand flats. Very low relief. Lyngbya very abundant.
	60	Hardpan interspersed with sand flats and coral rubble aggregations. Very low relief. Lyngbya very abundant. Small colonies of recently recruited P. meandrina abundant.
II	10	Calcium carbonate "finger knoll" on sand flat. Very low cover of living coral; very abundant growth of Sargassum.
	20	Calcium carbonate "finger knoll" on sand flat. Very low cover of living coral; very abundant growth of Sargassum.
	40	Sand cover over flat hardpan. Occasional large heads of P. lobata growing off reef surface.
	60	Sand cover over flat hardpan.
III	10	Finger knoll on sand flat. Abundant skeletal structural relief from living and dead P. lobata colonies extending off reef surface.
	20	Finger knoll on sand flat. Abundant skeletal structural relief from living and dead P. lobata colonies extending off reef surface.
	40	Finger knoll raised approximately 2 m over sand flat. P. meandrina dominant coral. Lyngbya abundant.
	60	Sand/rubble covered hardpan. Very small coral colonies. Lyngbya abundant.
IV	10	Finger knolls with steep sides rising out of sand channels. Large P. meandrina colonies.
	20	Ridges and fissures of hard bottom interspersed with sand channels. Abundant P. lobata and P. meandrina. Most well formed structural reef of entire survey area.
	40	Finger knoll on sand flat. P. lobata major coral, but no substantial relief from old colonies.
	60	Sand cover over flat hardpan. No relief above bottom.

Biotic Community Structure

Benthic Invertebrate Communities

Table II-2 summarizes the abundance of invertebrates throughout the region of study. The predominant macrobenthic (bottom-dwelling) fauna throughout the reef zones off Waikiki are reef-building corals, sea urchins, and encrusting sponges. Other benthic taxa were also observed, but were substantially less abundant.

Table II-3 provides a quantitative summary of coral community structure; data on individual transect are presented in Appendix A. Nine species of "stony" corals and one "soft coral" were encountered on transects, and the number of coral species at a singled sampling station ranged from two to six. Two species of corals (*Pavona varians* and *Cyphastrea ocellina*) were observed in the study area but did not occur on any transects (see Table II-1).

The dominant coral species at all of the Waikiki stations were *Porites lobata* and *Pocillopora meandrina*. *P. lobata* accounted for about 49% of the coral coverage measured on transects and *P. meandrina* accounted for about 45%. Thus, the eight remaining species totaled accounted for only about 6% of coral cover.

Figure II-2 depicts coral community structure and illustrates that relationships between the various depth zones and transects. With respect to coral cover, several patterns are evident. Overall coral cover is higher at the northwest end of the study area (transects III and IV) than at the southeast end. Along transects III and IV, cover is highest at the middle stations (20 and 40 feet in depth), and lowest at the deep (60 foot) stations. Along transects I and II, there are no such relationships, and coral cover is comparatively low (less than 15%) at all areas. The number and diversity of coral species do not show the same clear spatial trends as do coral coverage. The highest species number (6) and the highest diversity (1.25), however, were observed along transect IV, near the Hilton channel.

The higher coral coverage and diversity along the northwest transects apparently relates to the greater area of solid substratum available in these areas. The finger knolls that predominate along transects III and IV are not as abundant along transects I and II. Coral colonization was clearly greater on these structures, owing to the protection offered from sand scour. In areas with less vertical relief, coral colonization and growth appears to be severely restricted. Coral cover was uniformly low at all of the 60-foot stations, and the sea bottom consisted of carbonate hardpan covered with fine sediment.

Thus, it appears that the major factor controlling coral community structure at Waikiki is the degree of protection from

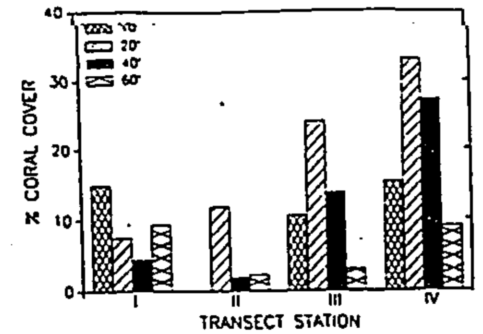
Table II-2. Abundance of marine invertebrates at Waikiki survey stations. For station locations, see figure II-1.

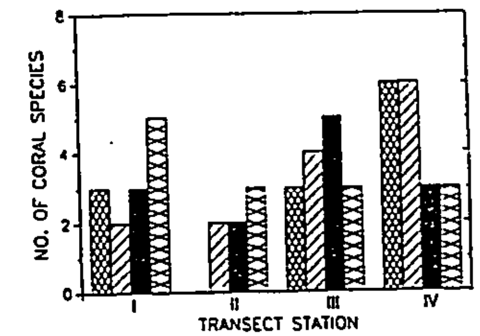
Abundance code:
"R" = rare (0 - 5 individuals or colonies sited on station)
"O" = occasional (5 - 20 individuals or colonies sited on station)
"C" = common (more than 20 individuals or colonies sited on station)

CORAL SPECIES	Transect I				Transect II				Transect III				Transect IV			
STATION DEPTH	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'
SCLERACTINIA (Reef-Building Corals)																
Porites lobata	C	C	C	C	R	C	C	C	C	C	C	C	C	C	C	C
Porites compressa				R				O				R		O	O	O
Porites brighami				R										R		
Pocillopora meandrina	C	C	C	C	R	C	C	C	C	C	C	C	C	C	C	C
Pocillopora eydouxi											R			R		
Montipora verrucosa	R	R	R	R		C	R	R	R	C	C	O	O	C	C	C
Montipora patula	R	R	R	R		O	R	R	R	C	C	O	O	C	C	C
Leptastrea purpurea	R	R	R	R				R		R	O		R	R	R	R
Cyphastrea ocellina						R			R	R	O	R	R	R	R	R
Pavona varians	R	R		R				R		R	R		R	O	O	
Pavona duerdeni		R						R						R	R	R
ZOANTHINIARIA (Colonial "soft" corals)																
Palythoa tuberculosa	R	R	R	R		R	R	R	R	R	R	R	R	R	R	R
ALCYONACEA (Colonial "soft" corals)																
Anthelia edmondsoni		R	R	R		R			R	R	R		R	R	R	R
HOLOTHUROIDEA (Sea Cucumbers)																
Actinopyga obesa								O			R					
Holothuria atra	R	R	R	R	R	R	R	O	R	R	R	R	R	R	R	R
Holothuria nobilis	R	R		R	R			O	R	R	R	R	R	R	R	R
ECHINOIDEA (Sea Urchins)																
Diadema paucispinum			R	R				R			R				R	
Echinothrix diadema	R	C	R	R	R	R		R	R	O	R	R	O	C	R	C
Echinothrix calamaris		R	R	R				R		R	R			C	R	R
Tripneustes gratilla	C	C	C	C	R	C	R	C	C	C	C	C	C	C	C	C
Echinometra mathaei	C	C	C	C	C	C	O	C	C	C	C	C	C	C	C	C
Echinometra oblonga	C	O	O	C				C		C	C		O	R	R	R
Echinostrephus aciculatus	C	O	O	C	R			R		C	R		C	C	O	O
Heterocentrotus mammillatus	R	R	R	C		C		C	R	C	C	C	C	O	O	O
ASTEROIDEA (Starfish)																
Linckia multifora																
Linckia diplax		R				R				R						
Acanthaster planci											R					
MOLLUSCS															R	
Spondylus tenebrosus				R							R					
Cyprea tigris														R		
CRUSTACEA																
Panulirus penicillatus																R
PORIFERA																
Iotrochota protea		R	C	C			C	C		O	C	C		O	C	C
misc. sponges	C	C	C	C	R	C	C	C	C	C	C	C	C	C	C	C

Table II-3. Coral coverage, abundance, and diversity, plus non-coral substrate coverage at Waikiki survey stations. For station locations, see Figure II-1.

	Transect I				Transect II				Transect III				Transect IV			
STATION DEPTH	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'
CORAL SPECIES																
Porites lobata	2.5	1.2	.1.4	3.9		7.2	1.3	1.6	5.1	14.8	4.8	1.4	3.2	25.5	15.0	2.5
Porites compressa														0.6		
Porites brighami				0.3												
Pocillopora meandrina	11.8	6.2	2.9	4.5		4.6	0.5	0.5	5.2	7.3	8.0	1.3	7.5	6.0	12.2	5.9
Pocillopora eydouxi													3.6			
Montipora patula										1.1	0.2			0.5		
Montipora verrucosa			0.1	0.3				0.1	0.2	0.8	0.6	0.3	0.1	0.2	0.1	0.6
Pavona duerdeni													0.6			
Leptastrea purpurea	0.5			0.2												
Palythoa tuberculosa											0.1		0.3	0.2		
TOTAL CORAL COVER	14.8	7.4	4.4	9.2	0.0	11.8	1.8	2.2	10.5	24.0	13.7	3.0	15.3	33.0	27.3	9.0
NUMBER OF SPECIES	3	2	3	5	0	2	2	3	3	4	5	3	6	6	3	3
CORAL COVER DIVERSITY	0.60	0.44	0.73	1.02	0	0.67	0.59	0.71	0.77	0.91	0.92	0.95	1.25	0.71	0.71	0.81
NON-CORAL SUBSTRATA																
Limestone	4.6	42.3	12.0	14.3	8.0	12.5	2.5	6.4	64.5	53.6	34.5	2.4	22.5	53.0	7.5	4.3
Sand	71.0	44.6	56.9	36.0	92.0	49.2	80.1	78.8	21.6	18.8	35.4	56.5	56.5	8.7	43.6	28.9
Rubble	9.6	5.7	26.7	40.5		26.5	15.6	12.6	3.4	3.6	16.4	38.1	5.7	5.3	21.6	57.8





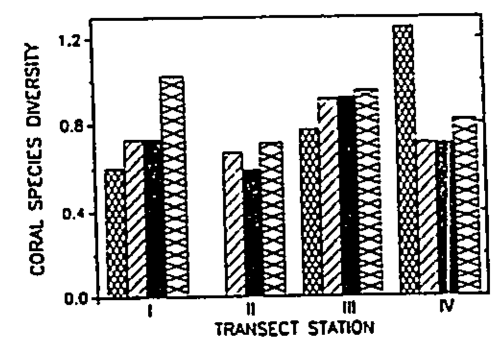


Figure II-2. Coral coverage, number of species, and diversity along Waikiki reef survey transects. For transect station locations, see Figure II-1.

shifting sand. In areas of high sand cover (low relief) corals are very limited; in areas where vertical relief provides settling surfaces above the level of sand movement, coral communities are moderately well-established.

In addition to corals, sea urchins (Class Echinoidea) were the only other group of macroinvertebrates commonly observed during this study. Table II-4 summarizes the occurrence of sea urchins at all of the survey stations. Offshore of Waikiki the most common urchin is *Echinometra matheai*, which occurs in all reef zones. *E. matheai* are small urchins, generally found within small indentations in basaltic and limestone substrata. *E. matheai* were most abundant at the mid-reef stations, where the number of individuals per station ranged from 34 to 135. The urchins *Tripneustes gratilla* and *Heterocentrotus mammillatus* also were observed throughout the Waikiki area. These are larger species than *E. matheai*, and inhabit the reef surface rather than indentations in the reef.

Table II-4. Abundance of sea urchins at Waikiki survey stations. For transect station locations, see Figure II-1.

	Transect I				Transect II				Transect III				Transect IV			
STATION DEPTH	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'
Echinometra matheai	17	24	6	4	8	21	3	2	9	26	7	2	43	21	48	3
Echinostrephus aciculatus	7	9	2	3	2	2			3	9	2		6	4	8	
Heterocentrotus mammillatus										4						
Tripneustes gratilla						8			1	2	1			2	2	
Echinothrix calamaris			1													
TOTAL URCHIN COUNT	24	33	9	7	10	31	3	2	13	41	10	2	51	27	58	3

Three species of sea cucumbers (Holothurians) were observed during the survey: *Holothuria atra*, *H. nobilis*, and *Actinopyga obesa*. Individuals of these species were distributed at wide intervals across the mid-reef and deep reef zones (Table II-2). Although rare in occurrence, the most widespread starfish (Asteroidea) observed on the reef surface was *Linckia* spp. Several crown-of-thorns (*Acanthaster planci*) were observed feeding on colonies of *Pocillopora meandrina*. Numerous sponges were also observed on the reef surface, often under ledges and in interstitial spaces.

The design of the reef survey was such that no cryptic organisms or species living within interstitial spaces of the reef surface were enumerated. Since this is the habitat of the majority of mollusks and crustacea, detailed species counts were not included in the transecting scheme. No dominant communities of these classes of biota were observed during the reef surveys at any of the study stations.

Benthic Algae

Table II-5 presents abundance estimates for benthic algae in the Waikiki study area. Although 21 species were encountered, two species of frondose algae (the blue-green alga *Lyngbya majuscula*, and the brown alga *Sargassum echinocarpum*) were clearly most abundant. *L. majuscula* was most common on the deep, flat, hard-pan areas, where it appeared as black, filamentous tufts attached to the bottom. *Sargassum* was most prevalent in the shallower "finger knoll" zones, especially along transect II. Other predominant frondose algal species included *Enteromorpha* spp., *Turbinaria ornata*, and *Hypnea* sp. Encrusting coralline algae (*Hydrolithon*, *Porolithon*, *Neogoniolithon*, and *Peysonellia* spp.) were observed throughout the study region.

Table II-5. Abundance of benthic marine algae at Waikiki survey stations. For station locations, see Figure II-1.

Abundance code: "R" = rare (0 - 5 individuals or colonies sited on station)
"O" = occasional (5 - 20 individuals or colonies sited on station)
"C" = common (more than 20 individuals or colonies sited on station)

	Transect I				Transect II				Transect III				Transect IV			
STATION DEPTH	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'
CHLOROPHYTA (Green algae)																
Caulerpa spp.	R		R		O	O		R	O	R	R	R	C	R	R	R
Enteromorpha sp.	C	C	C	C	O	O	O	C	R	O	O	R	R	O	O	R
Halimeda spp.	R	R	R	O	O	R	O	R	R	C	O	R	R	C	C	R
Neomeris annulata	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Ulva spp.	R				C					R	R	R	R	R	R	R
Valonia spp.	R		R	R	R			R								
CYANOPHYTA (Blue-green algae)																
Lyngbya majuscula	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
PHAEOPHYTA (Brown algae)																
Dictopteris spp.	O	R	R	R	O	R	O	O		O	R	R		O	O	R
Dictyota spp.	O	R	R	R	O	R	R	O		O	R	R		O	O	R
Padina spp.	O	R	R	R			R	R	R	O	R	R	R	O	O	R
Ralfsia sp.	O	R	R		R	R		R		O	R	R	R	O	O	R
Sargassum spp.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Turbinaria ornata	C	R		O	R	C	R	R		R	C	C	R	R	R	C
RHODOPHYTA (Red Algae)																
Acanthophora specifera	O		R		R	R	R	R		R	R	R		R	R	R
Asparagopsis taxiformis	O	R		R												
Hydrolithon spp.	C	R					O	C								
Hypnea spp.	C	R			C	C	C	C	C	R	R	R	C	R	R	R
Liagora spp.				R			C			C	C	R		C	C	R
Neogoniolithon sp.	C	R		R	R	R	C	C		O	O	O		O	O	O
Peysonellia rubra sp.		R		C		R	R	R								
Plocamium sp.					R	R	R		R	R	R	R	R	R	R	R
Porolithon spp.	C	R	R	R		C	C	C	R	C	C	C	R	C	C	C

Reef Fish Community Structure

Reef fish community structure was largely determined by the topography and composition of the benthos. Species abundance and diversity are summarized in Table II-6 and Figure II-3. Among the sampling stations, species diversity ranged from 0.70 to 2.90, number of species ranged from 6 to 12, and numbers of individuals from 15 to 2262. A total of 5,132 individuals representing 89 species were noted. Two thousand of these fish were a single large school of blue-lined snapper (taape, *Lutjanus kasmira*).

It is evident from survey results that reef fish community structure off Waikiki is largely a function of topographical relief of the bottom. Areas with little structural relief in the vertical dimension were poor habitats for reef fish. In such areas, few fish were noted and most of these were species such as triggerfishes (humuhumu, Balistidae) which inhabit barren areas and take shelter in small crevices in the bottom.

In contrast, areas with low rock ledges or finger knolls harbored substantial numbers of fish consisting of a variety of species. The fish in such areas can be grouped into four general categories: juveniles, planktivores, herbivores, and rubble-dwelling fish.

Juvenile fish belonged mostly to the family Acanthuridae (surgeon fish), with representatives from the families Labridae (wrasses), Mullidae (goat fish) and Chaetodontidae (butterfly fish). The predominant planktivorous fish were the blackfin chromis (*Chromis vanderbilti*) and the milletseed butterflyfish (lau-wiliwili, *Chaetodon milliaris*). The primary herbivore was the brown surgeonfish (ma'i'i'i, *Acanthurus nigrofuscus*). Other common herbivores were goldring surgeonfish (kole, *Ctenochaetus strigosus*), convict tangs (manini, *A. triostegus*) and small unicornfish (kala, *Naso unicornis*). The primary rubble dwelling fish were the saddle wrasse (hinalea lau-wili, *Thalasoma duperrey*) and manybar goatfish (moano, *Parupeneus multifasciatus*).

A few species of "food fish" (those preferred by commercial and/or recreational fishermen) were observed during the survey. A school of approximately 2000 juvenile blue-lined snapper (taape, *Lutjanus kasmira*) were observed at one site. Several grand-eyed porgeys (mu, *Monotaxis grandoculis*) were also observed. Rocky ledges and large coral heads sheltered occasional squirrelfish (u'u, *Myripristes berndti*). Other food fish included parrotfish (uhu, *Scarus* spp.), and goatfish (moana kea and malu, *Parupaneus cyclostomus* and *P. bifasciatus*). Overall, however, such fish were quite rare, tended to be small, and avoided divers. In general, the entire survey area appeared to be subjected to substantial fishing pressure which has noticeably impacted the abundance, size and behavior of sought-after species.

Table II-6. Abundance of reef fishes at Waikiki survey stations. For transect station locations, see figure II-?.

FAMILY	Transect I				Transect II				Transect III				Transect IV			
Species STATION DEPTH	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'	10'	20'	40'	60'
MURAENIDAE																
Gymnothorax meleagris	1							1							1	1
G. flavimarginatus				1												
G. undulatus															1	1
AULOSTOMIDAE																
Aulostomus chinensis	1				1	1								1		
CIRRHITIDAE																
Cirrhitops fasciatus						3			1							
Cirrhitus pinnulatus					1											
Paracirrhites arcatus	12	10				7	2		1	3	9			3	1	
P. forsteri	1	1														
MULLIDAE																
Mulloides flavolineatus					2											
M. vanicolensis														1		
Parupeneus multifasciatus	4			7	8	11		1	10	7	9			1	14	12
P. pleurostigma	1				1							6				5
P. bifasciatus		1			1											
P. porphyreus													6			
MALACANTHIDAE																
Malacanthus hoedtii								1								
LUTJANIDAE																
Lutjanus kasmira				50												2000
L. fulvus				8												
LETHRINIDAE																
Monotaxis grandoculis										1	1			1	1	
CHAETODONTIDAE																
Chaetodon lunula						1				1						
C. quadrimaculatus	4	1				2			1		2			1		
C. miliaris				50		3		1	1		6	17				5
C. ornatissimus										1						
C. unimaculatus					1											
C. multicinctus				5						1	5			3	3	7
C. fremblii				2				1		2	2	2	1			5
C. kleinii				150								1				4
Forcipiger flavissimus	1	3		4							5		2		3	1
Heniochus diphreutes											3	12				
POMACANTHIDAE																
Centropyge potteri				50				4			7				5	50
C. loriculus											1					
POMACENTRIDAE																
Abudefduf abdominalis					50			1								
Plectro. johnstonianus						1			1		3		4	2	3	
P. imparipennis	1	3				4		1	1		3	1			2	
Stegastes fasciolatus	4				2	5				1	3	7	1	5		

Table II-6. continued

FAMILY Species STATION DEPTH	Transect I 10'	20'	40'	60'	Transect II 10'	20'	40'	60'	Transect III 10'	20'	40'	60'	Transect IV 10'	20'	40'	60'
POMACENTRIDAE (continued)																
Dascyllus albisella				9			4	4		5	13					50
Chromis agilis		2												4		
C. hanui				10		1				5	4	2		4		6
C. vanderbilti	20	200		50		8			50	50	100	12	14		50	
C. ovalis														3		
LABRIDAE																
Novaculichthys taeniourus		2	3	2												1
Cheilinus bimaculatus												3				5
Pseudocheilinus octotaenia											5					2
Bodianus bilunulatus		1														4
Coris gaimard		2	2	2						5		3				1
C. venusta		2				1									2	3
Cheilio inermis									2							
Anampses chrysocephalus											1					
A. cuvier	1															
Thalassoma duperrey	100	100	6	50		50			25	50	15		50		16	8
T. trilobatum						1			2							
T. ballieui	1								1				1			
Gomphosus varius	2	1											2	3		
Labroides phthirophagus		1		2					1							
Macropharyngodon geoffroy		5		2		3		2		1	2	5		3		5
Pseudojuloides cerasinus			1					4		5	4					10
Stethojulis balteata	2				3	5			25	10	10	4	6	3	4	5
Halichoeres ornatissimus		4										3				
SCARIDAE																
Scarus sordidus	6															1
S. perspicillatus	1				1	2				6	3				2	2
S. rubroviolaceus	1															
juvenile Scarus											2			7		23
ACANTHURIDAE																
Zebrasoma flavescens		4		5					6	26				10		1
Acanthurus achilles					1								1			
A. triostegus	2				50								1			
A. olivaceus			2	10		3			6			6				4
A. dussumieri	3				1	2			2							
A. blochii		7			1				6					1		
A. nigrofuscus	150	9		5	4	17			15	50	19	1	53	27	10	1
A. nigrorus					1	3							4	7	3	5
Ctenochaetus strigosus	3	4		4					1					20	6	6
Naso lituratus		1			3				6					5		1
N. unicornis	20				50											
N. hexacanthus												6				
ZANCLIDAE																
Zanclus cornutus					1	1				5		1	1	3		6
MONOCANTHIDAE																
Pervagor spilosoma				1	1		4		1	1	2				1	2

Table II-6. continued

FAMILY Species STATION DEPTH	Transect I 10'	20'	40'	60'	Transect II 10'	20'	40'	60'	Transect III 10'	20'	40'	60'	Transect IV 10'	20'	40'	60'
BALISTIDAE																
Rhinecanthus rectangulus		10				6	1		1	2	4	4	2	3		
R. aculeatus			1		1											
Sufflamen bursa		4	3	5				3			3	3		1	6	2
S. fraenatus		1					3			1		2				1
Melichthys vidua		2									1	1		3	3	3
M. niger	10			15		2			10	3		3	2	1		6
OSTRACIONTIDAE																
Ostracion meleagris	1	1			4					1				1		1
TETRAODONTIDAE																
Arothron hispidus						2										
A. meleagris							1									1
Canthigaster jactator	4	7	4	7	4	2		1	1	4	6		3	6	3	2
C. coronata				4				1						1		3
DIODONTIDAE																
Diodon holocanthus									1							
TOTAL NUMBER OF SPECIES	27	28	8	27	24	27	6	14	26	26	31	23	18	30	22	42
TOTAL NUMBER OF INDIVIDUALS	357	389	22	510	193	147	15	26	178	247	253	105	154	134	140	2262
OVERALL SPECIES DIVERSITY	1.87	1.70	1.92	2.43	2.00	2.55	1.65	2.43	2.42	2.37	2.54	2.81	1.89	2.89	2.37	0.70

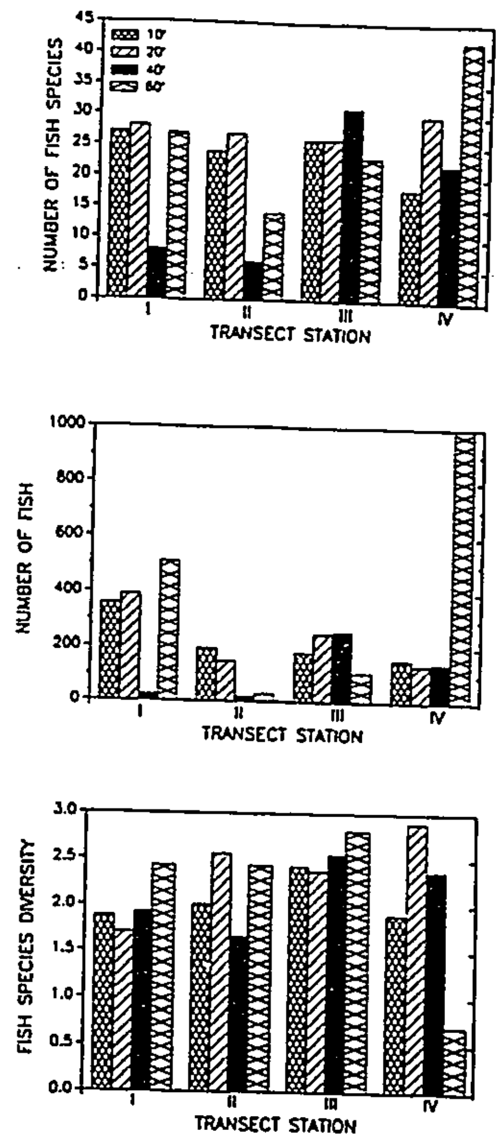


Figure II-3. Reef fish abundance and diversity at Waikiki survey stations. For transect station locations, see Figure II-1.

CONCLUSIONS

The nearshore marine environments off Waikiki are characterized by sand channels and flat limestone platforms. Benthos occupying the regions of solid substrate are subjected to the scouring action of wave-driven sand. As a result, the richest biotic assemblages occur in the areas where vertical structural relief affords protection from the continually shifting sands. Assessment of the marine communities does not indicate that there are impacts from activities on land.

It is probable that at least some of the sand found in the nearshore areas originated on Waikiki beaches during previous beach replenishment projects. It does not appear, however, that there is a quantitative data set describing the biotic structure of the region prior to the initiation of sand replenishment. Without such "baseline" data it is not possible to quantitatively assess the degree of biological change that has already taken place since sand replenishment began at Waikiki.

With regard to future replenishment, it would appear that this activity would not be likely to cause substantial changes relative to the current condition of the reefs. The data from the present assessment reveal that in areas presently subjected to sand scour, biotic composition is severely limited. Thus, it is unlikely that such composition would change even if the proposed sand replenishment results in incrementally more sand movement from the beach through the nearshore region. Similarly, the areas off Waikiki that presently serve as suitable habitats for benthos are so because of vertical relief that mitigates much of the scouring action of sand. Incremental increases in sand movement are not likely to introduce changes that will alter the characteristics of the area in terms of vertical relief.

In summary, it appears that the dominant environmental factor shaping the nearshore benthic and reef fish communities off Waikiki is the movement of sand, much of which originated in large part from prior beach replenishment projects. The proposed sand replenishment is not likely to qualitatively alter these conditions, and hence will probably result in no identifiable changes to biotic structure.

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APPENDIX A

REEF CORAL TRANSECT
DATA SHEETS

APPENDIX A.

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE:	WAIKIKI	MEAN CORAL COVER	14.8 %
TRANSECT ID #:	I-10'	STD. DEV.	15.9
DATE:	09/02/90	SPECIES COUNT	3
		SPECIES DIVERSITY	0.595

SPECIES	QUADRAT										SPECIES
	1	2	3	4	5	6	7	8	9	10	TOTAL
Porites lobata						23.0		2.0			25.0
Pocillopora meandrina	5.0	16.0	12.0	10.0		34.0	5.0	8.0		28.0	118.0
Montipora patula									5.0		5.0
QUADRAT TOTAL	5.0	16.0	12.0	10.0	0.0	57.0	5.0	10.0	5.0	28.0	148.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE:	WAIKIKI	MEAN CORAL COVER	7.4 %
TRANSECT ID #:	I-20'	STD. DEV.	6.9
DATE:	09/02/90	SPECIES COUNT	2
		SPECIES DIVERSITY	0.443

SPECIES	QUADRAT										SPECIES
	1	2	3	4	5	6	7	8	9	10	TOTAL
Porites lobata	3.0		1.0	3.0				3.0	2.0		12.0
Pocillopora meandrina	19.0		12.0	6.0			5.0	5.0	12.0	3.0	62.0
QUADRAT TOTAL	22.0	0.0	13.0	9.0	0.0	0.0	5.0	8.0	14.0	3.0	74.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: I-40'
DATE: 09/02/90

MEAN CORAL COVER 4.4 %
STD. DEV. 4.2
SPECIES COUNT 3
SPECIES DIVERSITY 0.725

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	1.0		2.0	3.0	2.0	4.0	2.0				14.0
Pocillopora meandrina	3.0		8.0		3.0	10.0	2.0	2.0	1.0		29.0
Montipora verrucosa										1.0	1.0
QUADRAT TOTAL	4.0	0.0	10.0	3.0	5.0	14.0	4.0	2.0	1.0	1.0	44.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: I-60
DATE: 09/02/90

MEAN CORAL COVER 9.2 %
STD. DEV. 4.6
SPECIES COUNT 5
SPECIES DIVERSITY 1.020

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	4.0	2.0	12.0	2.0	3.0	2.0	4.0	4.0	3.0	3.0	39.0
Porites brighami	3.0										3.0
Pocillopora meandrina		10.0	4.0	12.0		9.0			4.0	6.0	45.0
Montipora verrucosa	1.0					1.0			1.0		3.0
Leptastra purpurea			2.0								2.0
QUADRAT TOTAL	8.0	12.0	18.0	14.0	3.0	12.0	4.0	4.0	8.0	9.0	92.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: II-20'
DATE: 09/02/90

MEAN CORAL COVER 11.8 %
STD. DEV. 11.7
SPECIES COUNT 2
SPECIES DIVERSITY 0.668

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	2.0	3.0	2.0	12.0	12.0	2.0	33.0	2.0	2.0	2.0	72.0
Pocillopora meandrina	1.0	5.0	4.0	14.0	13.0		3.0	5.0	1.0		46.0
QUADRAT TOTAL	3.0	8.0	6.0	26.0	25.0	2.0	36.0	7.0	3.0	2.0	118.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: II-40'
DATE: 09/02/90

MEAN CORAL COVER 1.8 %
STD. DEV. 3.1
SPECIES COUNT 2
SPECIES DIVERSITY 0.590

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	1.0		5.0	5.0			1.0		1.0		13.0
Pocillopora meandrina				5.0							5.0
QUADRAT TOTAL	1.0	0.0	5.0	10.0	0.0	0.0	1.0	0.0	1.0	0.0	18.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: II-60'
DATE: 09/02/90

MEAN CORAL COVER 2.2 %
STD. DEV. 2.4
SPECIES COUNT 3
SPECIES DIVERSITY 0.708

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	4.0	1.0	1.0	1.0	2.0			2.0	5.0		16.0
Pocillopora meandrina	3.0			1.0	1.0						5.0
Montipora verrucosa	1.0										1.0
QUADRAT TOTAL	8.0	1.0	1.0	2.0	3.0	0.0	0.0	2.0	5.0	0.0	22.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: III-10'
DATE: 09/02/90

MEAN CORAL COVER 10.5 %
STD. DEV. 9.6
SPECIES COUNT 3
SPECIES DIVERSITY 0.774

SPECIES	QUADRAT										SPECIES
	1	2	3	4	5	6	7	8	9	10	TOTAL
Porites lobata	3.0		22.0		1.0		25.0				51.0
Pocillopora meandrina	6.0	8.0	3.0	3.0	8.0	10.0	6.0			8.0	52.0
Montipora verrucosa						2.0					2.0
QUADRAT TOTAL	9.0	8.0	25.0	3.0	9.0	12.0	31.0	0.0	0.0	8.0	105.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: III-40'
DATE: 09/02/90

MEAN CORAL COVER 13.7 %
STD. DEV. 6.0
SPECIES COUNT 5
SPECIES DIVERSITY 0.916

SPECIES	QUADRAT										SPECIES
	1	2	3	4	5	6	7	8	9	10	TOTAL
Porites lobata	12.0	8.0	3.0	8.0	4.0	4.0	3.0	3.0	3.0		48.0
Pocillopora meandrina	6.0	10.0	6.0	3.0	8.0	18.0		6.0	10.0	13.0	80.0
Montipora verrucosa	2.0		1.0			3.0					6.0
Montipora patula		1.0			1.0						2.0
Palythoa tuberculosa									1.0		1.0
QUADRAT TOTAL	20.0	19.0	10.0	11.0	13.0	25.0	3.0	9.0	14.0	13.0	137.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: III-20'
DATE: 09/02/90

MEAN CORAL COVER 24 %
STD. DEV. 19.4
SPECIES COUNT 4
SPECIES DIVERSITY 0.914

SPECIES	QUADRAT										SPECIES
	1	2	3	4	5	6	7	8	9	10	TOTAL
Porites lobata	45.0	14.0	31.0	2.0	3.0	21.0	6.0	2.0	2.0	22.0	148.0
Pocillopora meandrina	14.0	2.0	8.0	5.0		5.0	8.0	9.0	12.0	10.0	73.0
Montipora verrucosa	5.0			3.0							8.0
Montipora patula	8.0		3.0								11.0
QUADRAT TOTAL	72.0	16.0	42.0	10.0	3.0	26.0	14.0	11.0	14.0	32.0	240.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: III-60'
DATE: 09/02/90

MEAN CORAL COVER 3 %
STD. DEV. 3.0
SPECIES COUNT 3
SPECIES DIVERSITY 0.948

SPECIES	QUADRAT										SPECIES
	1	2	3	4	5	6	7	8	9	10	TOTAL
Porites lobata		1.0	7.0	1.0		2.0	1.0		1.0	1.0	14.0
Pocillopora meandrina		5.0	1.0						5.0	2.0	13.0
Montipora verrucosa	1.0	1.0	1.0								3.0
QUADRAT TOTAL	1.0	7.0	9.0	1.0	0.0	2.0	1.0	0.0	6.0	3.0	30.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: IV-10'
DATE: 09/02/90

MEAN CORAL COVER 15.3 %
STD. DEV. 12.0
SPECIES COUNT 6
SPECIES DIVERSITY 1.254

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	2.0	2.0	13.0	3.0	2.0		2.0	4.0	2.0	2.0	32.0
Pocillopora meandrina	18.0		18.0	2.0	12.0	1.0	8.0	2.0	10.0	4.0	75.0
Pocillopora eydouxi	20.0	16.0									36.0
Montipora verrucosa									1.0		1.0
Pavona duerdeni				6.0							6.0
Palythoa tuberculosa	2.0		1.0								3.0
QUADRAT TOTAL	42.0	18.0	32.0	11.0	14.0	1.0	10.0	6.0	13.0	6.0	153.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: IV-20'
DATE: 09/02/90

MEAN CORAL COVER 33 %
STD. DEV. 16.3
SPECIES COUNT 6
SPECIES DIVERSITY 0.707

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	21.0	12.0	21.0	26.0	19.0	38.0	58.0	33.0	24.0	3.0	255.0
Porites compressa		1.0			3.0			2.0			6.0
Pocillopora meandrina	6.0	3.0		14.0	8.0	1.0	13.0	3.0	8.0	4.0	60.0
Montipora verrucosa		1.0								1.0	2.0
Montipora patula					1.0	1.0				3.0	5.0
Palythoa tuberculosa							2.0				2.0
QUADRAT TOTAL	27.0	17.0	21.0	40.0	31.0	40.0	73.0	38.0	32.0	11.0	330.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: IV-40'
DATE: 09/02/90

MEAN CORAL COVER 27.1 %
STD. DEV. 15.6
SPECIES COUNT 3
SPECIES DIVERSITY 0.708

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	26.0	12.0	22.0	6.0	3.0	18.0	24.0	1.0	1.0	37.0	150.0
Pocillopora meandrina	9.0	5.0	16.0	14.0	18.0	9.0	17.0	11.0		21.0	120.0
Montipora verrucosa						1.0					1.0
QUADRAT TOTAL	35.0	17.0	38.0	20.0	21.0	28.0	41.0	12.0	1.0	58.0	271.0

REEF CORAL TRANSECT DATA SHEET
(PERCENT COVER)

TRANSECT SITE: WAIKIKI
TRANSECT ID #: IV-60'
DATE: 09/02/90

MEAN CORAL COVER 9 %
STD. DEV. 4.3
SPECIES COUNT 3
SPECIES DIVERSITY 0.813

SPECIES	QUADRAT 1	2	3	4	5	6	7	8	9	10	SPECIES TOTAL
Porites lobata	1.0	2.0	4.0	4.0	1.0	1.0		3.0	3.0	6.0	25.0
Pocillopora meandrina		6.0	8.0	5.0	8.0	8.0		8.0	8.0	8.0	59.0
Montipora verrucosa		1.0	1.0	1.0			1.0	1.0	1.0		6.0
QUADRAT TOTAL	1.0	9.0	13.0	10.0	9.0	9.0	1.0	12.0	12.0	14.0	90.0

Oceanic Institute
CENTER FOR APPLIED AQUACULTURE

March 3, 1999

RECEIVED
MAR 0 8 1999
EDWARD K. NODA & ASSOCIATES

Ms. Elaine Tamaye
E. K. Noda & Associates, Inc.
615 Piikoi Street, Suite 300
Honolulu, Hawaii 96814-3139

Dear Ms. Tamaye:

Kuhio Beach Improvements

Review comments by the State Division of Aquatic Resources on the Draft Environmental Assessment for the Kuhio Beach Improvement Project raised the issue of the sand channels being potentially important habitat for both infauna (mollusks, crustaceans and other invertebrates) as well as forage and resting habitat for fishes such as juvenile goatfish (weke). Pervious surveys for this project did not focus on the sand habitat, but rather focused on the hard bottom, coral reef habitat. In order to address the concerns raised by the DAR, we conducted a biological and sediment infaunal survey of the sand habitat.

Materials & Methods

Biological surveys were conducted on February 11, 1999, during a period of light winds and calm (1 ft) seas. Fish transects were conducted across the offshore sand channels (Figure 1) by a diver using SCUBA equipment. Observations of fish species, abundance and size were recorded within a 3 m band on each side of the transect line, between the surface and the bottom. Transects, across the total width of each sand channel, were between 96 and 118 m in length.

On Transects 2 and 3 there were rows (0.5 to 1 m wide and up to 10 m long) of loose *Sargassum echinocarpum* covering 10% to 30% of the sand bottom. The loose Sargassum was searched extensively for fish, but none were observed within the Sargassum drifts.

At two stations along each transect, grab samples of bottom sediment were taken, held in 2.5 l plastic containers, and transported back to the laboratory. Sand samples were gently floated through a 1 mm mesh sieve to collect small benthic organisms. The supernatant was also examined for organisms.

Results

Results of the three fish survey transects are presented in the table below.

The fish species seen on Transect 1, *Hyporhampus acutus*, also known as iheihe or acute halfbeak, is a surface-dwelling species, feeding on floating bits of algae, zooplankton and small fish. The only other fish seen over the sand channel but outside the transect area was a small school of 20 akule (*Selar crumenophthalmus*) about 0.17 m in length. Akule rest in schools over sandy areas during the day and feed primarily on zooplankton at night.

Makapuu Point, 41-202 Kalanianaole Highway, Waimanalo, Hawaii 96795•Phone (808)259-7951•Fax (808)259-5971

No large benthic invertebrates were observed on the transects. One solitary burrow (10 mm diameter) was seen, as well as a few worm casts on Transect 2. Only one organism was found in the sand samples.

	Transect 1	Transect 2	Transect 3
Depth (m)	2.1 – 3.0	3.7	3.9
Visibility (m)	7.6	9.1	6.1
Transect Length (m)	118	96	115
Biomass (grams m^{-2})	0.22	0	0
		No Fish	No Fish
Hyporhampus acutus	4 indiv. @ 0.3 m		
	No invertebrates observed	No invertebrates observed	No invertebrates observed

The results of the separation and microscopic analysis of sand samples are presented below. Only one living organism, a post-larval goby, was found in the sand samples.

Sample ID	Total vol. / >1mm frac.vol. (ml)	Live organisms	% mollusk fragments	% coral fragments and sand	% other (crab fragments, urchin spines, worm casing)
Transect 1A	1780 / 20	0	95	4	1<
Transect 1B	1500 / 200	1 (18 mm Gobidae)	30	70	1<
Transect 2A	1850 / 10	0	75	25	1<
Transect 2B	2095 / 20	0	70	30	1<
Transect 3A	1902 / 2	0	80	20	1<
Transect 3B	1410 / 10	0	75	25	1<

Examination of sediment samples collected from six locations along the three transects revealed no evidence of use of the habitat by small infauna. While the sediment samples contained from 30-95% mollusk fragments, no live mollusks of any size were found in the samples. Also absent were small crustaceans and polychaete worms, although fragments of crustacean carapace and worm castings were found in low numbers.

Summary

Our examination of the sand channel habitats off Kuhio Beach which are proposed as the source of sand for beach replenishment revealed the areas to be very barren in terms of infaunal organisms which could serve as food for larger invertebrates or fish. No large benthic invertebrates or bottom-feeding fish were observed in the sand habitats during the surveys. The sand habitat does not appear to support sufficient biological resources to serve as an important feeding area for large invertebrates or fish. While the sand habitat may be used as resting areas by certain species of fish, the removal of some portion of the sand is not expected to impact this use of the habitat. We conclude that the removal of some portion of the sand from these areas will have no significant impact on invertebrate or fish habitat utilization.

If you have any questions, please contact me at our offices.

Sincerely,

David Ziemann/LiC.

David A. Ziemann, Ph.D.

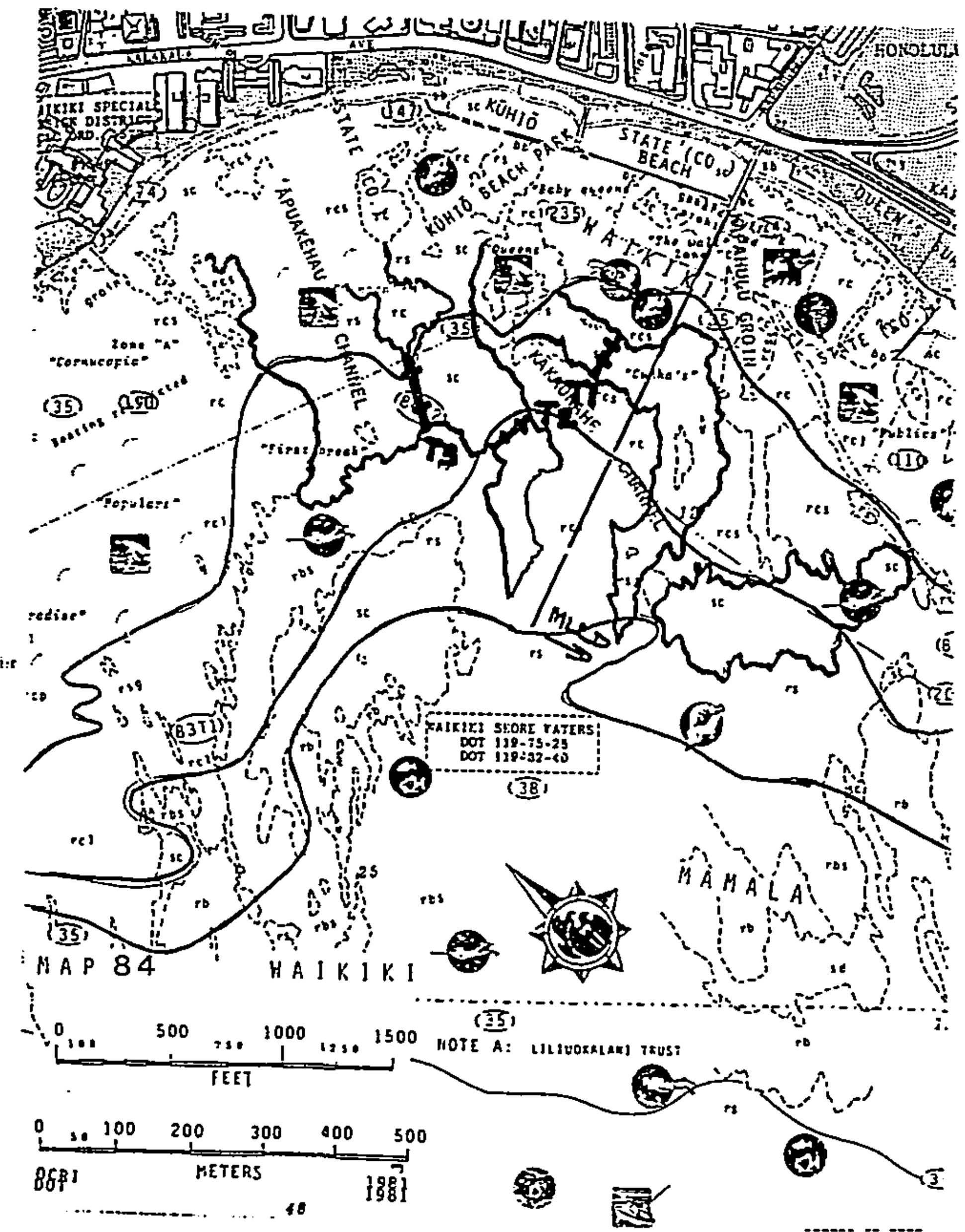


Figure 1. Transect Locations

Appendix D

Kuhio Beach Park Expansion & Kalakaua Avenue Promenade, Final Environmental Assessment

FINAL
ENVIRONMENTAL ASSESSMENT

Kuhio Beach Park Expansion & Kalakaua Avenue Promenade

HONOLULU, OAHU
HAWAII

AUGUST 1998

PREPARED FOR:
City and County of Honolulu
Department of Design and Construction
650 South King Street
Honolulu, Hawaii 96813

PREPARED BY:
R.M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817-4941

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

PROJECT SUMMARY

Project:	Kuhio Beach Park Expansion & Kalakaua Avenue Promenade
Applicant:	City and County of Honolulu, Department of Design and Construction 650 South King Street Honolulu, Hawaii 96813
Agent:	R.M. Towill Corporation Contact: Colette Sakoda (Project Manager) Address: 420 Waiakamilo Road, Suite 411 Honolulu, Hawaii 96817-4941 Telephone: (808) 842-1133
Approving Agency:	City and County of Honolulu Department of Public Works
Tax Map Keys:	TMK : 2-6-01:02, 03, 04, 08, 15, 18 & 19
Location:	2453 Kalakaua Avenue, Honolulu, Hawaii 96815
Owner:	City and County of Honolulu & State of Hawaii TMK : 2-6-01:02, 03, 04, & 18 & Kalakaua Avenue City and County of Honolulu 650 South King Street, Honolulu, Hawaii 96813 Phone: 527-6315 Fax: 523-4767 TMK : 2-6-01:15 State of Hawaii (City and County of Honolulu, DPR)
Total Acreage:	± 5 acres (total)
Land Use:	Urban
Zoning:	Waikiki Special District, Public Precinct
Development Plan Land Use Map:	Park and Recreation
Existing Land Use:	Beach Park and Public Street Right-of-Way

SECTION 1
PROJECT BACKGROUND

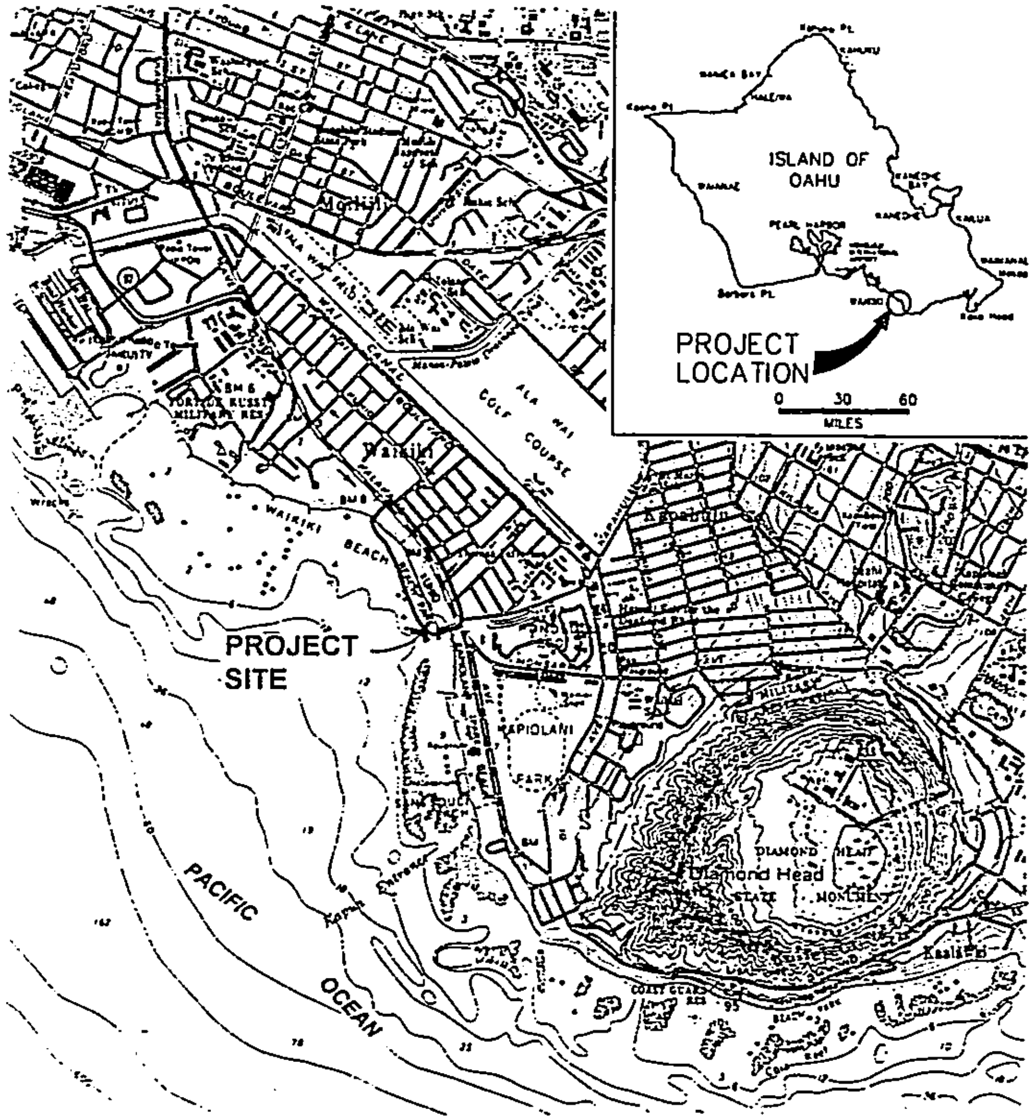
1.1 PROPOSED ACTION

The City and County of Honolulu, Department of Design and Construction (DDC), proposes improvements to Kuhio Beach Park and Kalakaua Avenue, Waikiki, Oahu. The project will involve the facilities improvements for a 3.40-acre beach park and modifications to a portion of Kalakaua Avenue between Kaiulani and Kapahulu Avenues.

The project is located on the southshore of Oahu (Figure 1). The project site is situated within the Waikiki Special District adjacent to a long stretch of sandy shoreline. The purposes of the project are to expand usable beach park areas to the mauka direction, increase green space along Kuhio Beach, and conserve a recreational beach frontage. The entire project site is situated within the special management area (SMA). The DDC will be applying for an SMA Major Use Permit. Due to the proposed use of city and county funds for development, this project is subject to Chapter 343, Hawaii Revised Statutes, pursuant to Chapter 200, Title 11, Hawaii Administrative Rules, as amended. This Environmental Assessment is being prepared to address the environmental impacts anticipated for this project.

1.2 GENERAL DESCRIPTION

Kuhio Beach is situated within the judicial District of Primary Urban Center and identified as Tax Map Keys (TMKs): 2-6-01:02, 03, 04, 08, 15, 18 & 19. This area of Oahu has long been urbanized and is among the highest density resort areas of the State. Kuhio Beach is part of the over one mile long stretch of sandy shoreline, commonly known as Waikiki Beach. Waikiki Beach is the best known and most visited beach in the State, which extends from the Diamond Head end of Fort DeRussy to the Waikiki Aquarium (Figure 2). Approximately seven (7)-million repeat visitors utilized the beach park in 1995 alone.



0 2000 4000 FEET

FIGURE 1
Location Map

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION

AUGUST 1998

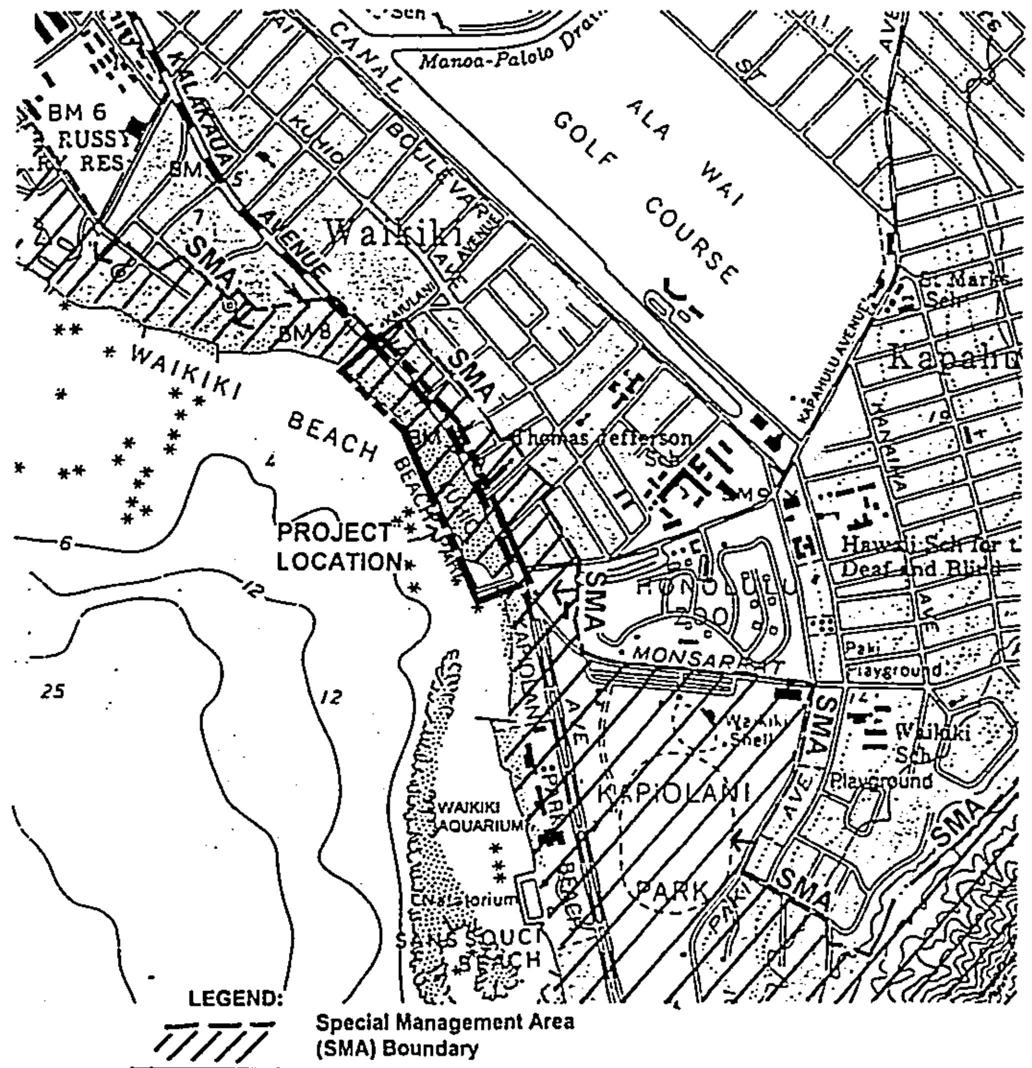


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FIGURE 2
SMA Map

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION

AUGUST 1998

Kalakaua Avenue forms the mauka border of Kuhio Beach Park. The roadway is an asphalt-paved four-lane one-way street, which functions as a major commercial street and provides access to hotels, shops, and other activities. The sidewalks along Kalakaua Avenue are the most heavily used pedestrianway in Waikiki. The mauka side of Kalakaua Avenue is fronted with high-rise hotels, store frontages, and condominiums. Both Kalakaua Avenue and Kuhio Beach Park are under jurisdiction of the City and County of Honolulu. A small portion at the western end of the beach park is owned by the State. However, the City and County of Honolulu, Department of Parks and Recreation (DPR) has been authorized to manage all State and City lands in Waikiki Beach.

Approximately 3.4 acres of Kuhio Beach Park currently contains the following facilities: one (1) comfort station; one (1) food concession; one (1) surfboard concession; (4) beachboy concessions; six (6) outdoor showers; and three (3) lifeguard towers.

1.3 SPECIAL MANAGEMENT AREA (SMA)

The entire project site is located within the special management area (SMA) as designated by City and County of Honolulu Ordinance Section 25-2.2 (see Figure 2). Since the project lies in the SMA and has a total construction cost in excess of $125,000.00, approval of a major SMA use permit is required. Prior to the Department of Land Utilization (DLU)'s acceptance of the SMA Use Permit request, the acceptance of a final Environmental Assessment (EA)/Finding of No Significant Impact (FONSI) is required.

The project site is partially within the forty (40)-foot shoreline setback area. A Shoreline Setback Variance is required to proceed with the proposed improvements at the beach park.

SECTION 2
DESCRIPTION OF PROJECT

2.1 TECHNICAL CHARACTERISTICS

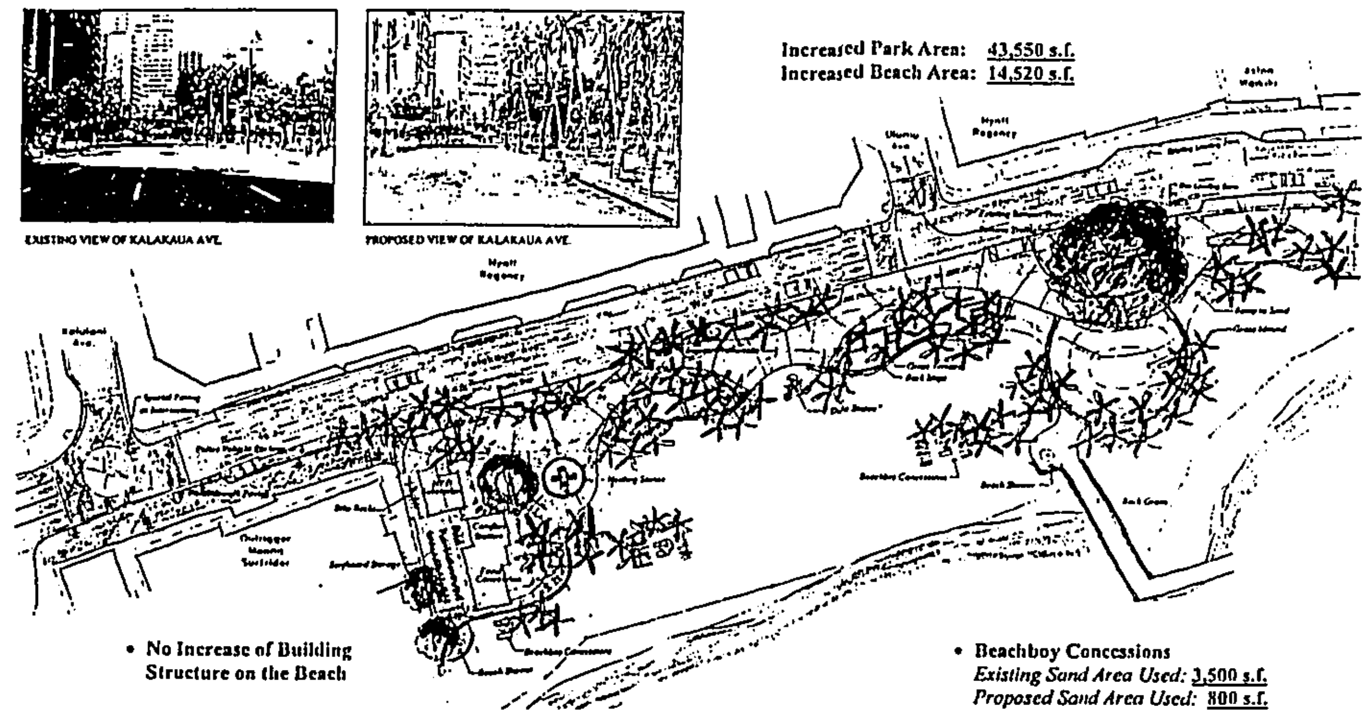
2.1.1 Use Characteristics

Kuhio Beach Park is located makai of Kalakaua Avenue between the Sheraton Moana Hotel and Kapiolani Park (Figure 3). The beach park is separated from mauka development by Kalakaua Avenue which is an asphalt-paved four-lane street. A long strip of sandy beach along Waikiki has been a gateway designation for both visitors and residents of Hawaii. Kuhio Beach Park occupies an area which is among the most crowded in Waikiki. Existing facilities and amenities include a police station, a food concession stand, a surfboard concession, three beachboy concessions, three lifeguard stands, six beach shower areas, outdoor tables, benches, bike racks, a seawall, and six arbors.

The proposed project will expand the landscaped ambiance of Kapiolani Park along Kuhio Beach and Kalakaua Avenue, enhance the mauka pedestrian link to Kuhio Beach, and improve public facilities and services for both visitors and local residents. Kalakaua Avenue would be transformed from a four-lane expanse of asphalt to a three-lane, tree-lined boulevard which accommodates loading bays for service vehicles and a meandering promenade for pedestrians. The proposed improvements will provide the added shade from new trees, as well as new grass and sand beach areas for sitting, relaxing, and enjoying the beach. The project will conserve a recreational beach frontage along the Waikiki shoreline and increase usable beach park areas by expanding the park in the mauka direction. There will be no increase of building structures on the beach. The proposed beach park improvement will comfortably accommodate the existing needs of visitors as well as residents.

2.1.2 Physical Characteristics

The project site includes approximately 3.4 acres of the beach park and Kalakaua Avenue right-of-way (ROW) between Kaiulani and Kapahulu Avenues. Most improvements proposed as a part



NOT TO SCALE

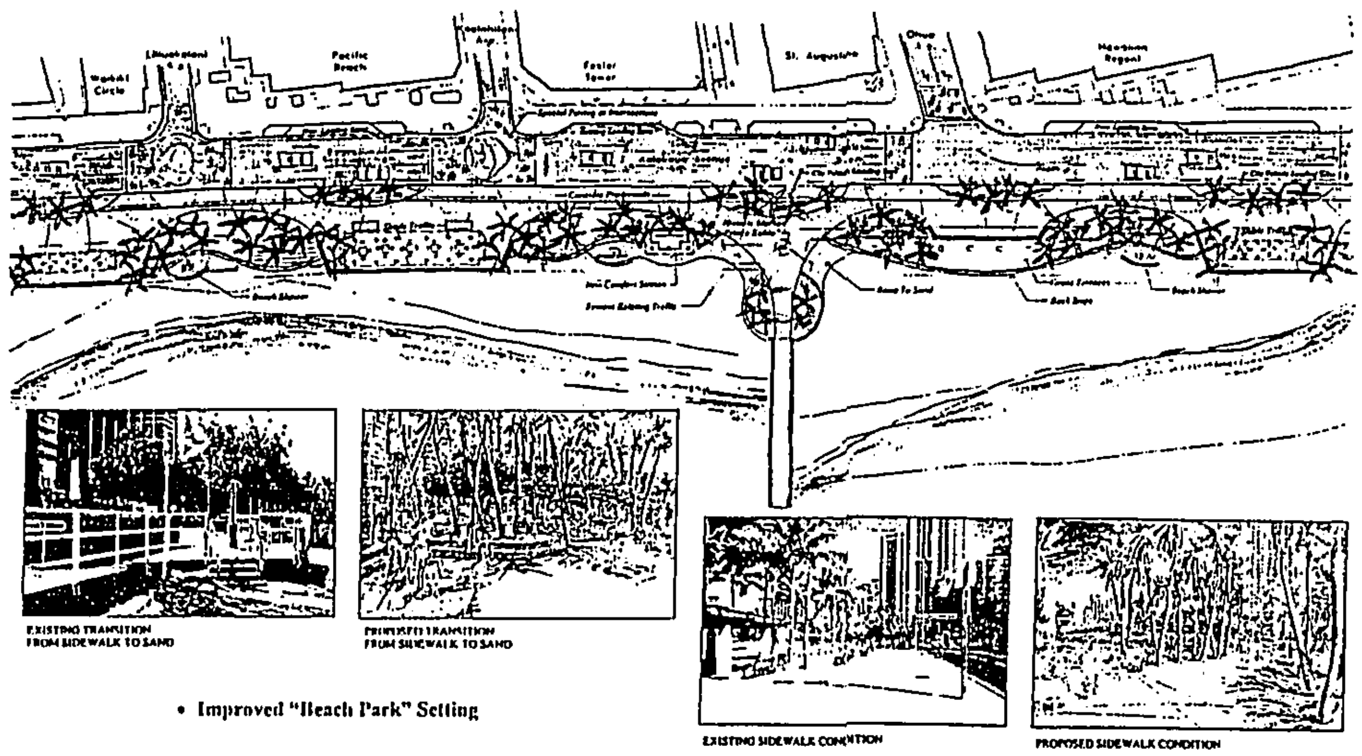
FIGURE 3a

Conceptual Site Plan

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION

AUGUST 1998



NOT TO SCALE

FIGURE 3b

Conceptual Site Plan

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION

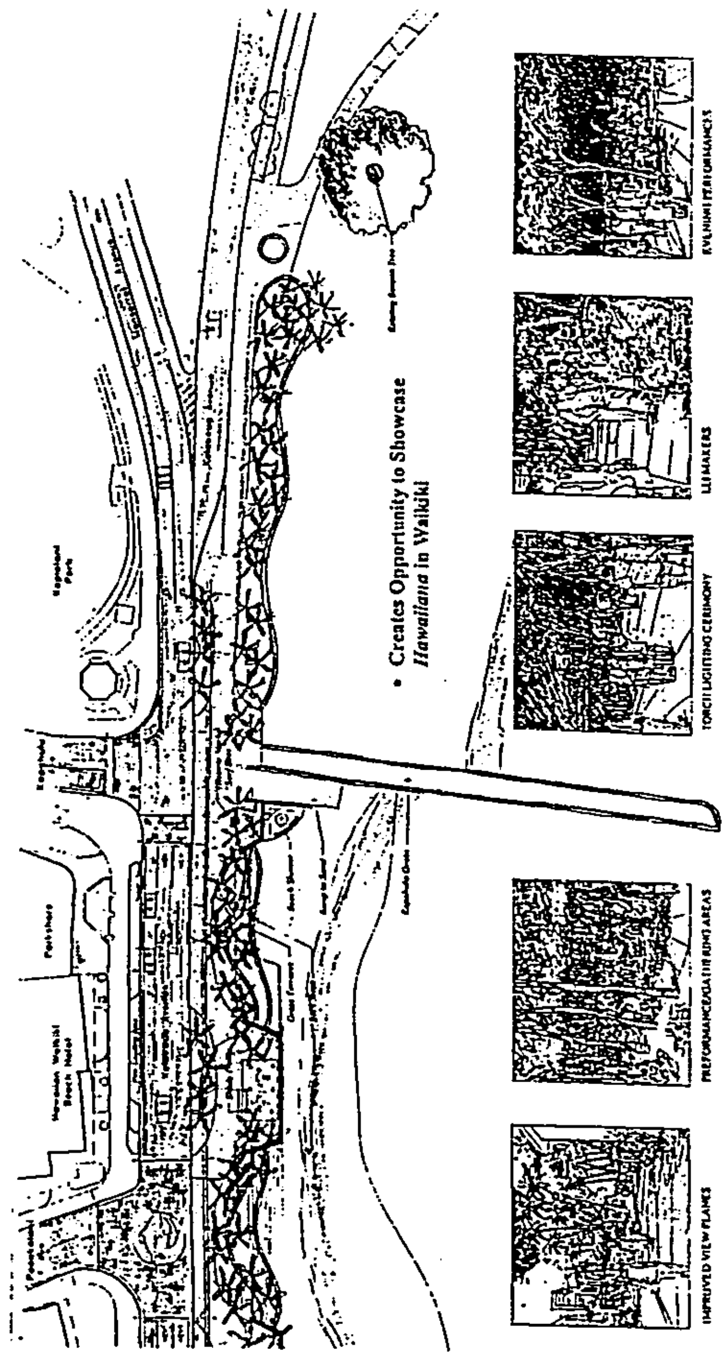


FIGURE 3c
Conceptual Site Plan

NOT TO SCALE

KUHIO BEACH &
KALAKAUA AVENUE
IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION
AUGUST 1998

of this project involve the road ROW and land-side improvements to the public beach.

Kalakaua Avenue will be converted from four (4) lanes to three (3) lanes with makai passenger loading and emergency and service vehicle turnouts (see Figure 3). The loading zone turnouts will be provided at various locations to accommodate loading activities that presently occur in a curbside lane. At least one loading zone will be provided on each block along the mauka side of Kalakaua Avenue between Kaiulani and Kapahulu Avenues. Therefore, adequate service vehicle turnouts for hotels and shops on the mauka side of Kalakaua Avenue will be maintained. While reducing the makai curbside lane, turnout areas for police parking, shuttle bus stop, passenger loading zone, bus loading zone, and city vehicle loading zone, will be provided along the makai side of Kalakaua Avenue. Also, the project will continue to accommodate passage for bicycles along the makai side curb on Kalakaua Avenue. The proposed modifications on Kalakaua Avenue would allow additional space for sidewalk and landscape improvements between the roadway and the beach.

The major improvements proposed at the existing beach park area include the plaza area renewal. The facilities located within the existing plaza area (approximately 3,000 SF) at the western end of the beach park will be demolished and replaced with a new HPD Police Substation, comfort station, food concession, bike racks, surfboard concession, and beach shower (Figure 4). The proposed building structure will be designed to blend with the surroundings through the use of landscape and architectural features, materials, and colors that are similar to the existing design elements. The building style will be similar to the early 1900's territorial style, and consistent with the existing City and County buildings at the Kapiolani Park district. The new facilities at the plaza area will occupy 700 SF less areas than the ones that will be demolished (Table 1). Other improvements include an additional comfort station, a new shed, beachboy concessions, water fountains, and other beach support facilities (Figure 5 & 6). The proposed shed at the makai end of Kapahulu groin is still preliminary and not within the scope of this project period. Two new water features proposed by the project will be similar to the fountain located at the intersection of Ala Wai and Kapahulu Avenues. The proposed locations for the water fountains are by Banyan Tree and the mauka end of Kapahulu groin. However, the locations and designs of the new water fountain are also still preliminary.

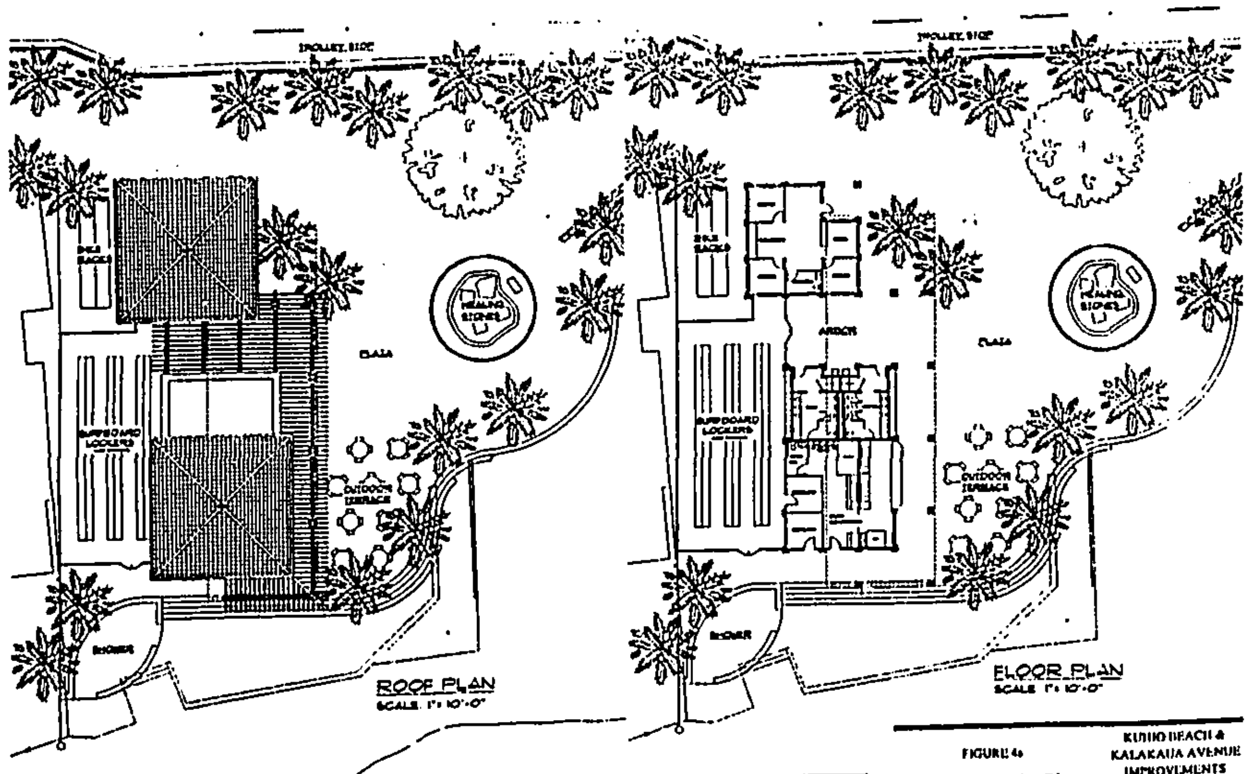


FIGURE 4a

Plaza Area Site Plan

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION

AUGUST 1998

Kuhio Beach & Kalakaua Avenue Improvements

Mayor Jeremy Harris
Office of Waikiki Development

City & County of Honolulu
Department of Public Works

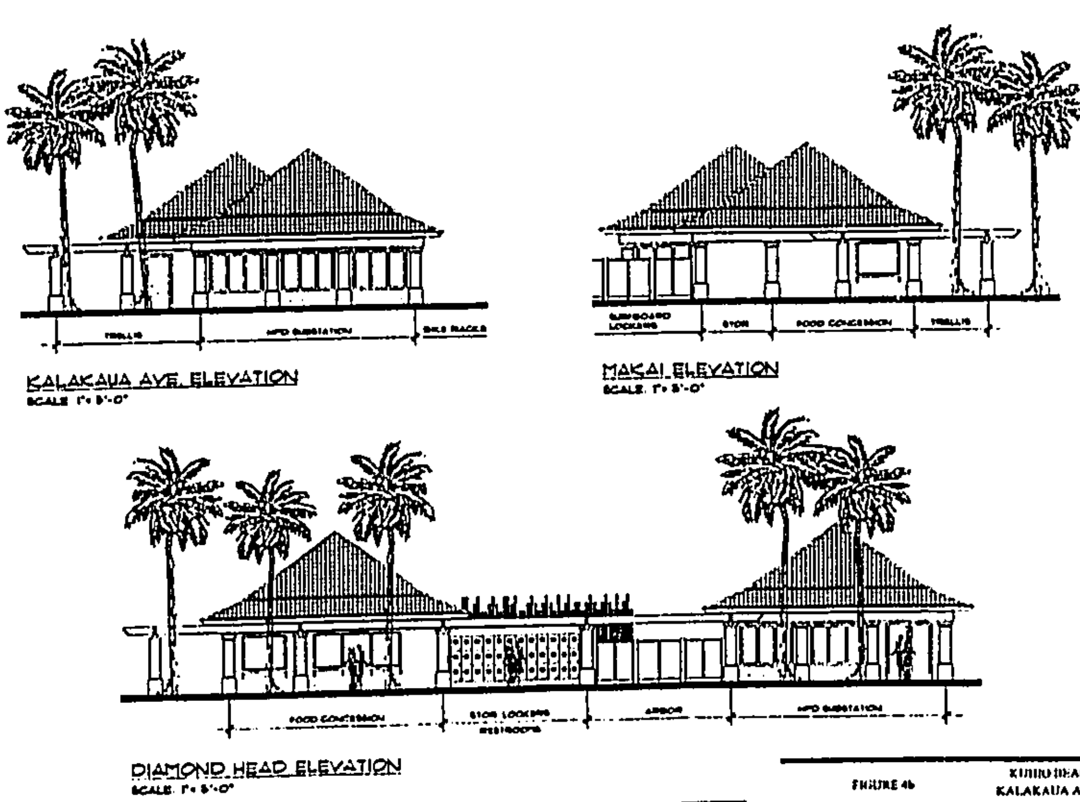


FIGURE 4b

Plaza Area Elevation

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION

AUGUST 1998

Kuhio Beach & Kalakaua Avenue Improvements

Mayor Jeremy Harris
Office of Waikiki Development

City & County of Honolulu
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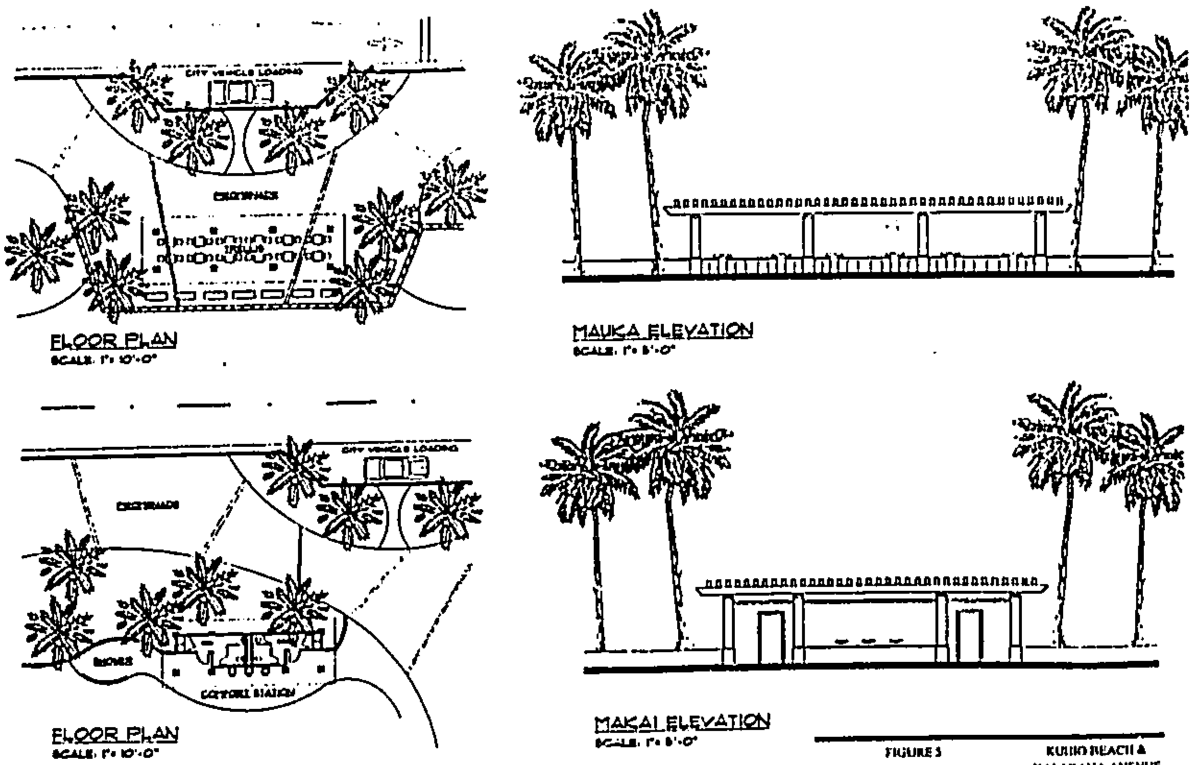
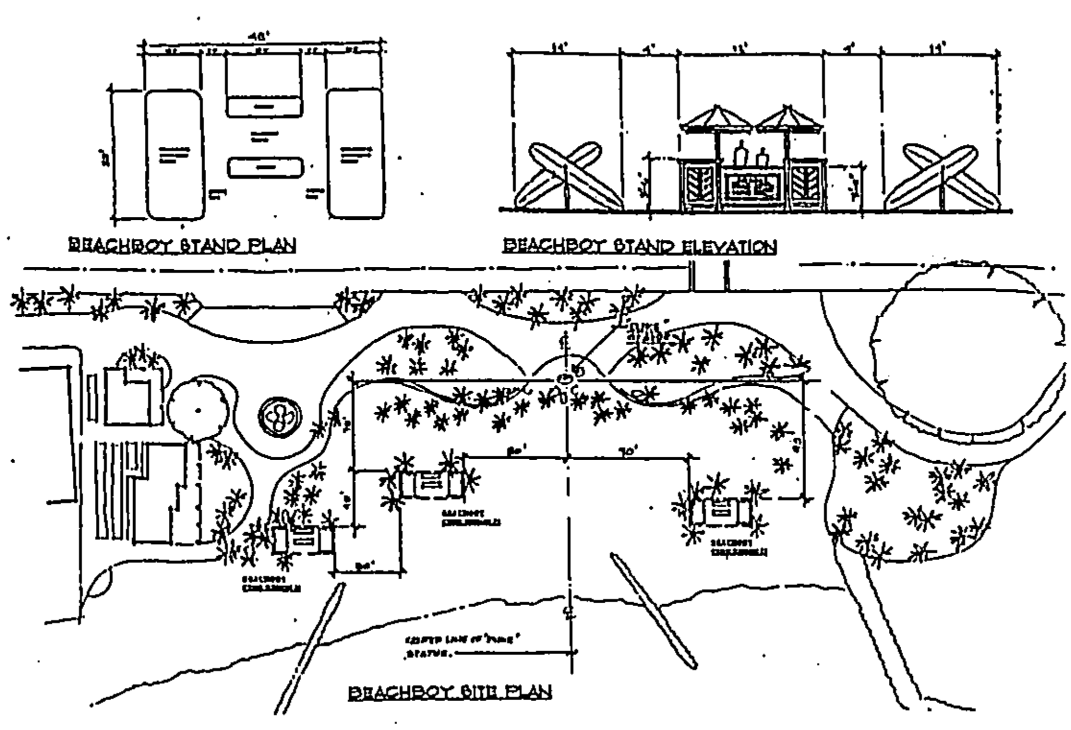


Kuhio Beach & Kalakaua Avenue Improvements
Mayor Jeremy Harris — *Office of Waikiki Development*
City & County of Honolulu — *Department of Public Works*

FIGURE 5
Comfort Station & Arbor
Site Plan & Elevation

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION
AUGUST 1998



Kuhio Beach & Kalakaua Avenue Improvements
Mayor Jeremy Harris — *Office of Waikiki Development*
City & County of Honolulu — *Department of Public Works*

FIGURE 6a
Beachboy Concessions
Site Plan & Elevation

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

R.M. TOWILL CORPORATION
AUGUST 1998

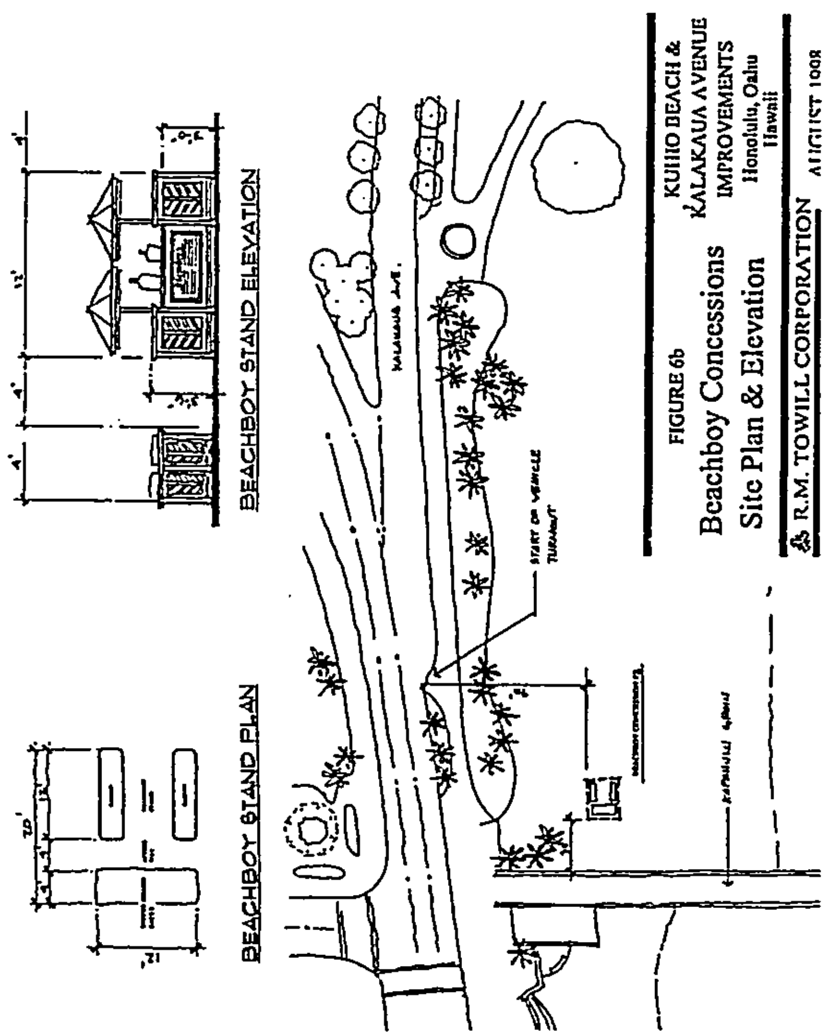


Table 1: Kuhio Beach Redevelopment Floor Area Takeoffs

	Existing	Proposed
Plaza Area		
H.P.D. Substation	625 sq.ft.	800 sq.ft.
Food Concession	1,100 sq.ft.	700 sq.ft.
Restrooms	800 sq.ft	600 sq.ft.
Storage	475 sq.ft.	200 sq.ft.
Total	3,000 sq.ft.	2,300 sq.ft.
Surfboard Lockers	500 sq.ft. (500 boards)	600 sq.ft. (600 boards)
Beachboy Concessions (Sand Area Used)	3,500 sq ft./stand (4 stands)	960 sq.ft./stand (4 stands)
Total	10,500 sq.ft.	1,920 sq.ft.

The existing transition from sidewalk to sand is through concrete terraces and steps. The project will replace them with grassed terraces and rock steps. Increased green space between Kuhio Beach and Kalakaua Avenue will consist of grass mounds, terraces, trees, and planting. The landscaped areas will be designed in a less formal manner to create a relaxed resort atmosphere and promote the connection with other open space areas such as Kapiolani Park. The ocean view along Kuhio Beach will be improved by reducing paved areas and size of structures, moving structures out of sight line, and increasing vegetative covers and sand beach areas. Palm trees will be dominant planting features which create a tropical atmosphere and do not obstruct views.
The proposed project will increase the park area by 43,550 square feet (SF) which include 14,520 SF of beach area. In addition, the proposed project will reduce the sand area used for each beachboy concession from the current 3,500 SF to approximately 960 SF. The total 8,020 SF of the areas that are currently occupied with beachboy concessions will become open sand areas.

2.1.3 Construction Characteristics

Development of the project will require excavation, filling, grading, general construction, and planting and landscaping. Clearing and grubbing will only take place within the areas that have already been paved and heavily developed.

Kalakaua Avenue improvements will involve replacement of asphalt pavement along the makai-end curbside lane between Kaiulani and Kapahulu Avenues. The surface of Kalakaua Avenue ROW will be saw cut to replace it with a pedestrian promenade, planting areas, and loading zone turnouts. The new pedestrian promenade will be enriched concrete to delineate the beach area. The planting areas will be graded to create grass mounds and to plant palm trees. The sections of the makai curbside lane that are currently engaged with loading activities will be designated for new loading zone turnouts.

Construction of the proposed facility improvements will require fencing off the beach park areas in the vicinity of the construction site for safety reasons. Some facilities and businesses will need to be temporarily closed or relocated. The plan for a new shed at the makai end of Kapahulu groin is preliminary, and the construction of the structure is not planned in this phase of the project.

The construction activity will be phased so that not more than the maximum permissible length shall be exposed at any one time. The existing trees and vegetation will be kept undisturbed as much as practicable. During construction, the site will be maintained under safe and clean conditions. Measures will be taken to expedite construction.

The contractor will schedule work activity between the hours of 8:30 a.m. to 3:00 p.m., Monday through Friday, excluding any State holidays. At least two through-lanes will be open while Kalakaua Avenue is worked on. In addition, the contractor shall provide ingress to and egress from driveways and public streets at all times. Should conditions warrant, the contractor may hire personnel to control the flow of traffic around the construction area.

The contractor will perform all applicable construction work in accordance with "the Standard Specifications for Public Works Construction " (September 1994) of the Department of Public Works (DPW), City and County of Honolulu, and the Revised Ordinances of Honolulu (ROH), 1978 as amended.

Additionally, construction and restoration of the existing pedestrian walk shall be performed in accordance with all applicable sections of the "Standard Specifications for Road and Bridge Construction" (1994). All work shall also conform with the "Administrative Rules of Hawaii Governing the Use of Traffic Control Devices at Work Sites on or Adjacent to Public Streets and Highways" and the "Manual of Uniform Traffic Control Devices for Street Maintenance Operation." Further, construction plans shall be submitted for review and approval by the City and County of Honolulu, Department of Transportation Services.

2.1.4 Utilities

a. Water Supply and Sewer System

The Waikiki water system is part of the Honolulu Low Service (180') system. The water service enters Waikiki via McCully Street, Ala Moana Boulevard and Kalakaua Avenue on the west, and Kuhio Avenue on the east. The wastewater system in Waikiki is part of the Sand Island wastewater system. Three pump stations currently serve Waikiki. The project site will be served via the existing water and wastewater lines in Kalakaua Avenue. Any proposed facilities such as showers, water fountains, and comfort stations will not pose significant demands on the existing water and sewer systems.

b. Electrical Power

The power system to the site is serviced by Hawaiian Electric Company (HECO) through ductlines leading from Kalakaua Avenue. The present level of support facilities and services provides adequate services to handle the current demand at the project site. The proposed improvement is not anticipated to place enough of a demand to result in the need to increase the level of current facilities and services. The DDC will coordinate with HECO for electrical needs.

2.1.5 Access

Vehicular access to the project site is primarily along Kalakaua Avenue. Kalakaua Avenue is a four-lane one-way street that carries vehicular traffic in the southeasterly (or Diamond Head) direction. The roadway provides access to hotels, shops, and other activities. The sidewalks along Kalakaua Avenue are heavily used by pedestrians in Waikiki. Most of the intersections on Kalakaua Avenue are signalized. Kapahulu Avenue provides an access to the project area from the mauka direction across Ala Wai Canal. Both Kalakaua and Kapahulu Avenues are city streets and used for minor traffic movements and a pedestrian crossing.

The proposed modification on Kalakaua Avenue is not anticipated to result in any unacceptable traffic conditions during future peak hours (Appendix A). A curbside lane is presently used mostly for loading activities for hotels, shops, and other activities. Loading zone turnouts will be provided at various locations to accommodate such activities.

2.2 ECONOMIC AND SOCIAL CHARACTERISTICS

2.2.1 Project Schedule and Cost

Development of the project will commence upon receipt of necessary permits. The project will be constructed in phases. Overall construction time required is estimated at 6 to 9 months.

The proposed improvements on Kuhio Beach Park and Kalakaua Avenue are not anticipated to have significant effects on the area's economic activities. Cost of full development of the project is estimated at approximately $13.5 million. The expanded beach park and improved facilities will relieve the current overcrowded condition at the beach park and comfortably accommodate both visitors and local residents. The proposed improvements in one of the most popular visitor spots in the State will help promote Waikiki as an international gateway destination, which will improve the quality of the living and recreational environments.

2.3 ENVIRONMENTAL CHARACTERISTICS

2.3.1 Climate and Air Quality

Average temperatures in Waikiki range between 72.8 and 80.3 degrees Fahrenheit during the coolest and warmest months, respectively. The extreme temperatures range from 51 to 95 degrees Fahrenheit. The average annual precipitation of the area is approximately 25 inches of

rain.

The present ambient air quality in the project area is generally considered good due to the prevailing tradewinds and the absence of "heavy" industries. Automobile emissions from traffic passing through Kalakaua Avenue are major sources of air pollution in the area.

Impacts: Except for short-term dust emissions during the construction phase of the project, the proposed improvements will not result in significant adverse impacts on the area's climatic conditions or air quality. The proposed landscape will help keep the sand from drifting onto Kalakaua Avenue.

Equipment that will be used during the construction phase will emit exhaust and airborne particulates, and construction work will also produce dust. Due to the close proximity to existing hotels, visitor destinations, and a thoroughfare along Kalakaua Avenue, appropriate mitigative measures will be employed by the contractor in order to reduce the potential for fugitive dust during construction of beach facilities and modifications on the Kalakaua Avenue ROW. Mitigative measures will include the following:

1. Construction will be phased to minimize the amount of excavation and exposed time of excavated areas.

2. Clearing and excavation will be held to the minimum necessary for site access and equipment.

3. Stockpiles will be covered with appropriate materials. Construction debris and excavated materials that will not be used for construction will be disposed of at permitted facilities.

4. The contractor will ensure proper vehicle maintenance. Construction trucks and equipment used at the site will be kept in good condition at all times.

5. Construction work will be scheduled to avoid peak traffic periods in Waikiki.

Also, normal tradewind patterns should disperse pollutant emissions generated by activities at the project site. Fugitive dust emissions will be reduced by following State DOH Rules and Regulations (Chapter 43, Section 10) which specify the control measures. Construction activities will comply with provisions of Hawaii Administrative Rules (HAR), Chapter 11-60.1, "Air Pollution Control," Section 11-60.1-33 on Fugitive Dust.

2.3.2 Topography and Soils

The project site is situated on a relatively flat coastal strip. The shoreline along Waikiki Beach was originally formed from coral reefs and alluvial sediments. The nearshore marine environment of the southshore Oahu typically consists of shallow limestone reefs, with a gently sloping reef bottoms covered with sand patches.

Waikiki was once covered with extensive wetlands; however, the area has been converted to a filled dryland and in intensive urban use for over 50 years. Waikiki Beach has since been subjected to a severe erosion force. In order to protect the shoreline, sand importation has been performed to artificially nourish several sections of beach frontage. Much of the current Waikiki shoreline consists of imported soils and fill materials. The reef areas were subjected to dredging activities in order to improve swimming conditions and to increase boat access to the shoreline.

The shoreline of the Kuhio Beach Park presently consists of a system of groins and offshore seawalls. Most of the sand within the seawalls was brought in as part of public beach widening projects.

The project site and the vicinity were previously mapped by the U.S. Department of Agriculture Soil Conservation Service as a part of an overall soil survey of the Hawaiian islands. According to the Soil Survey, the majority of the site is covered with beach sand (BS) and jaucas sand (JaC) at the mauka side. Jaucas sand consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean. Permeability is rapid. Runoff is very slow to slow. Workability is described as slightly difficult due to looseness and a lack of stability for supporting heavy equipment.

Impacts: The area has intensively been modified with filling, infrastructure improvements, and major hotel structures built near the water. The project will convert paved areas into grassed open space and planted median. The proposed beach facilities will be built within the areas that have been modified over time.

A majority of the work will be conducted mauka of the beach park. The project will not alter the configuration of the shoreline. During the actual construction phase, soil will temporarily be disturbed. However, upon completion of work, increased vegetative ground cover and landscaping will prevent further soil loss. The proposed project is not anticipated to have significant adverse effects on the current shoreline area.

2.3.3 Hydrology

According to the Flood Insurance Rate Map, the project is located in the area within Zone AE and X (Figure 7). Zone AE indicates "special flood hazard areas inundated by 100-year flood, base flood elevation is determined." The remaining area is within Zone X, which is defined as an "area determined to be outside 500-year flood plain." The Oahu Civil Defense Tsunami Evacuation Map indicates the entire project area is located within potential tsunami inundation areas.

Impacts: The proposed project is not anticipated to have significant adverse effects on the current drainage system of the area. The increased grassed open space and landscaped lands will provide infiltration and buffer zones to reduce surface runoff. The development of the project will be in compliance with the requirements of Federal Flood Insurance Program, the City and County of Honolulu Drainage Standards, Grading Ordinance, and Development Standards for DLU Flood Hazards District.

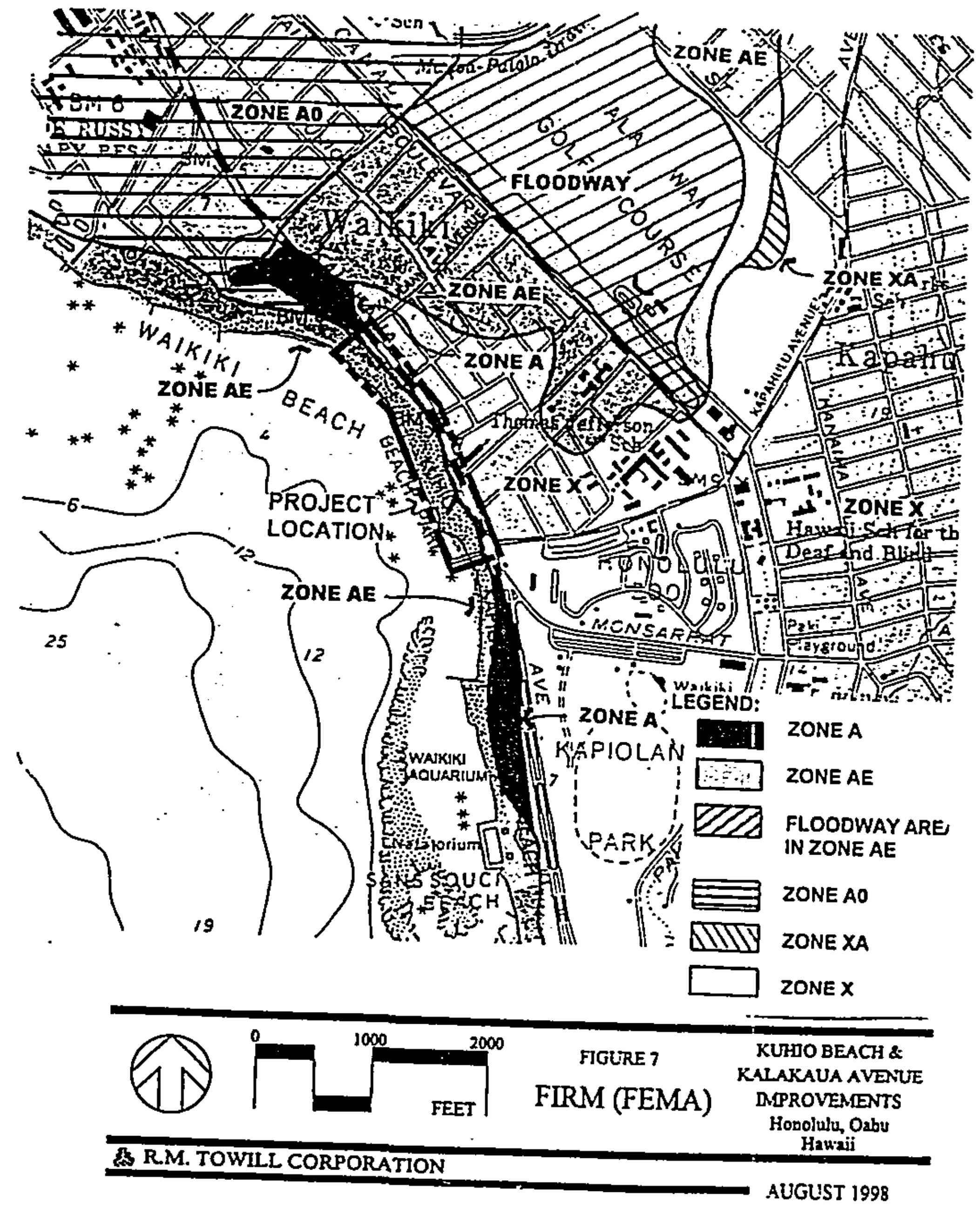


FIGURE 7

FIRM (FEMA)

KUHIO BEACH & KALAKAUA AVENUE IMPROVEMENTS
Honolulu, Oahu
Hawaii

AUGUST 1998

SECTION 3
AFFECTED ENVIRONMENT

3.1 SURROUNDING LAND USES AND LAND USE DESIGNATION

Waikiki is an urban resort area which has been characterized by an active street life, a wide range of entertainment, beach and waterfront amenities, and high-rise development. For over one hundred years, Waikiki has led the visitor industry in Hawaii. In 1995 alone, approximately 7-million repeat visitors utilized a beach park in Waikiki. The project area is now heavily utilized for resort purposes. However, the urbanization of Waikiki is a recent trend. Waikiki was once covered with extensive wetlands which had provided recreational and agricultural opportunities for residents. Conversion of the wetland areas to dryland started in the early 1900's.

The project site is located along approximately half a mile long stretch of public beach which is bordered by Kalakaua Avenue to the north, Moana Hotel to the west, and the Kapahulu Groin and Kapiolani Park to the east. Mauka of Kalakaua Avenue is crowded with a mixture of mid- and high-rise resort development. Kapiolani Park defines the eastern boundary of Waikiki and covers over 160 acres of the land at the foot of Diamond Head Crater. Kapiolani Park provides a range of recreational amenities, including beach facilities, ball fields, tennis courts, jogging trails, picnic and passive park areas, and the Waikiki Shell amphitheater.

The City and County of Honolulu and the State of Hawaii share the ownership of Kuhio Beach Park. The City has been authorized by the State to manage all State land within Kuhio Beach Park. The City Department of Parks and Recreation (DPR) currently regulates all organized and/or commercial activities within the beach park. Existing facilities and amenities include a police station, a food concession stand, a surfboard concession, four beachboy concessions, three lifeguard stands, six beach shower areas, outdoor tables, benches, bike racks, a seawall, and six arbors.

Offshore surf sites are popular with both visitors and local residents throughout the year. Every year during summer months (mid-May to October), Kuhio Beach Park is used as a staging area for local and national surf contests taking place almost every other week. The surrounding beach areas will also accommodate various activities and competitions, including surf events, canoe races, swimming meets, and professional beach volleyball tournaments.

The beach park is zoned within Waikiki Special District and designated as Public Precinct by the City and County of Honolulu. The City and County Development Plan Land Use classification identifies this area as Park and Recreation. The State Land Use classification is Urban. The existing land use is a public beach park.

> Impacts: The proposed project will enhance quality of the beach park by increasing usable green space at the mauka side of the beach park, enhancing visual quality and aesthetics of the area, and improving beach facilities and public access to the beach. While removing one existing traffic lane of Kalakaua Avenue, loading zone turnouts will be provided at various locations to accommodate loading activities which presently occur at the curbside lane.
>
> Some facilities and businesses located near the Kuhio Beach Park may need to be temporarily closed or relocated during the construction. Uninterrupted access to the Kuhio Beach Police Substation will be maintained except during the plaza reconstruction. While the plaza is being reconstructed, an appropriate sign will be posted on site to indicate locations of other substations within the Waikiki area. The substation at the Royal Hawaiian Shopping Center will be in closest proximity to the site, and police service will primarily be on-foot patrols during the time.
>
> Construction operations will temporarily increase traffic on nearby roadways. Traffic control measures will be necessary to mitigate the effects of the increased traffic during the transportation of equipment and material to and from the site. The contractor will be

required to maintain safe access for the public beach and parks. Construction activities will temporarily restrict recreational uses at certain sections of the beach park, and some facilities and businesses will need to be temporarily closed or relocated. Appropriate mitigation measures will be developed to ensure minimal disruption to the surrounding commercial activities and continued recreational uses of the beach park area.

3.2 TERRESTRIAL FLORA AND FAUNA

No known endangered/threatened flora or fauna has been reported to exist on site. Kalakaua Avenue is a concrete-paved four lane street. Kuhio Beach Park is an intensively modified urban beach park. The park is covered with large areas of pavement, landscaping, and sandy beach. Daily mechanical beach cleaning and heavy beach uses prevent vegetation growth except in designated landscaping areas. The existing trees are common non-native species such as coconut palm, false kamani, kou, milo, banyan, and hibiscus. Wild animal life within the Waikiki area consists of mammals commonly found in other areas of Oahu. The fauna in the vicinity of the project site includes mongoose, rats, and feral cats and dogs.

Impacts: The proposed improvement project is not anticipated to have significant effects on the area's flora or fauna resources. No known endangered/threatened flora or fauna has been reported to exist on site. The proposed project will increase grassed and landscaped areas. In addition, only terrestrial fauna species found on sites are those animals considered to be pests. Although the animals near the project site will likely be displaced during construction activities, it will not be considered adverse or significant impacts.

3.3 MARINE FLORA AND FAUNA

As noted earlier, the current development of Waikiki started after the dredging of Ala Wai Canal to drain much of the swamp and estuary areas in the early 1920's. The infilling of wetland areas, dredging of drain channels, and construction of walls along the shoreline to control erosion have significantly altered the shallow marine communities in the waters adjacent to the project site.

The beach sand replenishment program in 1950-51 and in the mid-1960's must also have accelerated the decline of corals on the reef flats adjacent to Waikiki beach. The historical alterations of the shoreline environment have reduced diversity in the benthic and fish communities in the area. Marine species normally found along the nearshore zone include various small fishes, algae, and other marine invertebrate. The intertidal zones of the project area is occasionally subjected to high wave energy which in part helps explain the relatively low diversity of species.

Rare and threatened species which may be found along the area include the protected green sea turtle and, during the winter months, humpback whales. Waikiki is the most heavily urbanized of the Hawaiian Islands, and beaches are crowded with humans which would serve as a deterrent to selection of a suitable undisturbed habitat for marine resources. Humpback whales, another protected species, are also rarely observed offshore of Waikiki.

Marine waters off the Waikiki aquarium and the adjacent area have been designated as a Waikiki Marine Life Conservation District, managed by the State Department of Land and Natural Resources.

Any construction activity that generates fine particulate material will lower light levels and in the extreme, bury benthic communities. Sedimentation has been implicated as a major environmental problem for coral reefs. Increases in turbidity may decrease light level resulting in a lowering of primary productivity. When light levels are sufficiently decreased, hermatypic corals (i.e., the majority of the corals found on coral reefs) will eject their symbiotic unicellular algae (zooxanthallae) on which they depend as source of nutrition. However, in nature corals will eject their zooxanthallae and survive (by later acquiring more zooxanthallae) if the stress is not a chronic (long-term) perturbation.

Impacts: The construction will take place only at the mauka side of the beach park. Therefore, no adverse impacts are anticipated on marine flora or fauna. The potential for impact to the shallow marine communities will be mitigated by appropriate erosion and sedimentation control measures such as silt fences/curtains and sand bags. The small scale and anticipated short duration of the project suggest a minimal impact to the coral reefs. In addition, through the use of silt curtains and/or sand bags at the construction site, adverse effects due to turbidity can be minimized by leaving a barrier of sand in place at the water's edge until completion of the project. Construction stormwater management and erosion control mitigation measures will be required and reviewed by the DDC and the State Department of Health (DOH) prior to the start of construction. Such design measures will be prepared in accordance with State and City rules and regulations.

3.4 WATER QUALITY

Variation in water quality parameters exists throughout the nearshore areas of Waikiki. Water quality is generally influenced by many factors including freshwater discharges from existing outlets, water circulation patterns, and wave activity. The dominant environmental factor shaping the nearshore environment off Waikiki appears to be the movement of sand, much of which originated in part from prior beach nourishment projects. High levels of dissolved nutrients and turbidity have been measured, exceeding the State Water Quality criteria for "dry" open coastal areas.

Impacts: The construction work is limited to the highly modified area at the mauka side of the beach park. The project is not anticipated to have significant effects on the water quality of the area.

3.5 SCENIC AND VISUAL RESOURCES

Waikiki is situated by open ocean, Diamond Head, and Koolau Mountain range, which creates a series of magnificent views. Makai view along Kalakaua Avenue between Kuhio Beach Park and Waikiki Aquarium provides a spectacular ocean view. The view toward Diamond Head from the beach park is one of the most distinguished coastal viewsheds of Oahu.

Impacts: The proposed project is not anticipated to result in significant adverse effects on the area's visual resources. Important viewsheds toward Diamond Head and the Pacific Ocean along Kalakaua Avenue will be maintained. The landscape areas will be designed in a less formal manner to create a relaxed resort atmosphere and to promote the connection with other open space areas such as Kapiolani Park. Palm trees will be dominant planting features because they represent a tropical atmosphere and do not obstruct views.

3.6 NOISE

The overall characteristics of the project vicinity range from high-density urban and residential development to open space environment. The existing ambient noise level in the project area can be characterized as being typical of urban communities. The major contributor to the noise level at the project site is vehicular traffic along Kalakaua Avenue. The other sources of the background noise include crowds, birds, wind, and surf along the shoreline.

Impacts: The proposed improvements to the park and Kalakaua Avenue ROW will not result in a significant increase in the current noise level. The construction activities will temporarily increase noise levels within the vicinity. Noise generated by construction activities will be mitigated to some degree by requiring contractors to adhere to State and local noise regulations. This includes ensuring that machinery is properly muffled and maintained.

3.7 HISTORIC/ARCHAEOLOGICAL RESOURCES

The Duke Kahanamoku statue and the Healing Stones are the only cultural and historic features that currently exist in Waikiki. The shoreline areas along Waikiki Beach have been extensively altered by past development activities. Any subsurface cultural artifacts that may have existed on site have probably been destroyed or replaced during previous developments. It is unlikely to encounter historic remains in the project area.

Impacts: The proposed project is not anticipated to have substantial impacts on cultural resources in the region. The Duke Kahanomoku statue and the Healing Stones will remain as the significant cultural focal points in Waikiki.

Although impacts to archaeological resources are not expected, if any unidentified cultural remains are uncovered during the course of the project, work in the immediate area will cease and the appropriate government agencies will be contacted for further instructions.

3.8 RECREATIONAL FACILITIES

The area is one of the most recognized visitor destinations in the State. A long stretch of sandy beach along Waikiki has been a gateway destination for both visitors and residents of Hawaii. Kuhio Beach is separated from mauka development by an asphalt-paved four-lane street, Kalakaua Avenue. The beach park occupies the area which is among the most crowded in Waikiki Beach. Existing facilities and amenities include a police station, a food concession stand, a surfboard concession, three beachboy concessions, three lifeguard stands, six beach shower areas, outdoor tables, benches, bike racks, a seawall, and six arbors. Kapiolani Park is situated at the eastern boundary of Kuhio Beach Park and covers over 160 acres of the land at the foot of Diamond Head Crater. Kapiolani Park provides a range of recreational amenities, including beach facilities, ball fields, tennis courts, jogging trails, picnic and passive park areas, and the Waikiki Shell amphitheater.

Impacts: The purpose of this project is to expand the landscaped ambiance of Kapiolani Park along Kuhio Beach and Kalakaua Avenue. The proposed improvements will provide the added shade from new trees, as well as new grass and sand areas for sitting, relaxing, and enjoying the beach. There will be no increase of building structures on the beach. The project will conserve a recreational beach frontage along the Waikiki shoreline and increase usable beach park areas by expanding the park in the mauka direction.

Construction activities will temporarily restrict recreational uses at certain sections of the beach park, and some facilities and businesses will need to be temporarily closed or relocated. However, these impacts will be only short-term and small scale. As much as practicable the construction activities will be scheduled to avoid conflict with any business, events, or activities that have been approved to use the beach park. Appropriate mitigation measures will be developed to ensure minimal disruption to the surrounding commercial activities and continued recreational uses of the beach park area. The project contractor will be required to maintain safe, uninterrupted, lateral pedestrian access along Kalakaua Avenue and the beach park.

SECTION 4
MITIGATION MEASURES

4.1 POTENTIAL SHORT-TERM IMPACTS AND MITIGATION

The proposed project is intended to relieve human impacts on Kuhio Beach Park and establish open space linkages between Kuhio Beach Park, Kalakaua Avenue and Kapiolani Park. Kuhio Beach Park is nearly always crowded, and the shoreline is under constant pressure from erosion forces. The proposed improvements will help reduce human impacts on the beach area and comfortably accommodate the existing levels of visitors' and residents' use of Waikiki Beach.

The project will generate short-term adverse impacts due to construction activities. The total construction period is estimated at 6 to 9 months; however, the actual work will be phased in order to minimize the anticipated impacts. The following is a discussion of potential short-term impacts and mitigation measures.

1. Kalakaua Avenue modifications will require blocking and removing surface pavements of the makai curbside lane between Kaiulani and Kapahulu Avenues. In order to avoid traffic congestion, at least two through lanes will be open during the construction period. The existing tour bus loading bay along Kalakaua Avenue between Police Station and the Duke Kahanamoku Statue will be closed. An alternative tour bus loading zone may need to be provided. If the pedestrianway along Kalakaua Avenue should be fenced off, alternative walkways will be designated during construction.

   In addition, the contractor shall provide ingress to and egress from driveways and public streets at all times. Should conditions warrant, the contractor may hire personnel to control the flow of traffic around the construction area.

2. In case the traffic flow should be limited only to two through lanes, traffic would be delayed. It is recommended by the City & County of Honolulu, Police Department

that special duty officers should be posted along the roadway to minimize the anticipated delays.

3. Construction of the proposed facility improvements will also require fencing off certain beach park areas. In order to mitigate these impacts, the project contractor will be required to maintain safe, uninterrupted, lateral pedestrian access along Kalakaua Avenue and the beach park.

3. Clearing and grubbing will disturb soils and cause some soil erosion. Adequate erosion control measures such as silt screens/curtains and/or sand bags will be provided to prevent silt and other undesirable materials from leaving the construction site. Prior to any construction, an Erosion Control Plan must be approved by the City and County of Honolulu. Following construction work, planting will be conducted, as appropriate, to minimize further soil loss.

4. Turbidity and siltation from excavation activities will be minimized and contained to the immediate vicinity of the excavation site through the use of effective silt containment devices and curtailment of work during adverse weather conditions. Excess material not utilized for fill will be disposed of at permitted facilities.

5. No construction materials will be stockpiled in the marine environment.

6. All waste generated from the project will be disposed of in accordance with applicable State and City regulations.

7. All on-site vehicles will be monitored for leaks and receive regular maintenance to reduce the probability of leakage. Petroleum products will be stored in appropriate containers and clearly labeled. Any asphalt substances will be used according to the manufacturer's recommendations.

8. A contingency plan to control petroleum products accidentally spilled during construction should be developed by the contractor. The manufacturers' recommended spill clean up method will be clearly posted and site personnel will be made aware of the information and location of clean up supplies. The contractor will coordinate spill prevention and clean up.

9. Construction operations will temporarily increase noise levels. Noise generated from construction activities will be mitigated to some degree by requiring the contractor to adhere to State of Hawaii DOH regulations and the City and County of Honolulu Noise Ordinance, which limits construction operations and resultant noise to daytime hours and specific maximum levels.

10. Construction activities will temporarily impact the area's air quality in the form of fugitive dust and emissions from construction equipment and vehicles. Fugitive dust emission will be reduced by following State DOH Rules and Regulations (Chapter 43, Section 10) which specifies the control measures. This type of emission will be controlled by frequent watering of the construction site. Another measure is to maintain equipment in proper working order.

4.2 POTENTIAL LONG-TERM IMPACTS AND MITIGATION

The project is not anticipated to result in significant long-term adverse effects. All anticipated adverse impacts are construction-related and only short-term.

The traffic study was conducted to determine potential impacts of the proposed Kalakaua Avenue modifications to traffic operations in the area (Appendix A). The study concluded that the proposed modifications on Kalakaua Avenue would not result in any unacceptable traffic conditions during future peak hours. Kalakaua Avenue is a city street and used for minor traffic movements and frequent pedestrian crossing. The roadway provides access to hotels, shops, and other activities. A curbside lane is presently used mostly for loading activities for hotels, shops, and other activities. Loading zone turnouts will be provided at various locations to accommodate

such activities.

Another traffic study is currently conducted by the City and County of Honolulu, Department of Transportation Services (DTS). One traffic lane along Kalakaua Avenue between Kaiulani and Kapahulu Avenues has been closed during the August of 1998 to conduct a pilot project to assess traffic impacts resulting from the lane reduction of the roadway. The results will be available by the end of September, 1998, upon completion of the Department's study.

The proposed project involves facility improvements along the mauka side of Kuhio Beach Park. The construction of a new comfort station will take place within highly modified areas, outside of the forty (40)-foot shoreline setback areas. The proposed improvements on Kuhio Beach Park and Kalakaua Avenue will allow the beach park to expand in the mauka direction, which will increase usable areas for both positive and passive recreational activities at the beach park and relieve congestion on the existing shoreline.

Planting and landscaping are integral elements of this project. The existing trees will be kept undisturbed as much as practicable. The landscaped areas will be designed in a less formal manner to create a relaxed resort atmosphere and promote a connection with nearby open space areas such as Kapiolani Park. A new comfort station between Kealohilani and Ohua Avenues and other beach facilities will be designed to blend in the surrounding landscape. The proposed improvements will provide the added shade from new trees, as well as new grass and sand areas for sitting, relaxing, and enjoying the beach. The project will enhance the aesthetics and recreational amenities of the area that is most frequently visited by the visitors and residents.

SECTION 5
RELATIONSHIP TO STATE AND COUNTY LAND USE PLANS AND POLICIES

5.1 THE HAWAII STATE PLAN

The Hawaii State Plan, Chapter 226, Hawaii Revised Statutes, serves as a written guide for the future long range development of the State. The Plan identifies statewide goals, objectives, policies, and priorities.

The proposed project would be in conformance with the State Plan's objectives and policies for the economy - visitor industry. According to Section 226-8 objectives and policies for the economy-visitor industry, and Section 226-23 socio-cultural advancement-leisure, the following policies would apply to the proposed project:

Section 226-8: Objectives and policies for the economy-visitor industry
(b)(2) Improve the quality of existing visitor destination areas.

Section 226-23: Objectives and policies for socio-cultural advancement-leisure
(b)(3) Enhance the enjoyment of recreational experiences through safety and security measures, educational opportunities, and improved facility design and maintenance.

5.2 STATE LAND USE LAW

The project site lies within the state land use classification category of "urban". The proposed improvements to the existing park and roadway are permitted under this land use designation.

5.3 STATE FUNCTIONAL PLAN

The Hawaii State Functional Plans (Chapter 226, Hawaii Revised Statutes) provide a management program that allows use of State resources to improve current conditions and attend to various

social issues and trends. The proposed project is consistent with the State Functional Plan for Tourism and Recreation through the following Implementing Action:

TOURISM
OBJECTIVE II.A: Development and maintenance of well-designed visitor facilities and related developments which are sensitive to the environment, sensitive to the neighboring communities and activities, and adequately serviced by infrastructure and support services.

Policy II.A.7: Improve the quality of existing parks and recreational areas, and ensure that sufficient recreational areas--including scenic byways and corridors—are available for the future.

Implementing Action II.A.7.d: Develop plans, landscape and beautify Kapiolani Park, Kuhio Beach Park, Waikiki mini-parks, Ala Wai Boulevard, Ala Wai Canal, Ala Wai Promenade and Ala Moana Park.

RECREATION
OBJECTIVE I.A: Address the problem of saturation of the capacity of beach parks and nearshore waters.

Policy I.A.4: Develop areas mauka of existing beach parks to increase their capacities and to diversify and encourage activities away from the shoreline.

Implementing Action I.A.4.a: Connect beach parks with designated accessways for walking, jogging, bicycling, and hiking to offer diversification of activities away from the shoreline.

5.4 CITY AND COUNTY ZONING

The project site is located in Waikiki Special District and designated as Public Precinct by the City and County of Honolulu. The proposed project would be in conformance with the objectives of

Waikiki Special District, Section 7.80-1 of the LUO:

7.80-1(l) Emphasize a pedestrian-orientation in Waikiki. Acknowledge, enhance and promote the pedestrian experience to benefit both commercial establishments and the community as a whole. The walkway system shall be complemented by adjacent landscaping, open spaces, entryways, inviting uses at the ground level street furniture, and human-scale architectural details. Where appropriate, open spaces should be actively utilized to promote the pedestrian experience.

7.80-1(m) Provide-people oriented, interactive, landscaped open space to offset the high-density urban ambience. Open space are intended to serve a variety of objectives including visual relief, pedestrian orientation, social interaction, and fundamentally to promote a sense of "Hawaiianness" within the district. Open spaces, pedestrian pathway and other ground level features should be generously supplemented with landscaping and water features to enhance their value, constitute to a lush, tropical setting and promote a Hawaiian sense of place.

Development of public precinct lands for public uses and structures, such as this project, is a permitted principal use and would not conflict with the Special District objectives.

The project will require Waikiki Special District permits for construction of new beach facilities such as a comfort station and alteration of streetscape along Kalakaua Avenue right-of-way. The entire project site is located with the 100-foot shoreline setback area. The project will be designed and constructed to meet development standards for Waikiki Special District Public Precinct District as specified in Section 7.80-9 of LUO.

5.5 CITY AND COUNTY GENERAL PLAN & DEVELOPMENT PLAN

The General Plan identifies the long-range planning goals and objectives which the City and County of Honolulu attempts to accomplish in the interest of Oahu residents. The Development Plan Land Use classification identifies this area as Park and Recreation.

The proposed project is in conformance with the General Plan's objectives and policies for Economic Activity as well as Culture and Recreation:

Economic Activity
Objective B: To maintain the viability of Oahu's visitor industry.

Policy 1: Provide for the long term viability of Waikiki as Oahu's primary resort area by giving the area priority in visitor industry related public expenditures.

Policy 2: Provide for a high quality and safe environment for visitors and residents in Waikiki.

Policy 8: Preserve the well-known and widely publicized beauty of Oahu for visitors as well as residents.

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 3: Develop and maintain urban parks, squares, and beautification areas in high density urban places.

Policy 12: Provide for safe and secure use of public parks, beaches, and recreation facilities.

5.6 SPECIAL MANAGEMENT AREA (SMA) RULES AND REGULATIONS

The City and County of Honolulu has designated the shoreline and certain inland areas of Oahu as being within the special management area (SMA) as designated by City and County of Honolulu

Ordinance Section 25-2.2. SMA areas are defined sensitive environments that should be protected in accordance with the State's coastal zone management policies, HRS, Section 205A.

Since the project is located within the SMA boundary and has an estimated construction cost in excess of $125,000.00, approval of a major SMA use permit is required from the Department of Planning and Permitting (DPP) and City Council. This Environmental Assessment is prepared as a supplement to the SMA use permit application.

In addition, the project site is partially located within the forty (40)-foot shoreline setback area. All proposed buildings will be constructed outside of the setback area. Except for the small portions of the trellis at the plaza, new pavilion at the existing Kapahulu Groin, beachboy concessions, and several beach showers, no other structure will be built within the setback area. The small portions of the outdoor terraces at the plaza area and the platform by the Banyan tree arbor will be located within the shoreline setback area. Also, some of the grassed terraces that are proposed to replace the existing concrete ramps and steps will be affected by the setback area.

The project will comfortably accommodate the existing needs for the recreational uses of the area. A Shoreline Setback Variance is required to proceed with the proposed improvements. Compliance with the shoreline setback rules would require that Kuhio Beach Park remain with the existing over-crowded conditions with broad concrete-paved sidewalks. This would continue a hardship for the City and County of Honolulu who would be denied the reasonable use of public lands for the purpose of public enjoyments. Also, the waves and salt waters will eventually deteriorate the existing concrete ramps and steps. This hardship would be a lost opportunity to relieve the existing over-crowded beach park from on-going human impacts, improve beach access, and enhance aesthetics and visual quality of the area, which would fail to improve a recreational amenity in one of the most prominent visitor destinations in the State.

5.7 WAIKIKI MASTER PLAN (1992)

The Waikiki Master Plan, 1992, provides goals and policies to guide the physical developments of Waikiki. The plan was generated through a planning process which integrates inputs from representatives of government agencies, visitor industry organizations, City and State elected representatives, Waikiki property owners, professional associations, and citizen organizations.

The proposed project implements the following urban design goals and polices of the Waikiki Master Plan for Urban Design goals and policies:

Improve beaches and parks on the edges of Waikiki and make them more accessible by foot.

- Widen Waikiki Beaches and parks and add a pathway meeting the Americans with Disabilities Act along the mauka edge of the beach.

Increase open space within Waikiki

- Secure major public open spaces in conjunction with the redevelopment of large, strategically located sites, giving special emphasis to those within Waikiki's core area (between Kalakaua and Kuhio).

SECTION 6
RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

No short-term exploitation of resources resulting from the development of the project site for the beach park improvements and roadside modifications will have long-term adverse consequences. The proposed development will create increased grassed and landscaped lands. The existing beach areas will be restored and expanded in the mauka direction to provide a wide range of recreational opportunities.

Once construction activities for the necessary site preparation are completed there will be no negative effects on air and noise quality, wildlife, or residents of the area.

Long-term gains resulting from the development of the proposed project include provision of a world-class resort destination which accommodates both visitors' and residents' interests to enjoy the beautiful natural resources in Hawaii. The project will enhance the quality of the recreational land which is now heavily urbanized and overcrowded.

SECTION 7
IRREVERSIBLE/IRRETRIEVABLE COMMITMENT OF RESOURCES BY THE PROPOSED ACTION

Development of the proposed project will involve the irretrievable loss of certain environmental and financial resources. However, the costs associated with the use of these resources should be evaluated in light of recurring benefits through increased recreational amenities which are renewable resources.

It is anticipated that the construction of the proposed project will commit the necessary construction materials and human resources (in the form of planning, designing, engineering, construction and labor). Reuse for much of these materials and resources is not practicable, and labor expended for project development is not retrievable.

SECTION 8
DETERMINATION

This Environmental Assessment, prepared to support the SMA Use Permit application pursuant to Chapter 25 ROH - Shoreline Management, has concluded that the potential for impacts associated with the proposed action will be minimal.

The potential effects of the proposed project are evaluated based on the significance criteria in section 11-200-12 (Hawaii Administrative Rules, revised in 1996). The following is a summary of the potential effects of the action.

(1) Involves an irrevocable commitment to loss or destruction of any natural or cultural resource:

The area has intensively been altered for recreational and resort uses. The natural and cultural resources that was originally found on site have been replaced with pavements, artificial beaches, and shoreline protection structures. Also, the costs associated with the use of the existing resources should be evaluated in light of recurring benefits through increased beach park areas, recreational amenities, and aesthetics provided by the proposed improvements.

(2) Curtails the range of beneficial uses of the environment:

The project will not curtail the range of beneficial uses of the environment. The project will increase usable park areas and improve the current park facilities and access to the beach. The proposed improvements on the beach park will comfortably accommodate various needs for both visitors and residents using the park area. Construction activities will temporarily restrict recreational use of the certain beach park areas for public safety reasons, and some facilities and businesses will need to be temporarily closed or relocated.

Appropriate mitigation measures will be developed to ensure minimal disruption to the surrounding commercial activities and continued recreational uses of the beach park area.

(3) Conflicts with the state's long-term environmental policies or goals and guidelines as expressed in chapter 344, HRS:

The project would be in conformance to the Chapter 344, HRS, State Environmental Policy. The project will improve recreational amenities and aesthetics of the Hawaii's most prominent visitor destination, which would benefit both visitors and residents of Hawaii. Increased green space along Kuhio Beach Park will be designed to showcase a sense of place that is uniquely Hawaiian.

(4) Substantially affects the economic or social welfare of the community or State:

The proposed project is not anticipated to have significant effects on the surrounding commercial activities. While reducing the makai curbside lane of Kalakaua Avenue, turnout areas for police parking, shuttle bus stop, bus loading zone, passenger loading zone, and city vehicle loading zone, will be maintained along the makai side of Kalakaua Avenue. At least one loading zone will be provided at each block along the mauka side of Kalakaua Avenue between Kaiulani and Kapahulu Avenues. Therefore, adequate service vehicle turnouts for hotels and shops along Kalakaua Avenue will be maintained.

The project will increase usable park areas, improve supporting facilities, and provide additional landscaping areas, which will benefit both visitors and local residents. The proposed improvements on the one of the most popular visitor destinations of the State would help promote Waikiki as an international gateway destination, which would improve economic environments of the State.

(5) Substantially affects public health:

The proposed project is not anticipated to have substantial effects on public health. The project will relieve the current overcrowded condition on Kuhio Beach Park by increasing usable park area. The proposed facility improvements on the beach would comfortably accommodate the existing level of recreational needs for both visitors and local residents.

(6) Involves substantial secondary impacts, such as population changes or effects on public facilities:

The proposed development would not result in substantial secondary impacts, such as population changes or effects on public facilities. The proposed improvement project is not anticipated to pose significant demands on the existing water and sewer systems. The present level of public facilities and services provides adequate services to handle the current demand at the project site. The improvement is not anticipated to place enough of a demand to result in the need to increase the level of current facilities and services.

(7) Involves a substantial degradation of environmental quality:

The area has intensively been modified by previous developments. The project will improve aesthetics and visual quality of the area by converting a concrete-paved vehicular lane into a landscaped pedestrian promenade and creating additional green space for recreational uses. Therefore, the proposed project is not anticipated to involve a substantial degradation of environmental quality.

(8) Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions:

The project will reduce the areas covered with impervious surface and increase sand and green areas. The proposed improvement is small scale and is not anticipated to result in

cumulative effects; therefore, it would not involve a commitment to larger actions.

(9) Substantially affects a rare, threatened, or endangered species, or its habitat:

The proposed project is not anticipated to have substantial effects on rare, threatened, or endangered species, or their habitats. As discussed in Sections 3.2 and 3.3, no known endangered/threatened flora or fauna has been reported to exist on site. In addition, construction work will take place within the area that has intensively been modified overtime.

(10) Detrimentally affects air or water quality or ambient noise levels:

The proposed project is not anticipated to cause significant effects on the area's long-term air or water quality or ambient noise levels. Construction activities at Kalakaua Avenue would involve excavation, pavement removal, and filling activities to convert a curbside lane into a landscaped promenade. Due to the proximity to the existing resorts, thoroughfare, and beach areas, there are potential impacts from fugitive dusts, increased noise, and soil erosion. Mitigative measures will be provided to minimize the impacts on the surrounding areas as described in Section 4. Upon completion of the work, the project will provide increased green space which buffers the beach park from traffics passing through Kalakaua Avenue.

(11) Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters:

The project is partially situated in a flood-prone plain. The entire area is within potential tsunami inundation areas as indicated by the Oahu Civil Defense Tsunami Evacuation Map. The development of the project will be in conformance with the requirements of

Federal Flood Insurance Program, the City and County of Honolulu Drainage Standards, Grading Ordinance, and Development Standards for DLU Flood Hazards District.

(12) Substantially affects scenic vistas and viewplanes identified in county or states plans or studies:

The proposed project is not anticipated to cause significant adverse effects on the area's visual resources. Important viewsheds toward Diamond Head and the Pacific Ocean along Kalakaua Avenue will be increased by reducing the paved areas and size of the structures and moving the structures out of sight line. The landscape areas will be designed in a less formal manner to create a relaxed resort atmosphere and promote connection with other open space areas such as Kapiolani Park.

(13) Requires substantial energy consumption:

The proposed improvement project is not anticipated to result in substantial energy consumption.

In accordance with the provision set forth in Chapter 343, Hawaii Revised Statutes, this Environmental Assessment has preliminarily determined that the project will not have significant adverse impacts to water quality, air quality, existing utilities, noise, archaeological sites, or wildlife habitat. Therefore, it is recommended that an Environmental Impact Statement (EIS) not be required and a Finding of No Significant Impact (FONSI) be issued for this project.

SECTION 9
NECESSARY PERMITS AND APPROVALS

9.1 CITY AND COUNTY OF HONOLULU

The following City and County Permits are required:

- Building Permit
- Construction Permit
- Grading, Grubbing, Excavating and Stockpiling Permits
- Industrial Wastewater Discharge Permit
- Special District permits
- Special Management Area (SMA) Use Permit
- Shoreline Setback Variances (SSV)
- Street Usage Permit

The following approvals are required by the City and County of Honolulu:

- Flood Determination in General Flood Plain District
- Landscaping Plan
- Board of Water Supply
- Department of Design and Construction, Division of Infrastructure Design and Engineering
- Department of Wastewater Management
- Sewer Connection Application

9.2 STATE

The following permits are required by the State:

- Air Pollution Permit - State Department of Health (Chapter 60)
- NPDES Permit for Construction Related Discharges - State Department of Health (Chapter 55)

The following approvals are required by the State:

- Archaeological Review - State Department of Land and Natural Resources, Historic Preservation Division
- Community Noise Control - State Department of Health (Chapter 43)
- Wastewater Systems - State Department of Health (Chapter 62)
- Commission on Persons With Disabilities

9.3 FEDERAL

No federal permit is required for this project.

9.4 UTILITY COMPANIES

Construction plans will be reviewed by the following utility companies:

- Gasco
- Hawaiian Electric Company
- Hawaiian Telephone Company
- Oceanic Cablevision

SECTION 10
CONSULTED AGENCIES AND PARTICIPANTS IN THE PREPARATION OF THE ENVIRONMENTAL ASSESSMENT

10.1 FEDERAL AGENCIES

U.S. Army Corps of Engineers
U.S. Department of Interior, Fish and Wildlife Service, Pacific Islands Ecoregion

10.2 STATE AGENCIES

Department of Business, Economic Development & Tourism, Office of Planning
Department of Health
Department of Land and Natural Resources, Historic Preservation Division
Department of Land and Natural Resources, Forestry and Wildlife Division
Office of Environmental Quality Control
Office of Hawaiian Affairs

10.3 CITY & COUNTY OF HONOLULU

Board of Education
Board of Water Supply
Department of Budget
Department of Design and Construction
Department of Environmental Services
Department of Parks and Recreation
Department of Planning and Permitting
Department of Transportation Services
Honolulu City Council
Honolulu Fire Department
Honolulu Police Department

10.4 OTHERS

ABC Stores

American Institute of Architects, Honolulu Chapter - Urban Design Committee

Charlie's Taxi

Hawaii Hotel Association

Hawaii Transportation Association

Hilton Hawaiian Village

Hyatt Regency Waikiki

Oahu Visitors Association

Ocean Safety & Lifeguard Services

Outrigger Enterprises, Inc.

Waikiki Area Action Association

Waikiki Improvement Association

Waikiki Neighborhood Board

Waikiki Residents Association

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Appendix A

TRAFFIC STUDY: KALAKAUA AVENUE MODIFICATIONS

Kaiulani Avenue to Kapahulu Avenue

▶ TRAFFIC STUDY

KALAKAUA AVENUE MODIFICATIONS

Kaiulani Avenue to Kapahulu Avenue

▶ HONOLULU, HAWAII

▸ prepared for:

City and County of Honolulu
Department of Public Works

▸ prepared by:

Julian Ng, Incorporated
P. O. Box 816
Kaneohe, Hawaii 96744

▸ January, 1998

Table of Contents

Traffic Study
Kalakaua Avenue Modifications
Kaiulani Avenue to Kapahulu Avenue

January, 1998

The City and County of Honolulu Department of Public Works has proposed improvements to Kuhio Beach, in Waikiki; as part of these improvements to expand the beach area, modifications to a portion of Kalakaua Avenue between Kaiulani Avenue and Kapahulu Avenue has been proposed. A traffic study was conducted to determine if these modifications would have any impacts to traffic operations in the area.

The proposed project is located along Kalakaua Avenue in Waikiki, between Kaiulani Avenue and Kapahulu Avenue (Exhibit 1). The traffic impact of the project would result from the proposed modification, which would close of one of the existing lanes on Kalakaua Avenue; the lane closure would permit additional space for landscaping improvements between the roadway and the beach.

Existing Traffic Conditions - Waikiki

All of the public roadways in Waikiki with the exception of Ala Moana Boulevard are City streets. Ala Moana Boulevard is a divided highway, with a typical section of six lanes. Ala Moana Boulevard is the major makai arterial east of downtown Honolulu. West of Kalakaua Avenue, Ala Moana Boulevard has two signalized intersections which are operated in six phases, at Kalia and Ena Roads and at Hobron Lane.

Of the City streets, Kalakaua Avenue is the main street through Waikiki, carrying vehicular traffic in the southeasterly (or diamondhead) direction. The street is a major commercial street and provides access to hotels, shopping centers, smaller shops, and other activities. The sidewalks along Kalakaua Avenue are the major pedestrianway in Waikiki.

Traffic entering Waikiki on Kalakaua Avenue across the Ala Wai Canal travels on an undivided street; between Ala Wai Boulevard and Ena Road, two diamondhead bound lanes are located makai of a landscaped median, and one diamondhead bound lane and two ewa bound lanes are located mauka of the median. Between McCully Street and Kuhio Avenue, Kalakaua Avenue has four lanes in the diamond head direction and a single lane for City buses in the ewa direction. Between Kuhio Avenue and Kapahulu Avenue, Kalakaua Avenue has four lanes traveling toward Diamond Head, with additional width at selected locations for loading zone turnouts.

Most of the intersections on Kalakaua Avenue are signalized. Operation is typically two-phase, with one phase for traffic on Kalakaua Avenue and one phase for the cross street. Pedestrian crossings generally occur with the parallel vehicular movement. A "Barnes Walk" crossing is used at several intersections: one phase is provided for the vehicular traffic on

Kalakaua Avenue and the other is used for minor traffic movements and the pedestrian crossing, which can be made in any direction, including diagonally across the intersection.

The State Highways Division has a traffic counting program which includes stations along Ala Moana Boulevard. The City and County of Honolulu Department of Transportation Services collects and maintains traffic count data for streets under City jurisdiction; many traffic counts have been taken within Waikiki between 1993 and 1996. Table 1 shows a portion of the traffic data available for streets within Waikiki. A review of the recent counts indicates that traffic volumes have not changed significantly over the past four years.

Table 1
TRAFFIC COUNT DATA

	24-hour Total	AM Peak Hour	PM Peak Hour
Ala Moana Boulevard at Ala Wai Bridge			
northwestbound (April 1996)	26,144	1,601	2,052
southeastbound (April 1996)	26,960	1,339	2,117
Ala Moana Boulevard (March 1996)			
westbound west of Kalakaua Avenue	15,592	1,116	990
eastbound approaching Kalakaua Avenue	19,768	1,023	1,257
Ala Wai Boulevard (westbound)			
approaching Paoakalani Avenue (July 1995)	20,525	1,704	1,390
approaching Lewers Street (July 1994)	30,063	2,026	2,061
approaching Kuamoo Street (July 1995)	41,648	2,357	2,805
approaching McCully Street (July 1995)	38,018	1,941	2,482
approaching Kalakaua Avenue ((July 1994)	20,762	1,339	1,311
Kalakaua Avenue (northwestbound) at Ala Wai Bridge (April 1996)	22,895	1,597	1,574
Kalakaua Avenue (southeastbound)			
at Ala Wai Bridge (April 1996)	26,340	1,396	1,852
approaching Ena Road (July 1995)	25,637	1,290	2,005
approaching Saratoga Road (August 1994)	36,688	2,142	2,489
approaching Lewers Street (July 1993)	33,621	1,746	2,289
approaching Seaside Avenue (July 1993)	33,009	1,656	2,262
approaching Kaiulani Avenue (May 1996)	27,574	1,357	1,938
approaching Uluniu Avenue (August 1995)	19,936	828	1,622
approaching Liliuokalani Avenue (August 1994)	23,928	1,181	1,756
approaching Paoakalani Avenue (August 1995)	21,957	1,015	1,742
approaching Kapahulu Avenue (September 1994)	14,284	620	1,193
southeast of Monsarrat Avenue (August 1995)	8,258	339	636

Sources: State Department of Transportation, Highway Planning Branch; City and County of Honolulu Department of Transportation Services

Traffic data are also available at other locations, including most mauka-makai streets. The traffic data were reviewed and estimates were made of the daily traffic and peak hour in Waikiki, as illustrated in Exhibits 2 and 3.

Project Description

The proposed project provides additional sidewalk widths along Kalakaua Avenue between Kaiulani Avenue and Kapahulu Avenue. While one existing traffic lane is removed, loading turnouts are proposed at various locations to accommodate loading activities which presently occur in a curbside lane.

Exhibit 4 is a schematic showing the existing number of lanes on Kalakaua Avenue and the side streets within the project area. Kalakaua Avenue is a four-lane roadway with additional width provided for loading at three locations: makai side near the police substation between Kaiulani Avenue and Uluniu Avenue, and mauka side before and after Liliuokalani Avenue.

At the Kaiulani Avenue and Kapahulu Avenue approaches, the mauka lane is designated for left turns only. At the other intersections where mauka bound traffic is permitted on the side street, the mauka lane is an option lane used by through as well as left turning traffic. Three lanes continue beyond Kapahulu Avenue: the makai lane leads to the makai side of the divided Kalakaua Avenue within Kapiolani Park, while the other two lanes direct traffic onto Monsarrat Avenue.

At the intersections with Uluniu Avenue, Ohua Avenue, and Kapahulu Avenue, where there is significant makai bound traffic turning left onto Kalakaua Avenue, traffic signals stop the Kalakaua Avenue traffic for the side street traffic and the pedestrian crossing of Kalakaua Avenue; pedestrian crossing of the side street occurs in the phase in which Kalakaua Avenue traffic moves. At the other intersections, "Barnes Walk" phasing is used, in which traffic on Kalakaua Avenue is stopped to permit pedestrian crossing in any direction; no pedestrian crossing is permitted when traffic on Kalakaua Avenue has the green light.

Exhibit 5 illustrates the proposed modifications to Kalakaua Avenue. Between Kaiulani Avenue and Uluniu Avenue, the sidewalk will be widened into the mauka lane. The loading zone on the makai side that is presently used by police vehicles and for concessionaire loading would remain; however, its length may be shortened if the police substation is relocated. The reduction of one lane would not affect traffic on Kalakaua Avenue approaching Kaiulani Avenue since the mauka approach lane is already designated for left turns only.

The sidewalk widening on the mauka side continues across Uluniu Avenue; the existing curve in Kalakaua Avenue provides for a smooth transition of the traffic lanes as the sidewalk widening transitions from the mauka side to the makai side. The existing loading zone on the mauka side will be relocated to conform to the new curbline; a new loading turnout is proposed on the makai side. Between Liliuokalani Avenue and Kapahulu Avenue, the sidewalk widening will be on the makai side; the mauka curb would remain in its existing location. A new loading turnout is proposed between Ohua Avenue and Paoakalani Avenue. The through lanes approaching the Kapahulu Avenue intersection would lead into Monsarrat Avenue; the lane leading to Kalakaua Avenue through Kapiolani Park is introduced as an added lane on the right on the far side of the Kapahulu Avenue intersection.

Traffic Analyses

The traffic count data included counts taken at various times of the year; counts taken during the summer were higher than during other months. However, there was sufficient data to derive estimates of existing peak hour traffic for a peak weekday during the summer. The morning peak hour (AM Peak Hour), which typically occurs between 8:00 and 9:00 AM, generally has less traffic than the afternoon peak hour (PM Peak Hour), which occurs around 4:30 to 5:30 PM. Exhibit 6 shows the existing peak hour volumes in the vicinity of the proposed project.

Traffic conditions are usually described by a "Level of Service" ranging from "A" (good) to "F" (poor). These Levels of Service are related to average delays experienced by motorists. Several complex analytical methods are available to determine these delays; however, the results would apply to the specific conditions used in the analysis. An simpler alternative method relates Levels of Service to capacities, using the ratio of volume to capacity (v/c ratio); in this method, Levels of Service are estimated as follows:

Level of Service A (little or no delay)	$v/c \leq 0.60$
Level of Service B (minor traffic delays)	$0.60 < v/c \leq 0.70$
Level of Service C (average traffic delays)	$0.70 < v/c \leq 0.80$
Level of Service D (long traffic delays)	$0.80 < v/c \leq 0.90$
Level of Service E (very long delays)	$0.90 < v/c \leq 1.00$
Level of Service F (congested, over capacity)	$v/c > 1.00$

The capacity of an urban street is controlled by the traffic which can be served by signalized intersections. A simplified analysis procedure, in which the capacity is the product of the number of lanes, the saturation flow (defined below), and the green/cycle ratio (also defined below), was used.

The saturation flow is the number of vehicles per hour that can flow in one lane, assuming that the flow is continuous (has a green light 100% of the time). The saturation flow under ideal conditions is 1,900 passenger cars per hour of green per lane; trucks and other large vehicles, as well as pedestrian conflicts, grades, curbside parking, transit bus stops, and lane widths will each reduce the saturation flow.

For Kalakaua Avenue within the study area, saturation flows of 1,400 vehicles per hour of green per lane were used for through lanes (minimal pedestrian conflicts). A

saturation flow rate of 1,000 vehicles per hour of green was used where there are pedestrian conflicts (such as the left turn lane at Kapahulu Avenue, in which left turns yield to the parallel pedestrian crossing). On the side streets turning onto Kalakaua Avenue and where pedestrian conflicts exist because of pedestrians' disregard of the signal, saturation flows of 1,200 vehicles per hour of green per lane were used.

The green/cycle ratio accounts for the traffic signal timing. Traffic signals reduce the capacity for each movement, since part of the total time is assigned to other movements. The typical cycle length for the signals along Kalakaua Avenue is 80 seconds, with the minor movement being timed for the pedestrian crossing of Kalakaua Avenue. For "Barnes Walk" crossings, a minor street green phase of 26 seconds is needed; 21 seconds would be required at the other intersections. The capacities and volume/capacity (v/c) ratios for each approach were computed and Levels of Service were determined.

Tables 2 and 3 summarize the findings of the capacity analyses for existing traffic and existing laneage on Kalakaua Avenue. As indicated in Tables 2 and 3, acceptable conditions (Level of Service D or better) are present at all intersections except the Kalakaua Avenue left turn lane to Kaiulani Avenue in the PM Peak Hour. Field observations confirm the analyses; at most intersections, the right lane on Kalakaua Avenue carried minimal traffic.

Table 2
EXISTING TRAFFIC CONDITIONS
AM Peak Hour

	Existing Volume	# of lanes	Saturation Flow	g/C ratio	v/c ratio	LOS
Kalakaua Avenue						
Through lanes at Uluniu Avenue	1,060	4	1,400	0.64	0.30	A
Approach to Liliuokalani Avenue	1,290	4	1,350	0.58	0.42	A
Approach to Kealohilani Avenue	1,070	4	1,300	0.58	0.36	A
Approach to Ohua Avenue	1,060	4	1,400	0.64	0.30	A
Approach to Paoakalani Avenue	1,270	4	1,350	0.58	0.41	A
Left turn lane at Kapahulu Avenue	410	1	1,000	0.64	0.64	B
Through lanes at Kapahulu Avenue	530	3	1,400	0.64	0.20	A
Side street approaches						
Uluniu Avenue left turns	230	2	1,200	0.26	0.37	A
Kealohilani Avenue left turn	10	1	1,000	0.32	0.03	A
Ohua Avenue left turns	210	2	1,200	0.26	0.34	A
Kapahulu Avenue left turns	250	1	1,200	0.26	0.80	D

Table 3
EXISTING TRAFFIC CONDITIONS
PM Peak Hour

	Existing Volume	# of lanes	Saturation Flow	g/C ratio	v/c ratio	LOS
Kalakaua Avenue						
Through lanes at Uluniu Avenue	1,650	4	1,400	0.64	0.46	A
Approach to Liliuokalani Avenue	1,850	4	1,350	0.64	0.60	A
Approach to Kealohilani Avenue	1,600	4	1,300	0.58	0.54	A
Approach to Ohua Avenue	1,580	4	1,400	0.64	0.44	A
Approach to Paoakalani Avenue	1,790	4	1,350	0.58	0.57	A
Left turn lane at Kapahulu Avenue	410	1	1,000	0.64	0.64	B
Through lanes at Kapahulu Avenue	970	3	1,400	0.64	0.36	A
Side street approaches						
Uluniu Avenue left turns	200	2	1,200	0.26	0.32	A
Kealohilani Avenue left turn	30	1	1,000	0.32	0.09	A
Ohua Avenue left turns	210	2	1,200	0.26	0.34	A
Kapahulu Avenue left turns	270	1	1,200	0.26	0.87	D

The capacity analyses were redone for future conditions to evaluate the effects of the proposed lane closures to the roadway. Because peak hour traffic volumes in Waikiki have not increased in recent history, future traffic volumes are expected to be similar to the existing volumes.

With the proposed lane closure, the timing of traffic signals within the project area could be adjusted to permit slightly more green time for Kalakaua Avenue, since the shorter distance for pedestrians crossing Kalakaua Avenue would require less green time for the secondary phase. A decrease in width of one lane (11 feet) could be accompanied by an increase in g/C ratio for Kalakaua Avenue of 0.04 at intersections where the minor street volumes are adequately handled. The capacity analyses were repeated for the future condition with the proposed street modifications. The results, shown in Tables 4 and 5, indicate that the proposed lane closure will not cause any unacceptable traffic conditions during future peak hours.

Other measures to increase vehicular capacities which should be considered include the reduction of pedestrian interference with traffic during the signal phases in which traffic is permitted to move. The relocation of the pedestrian signals (WALK/DON'T WALK) for the crossings parallel to Kalakaua Avenue away from the curb to a location over the sidewalk would increase the visibility of the signal for pedestrians, reduce confusion on the part of pedestrians, and increase safety and vehicular capacities by reducing vehicle/pedestrian conflicts. The mauka edge of the crosswalks where "Barnes Walk" is used should be brought closer to the curb, since the width of the crosswalk is not critical as pedestrians would be able to enter Kalakaua Avenue in crossing the side streets. The narrowed crossing would also

alert pedestrians that a special crossing is used at that intersection. If these measures are successful in reducing conflicts between vehicles and pedestrians, higher saturation flows for lanes in which left turns are permitted could be expected; lower v/c ratios and improved levels of service may result.

Table 4
FUTURE TRAFFIC CONDITIONS
AM Peak Hour

	Existing Volume	# of lanes	Saturation Flow	g/C ratio	v/c ratio	LOS
Kalakaua Avenue						
Through lanes at Uluniu Avenue	1,060	3	1,400	0.68	0.37	A
Approach to Liliuokalani Avenue	1,290	3	1,330	0.62	0.52	A
Approach to Kealohilani Avenue	1,070	3	1,270	0.62	0.45	A
Approach to Ohua Avenue	1,060	3	1,400	0.68	0.37	A
Approach to Paoakalani Avenue	1,270	3	1,330	0.62	0.51	A
Left turn lane at Kapahulu Avenue	410	1	1,000	0.64	0.64	B
Through lanes at Kapahulu Avenue	530	2	1,400	0.64	0.30	A
Side street approaches						
Uluniu Avenue left turns	230	2	1,200	0.22	0.44	A
Kealohilani Avenue left turn	10	1	1,000	0.28	0.04	A
Ohua Avenue left turns	210	2	1,200	0.22	0.40	A
Kapahulu Avenue left turns	250	1	1,200	0.26	0.80	D

Table 5
FUTURE TRAFFIC CONDITIONS
PM Peak Hour

	Existing Volume	# of lanes	Saturation Flow	g/C ratio	v/c ratio	LOS
Kalakaua Avenue						
Through lanes at Uluniu Avenue	1,650	3	1,400	0.68	0.58	A
Approach to Liliuokalani Avenue	1,850	3	1,330	0.68	0.68	B
Approach to Kealohilani Avenue	1,600	3	1,270	0.62	0.68	B
Approach to Ohua Avenue	1,580	3	1,400	0.68	0.55	A
Approach to Paoakalani Avenue	1,790	3	1,330	0.62	0.72	C
Left turn lane at Kapahulu Avenue	410	1	1,000	0.64	0.64	B
Through lanes at Kapahulu Avenue	970	2	1,400	0.64	0.54	A
Side street approaches						
Uluniu Avenue left turns	200	2	1,200	0.22	0.38	A
Kealohilani Avenue left turn	30	1	1,000	0.28	0.11	A
Ohua Avenue left turns	210	2	1,200	0.22	0.40	A
Kapahulu Avenue left turns	270	1	1,200	0.26	0.87	D

As indicated in Tables 4 and 5, acceptable conditions are present at all approaches affected by the proposed modification. The analyses indicate that the intersections would be able to accommodate an additional 25% [maximum v/c for LOS D (0.90) divided by highest v/c (0.72)] traffic on Kalakaua Avenue, which would be greater that the forecasted increase of 16% in daily vehicle trips from 1990 to year 2020 across the Manoa-Palolo screenline (a mauka-makai line across the east-west roadways, including those in Waikiki) from the *Oahu Regional Transportation Plan* (Table 2-6).

Other Changes to Waikiki Roadways

Several other roadway projects are being planned for Waikiki. These projects are located near the northwest end of Waikiki, where traffic volumes are typically higher than near the proposed lane closure project. Improvements to Kalakaua Avenue at the Ala Wai Canal and between the canal and Ala Moana Boulevard are listed in the Transportation Improvement Program of the City and County of Honolulu Department of Transportation Services, which would qualify the projects for Federal aid. These projects, however, lack local funding and are not being actively pursued at this time.

The State Highways Division has proposed the widening of the eastbound lanes of Ala Moana Boulevard, from west of Kalia Road to Kalakaua Avenue. One additional lane would be provided for eastbound traffic through the Kalia Road intersection. The additional lane would be carried to Kalakaua Avenue, where an additional right turn lane would be provided. The situation on Ala Moana Boulevard is quite different from the situation on Kalakaua Avenue between Kaiulani Avenue and Kapahulu Avenue. A six-phase operation of the signal at the intersection of Ala Moana Boulevard and Kalia Road is needed to accommodate the heavy left turn movements and the through traffic on Ala Moana Boulevard. This signal phasing, combined with the long pedestrian crossing of Ala Moana Boulevard, limits the g/C ratio for the eastbound through movement on Ala Moana Boulevard to less than 0.20. Peak hour conditions are described as LOS D for existing traffic, and if traffic demand increases by 0.5% per year as indicated by the *Oahu Regional Transportation Plan*, afternoon peak hour conditions would become LOS E by the year 2000. The addition of one lane for eastbound through traffic has been identified as a possible mitigation measure and has been recommended for implementation.

Koa Avenue Loading

Another concern in the vicinity of Kalakaua Avenue and Kaiulani Avenue is the loading and unloading activities that occur on Koa Avenue, between Kaiulani and Uluniu Avenues. This activity includes freight and passenger loading on both sides of the street.

Existing Conditions - Koa Avenue is a one-way street (diamond head bound) parallel to Kalakaua Avenue, running for two blocks between Kaiulani Avenue and Liliuokalani Avenue. While the street is 36 feet wide, it is used only for one lane of traffic. At the

Kaiulani Avenue intersection, it serves as the outlet for makai bound traffic on Kaiulani Avenue since the short block between Kalakaua Avenue and Koa Avenue is one-way mauka bound. An all-way stop controls traffic at the intersection of Koa Avenue and the makai bound Uluniu Avenue; Koa Avenue traffic stops before entering Liliuokalani Avenue, which is one-way mauka bound.

Koa Avenue between Kaiulani and Uluniu Avenues provide access to driveways to the basement parking garage for King's Village and to the service areas of the Hyatt Regency Hotel. While no curbside parking spaces are designated along Koa Avenue, freight loading zones are located on both sides. A bus loading zone for passengers is located on the makai side near the Koa Avenue entrance to the Hyatt Regency Hotel. Several residential apartment buildings are located mauka of Koa Avenue. Traffic counts taken in 1994 and 1996 by the Department of Transportation Services show weekday volumes of 6,050 and 5,840 vehicles per day. Daily traffic on Koa Avenue between Uluniu and Liliuokalani Avenue was 3,900 vehicles per day in a count taken in 1995.

Freight loading along Koa Avenue occurs throughout the day, with most activity occurring during hours when freight loading on Kalakaua Avenue is not permitted (9 AM to 10 PM). The loading areas serve deliveries to small shops and businesses along Kalakaua, Kaiulani, Uluniu, and Kuhio Avenues. Deliveries to the Hyatt Regency Hotel are scheduled by the hotel management during daylight hours to minimize noise impacts, since large trucks need to back up into or out of the loading areas.

The passenger loading area is used by tour companies and independent travelers. It is the designated loading/unloading area for guests at not only the Hyatt Regency, but also the Princess Kaiulani, Moana-Surfrider, Outrigger, and other hotels near Kaiulani Avenue. The busiest times are between 7 and 9 AM, and 4 and 6 PM, when hotel guests start on day or evening activities and are picked up by buses.

The tour bus operations have the highest use per vehicle, i.e., the vehicles are the largest and the loading and unloading requires the most time. While some tours are ready to board when the vehicle arrives, some vehicles wait at the loading area, with engines running to cool the interior with the air conditioning on. During most of the daylight hours, shuttle buses for various visitor attractions, such as shopping areas and cruises, pick up or drop off passengers in this area. These shuttle vehicles are typically vans or trolley replicas, and stop only long enough to load or unload passengers. The tour buses and shuttle vehicles leave the area by turning right onto Uluniu Avenue if they desire to get back to Kalakaua Avenue to proceed toward Diamond Head, or continue on Koa Avenue to turn left onto mauka bound Liliuokalani Avenue to get to Kuhio Avenue or to leave Waikiki via Ala Wai Boulevard.

Alternatives - Several alternatives to reduce traffic and other activity along Koa Avenue have been considered. These include converting Kaiulani Avenue between Kalakaua and Koa Avenues to two-way, relocating the bus loading zone to Kaiulani or Uluniu Avenue, limiting freight loading, and closure of Koa Avenue at various times of the day.

Conversion of Kaiulani Avenue to two-way traffic would require the widening of the street and reconstruction of portions of the sidewalk, including the loss of a portion of the sidewalk at the mauka-ewa corner of the intersection of Kalakaua Avenue and Kaiulani Avenue. Modifications to the traffic signal would also be necessary; the existing "Barnes Walk" crossing at this intersection may not be workable with traffic approaching from the mauka leg of the intersection. Without the "Barnes Walk" crossing, pedestrians crossing Kaiulani Avenue parallel to Kalakaua Avenue would conflict with the high volume of left turns, which would create increased vehicular delays at the intersection.

The conversion of Kaiulani Avenue to permit makai bound traffic to continue to Kalakaua Avenue could be expected to reduce traffic on Koa Avenue. Of the 6,000 or so daily vehicles on Koa Avenue, between half and 2/3 originated on makai bound Kaiulani Avenue, as indicated by traffic counts taken in 1994 and 1996. Much of this traffic, however, appears to be turning back in the mauka direction; the total makai bound volumes counted on Kaiulani and Uluniu Avenues in 1994 was 7,060 vehicles per day mauka of Koa Avenue and 5,010 vehicles per day makai of Koa Avenue. Koa Avenue is also the most direct route for entry into the Hyatt Regency parking garage (driveway on Uluniu Avenue makai of Koa Avenue) from Kalakaua Avenue.

The relocation of the passenger loading zone to Kaiulani Avenue between Kalakaua Avenue and Koa Avenue would also require a widening of Kaiulani Avenue, since the loading zone would take up one lane. The short block between Kalakaua and Koa Avenues limit the amount of curbspace which could be used, and any buses that cannot be served would either block traffic while waiting, or would need to make a large loop to recirculate to reapproach the loading zone. If combined with conversion to two-way, a two-lane widening (and related sidewalk narrowing) would be necessary.

The relocation of the passenger loading zone to Uluniu Avenue is not feasible. The distance between the driveways to the main entrance of the Hyatt Regency Hotel and the adverse impact of large vehicles to the sight lines for traffic exiting this area preclude the use of the ewa curb of Uluniu Avenue between Koa and Kalakaua Avenues. Use of the diamond head curb, which has a single driveway to the Hyatt parking garage, has the same constraints but a longer curbspace is available. However, since the buses load from the right, use of the diamond head curb would require that traffic on Uluniu Avenue be reversed to mauka bound; such a reversal will affect the circulation pattern and may require that traffic on Liliuokalani Avenue (and possibly Ohua and Paoakalani Avenues) also be reversed.

The relocation of the passenger loading zone to the triangular park near the intersection of Kaiulani Avenue and Kuhio Avenue has also been proposed. Use of the Kuhio Avenue edge of the triangle would conflict with the existing public bus operations. Locating a bus loading area on Kanekapolei Avenue on the ewa side of the triangle may be possible; however, the only way buses could get to this location would be from Kalakaua Avenue, turning left onto Kaiulani Avenue. If the bus loading area is located on Kaiulani Avenue across the triangular park, the makai corner of the triangular park would require

some modification to allow makai bound buses on Kanekapolei Avenue to turn onto Kaiulani Avenue, mauka bound, to access the bus loading area.

The reduction of passenger loading and unloading activity on Koa Avenue could also be achieved by limiting the use of the area to guests of the Hyatt Regency Hotel. This alternative, however, would force the tour bus companies to alter their operations to include stops at the other hotels or at an alternative location. Of the possible locations between Seaside and Ohua Avenues, the existing location appears to be the best: the street width has adequate width, the sidewalk and adjacent area is compatible for waiting, and vehicular access to the site is relatively easy.

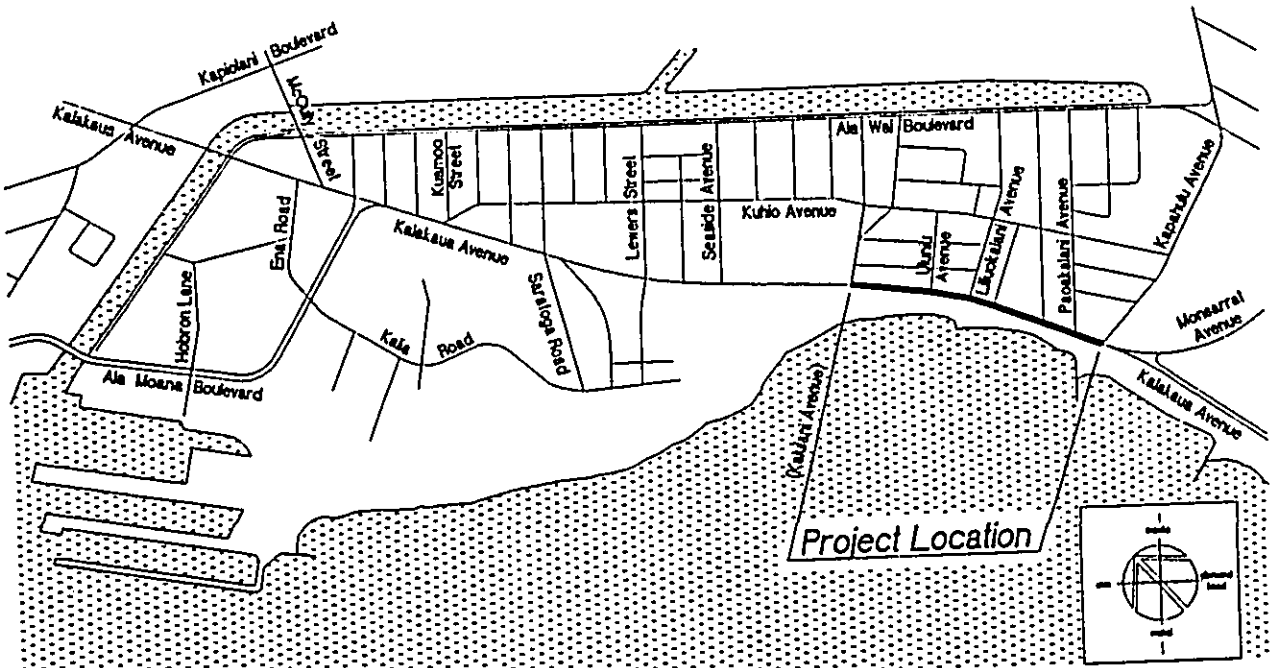
The limiting of freight loading operations would be done by signing and would require enforcement. Additional costs which may be incurred by the trucking companies or suppliers because of any new limitations will probably be passed on to the merchants and customers. This alternative, combined with a reevaluation of the time limits for loading on Kalakaua Avenue, should be evaluated further.

The closure of Koa Avenue at various times of the day would affect access to the King's Village parking garage and to the Hyatt Regency Hotel loading area. Closure would also affect traffic circulation since Koa Avenue is the only outlet from the intersection of Kaiulani and Koa Avenues. If combined with the conversion of Kaiulani Avenue to two-way traffic, closure could be possible. However, access to the Hyatt parking garage would be affected and additional traffic on Kalakaua Avenue between Kaiulani and Liliuokalani Avenues could be expected.

Proposed Action - In view of the constraints discussed above, the retention of existing loading activities on Koa Avenue is recommended. No changes in traffic circulation should be implemented solely for the purpose of reducing traffic on Koa Avenue. The separation of the two types of passenger loading activity (tour bus and shuttle) should be considered. The relocation of shuttle bus loading and unloading activity to Kalakaua Avenue would reduce the activity on Koa Avenue and ease some of the congestion that occurs during busy times. In addition, modifications in operations should be explored; these include the establishment of a convenient staging area, improved communications between the tour desks and drivers to reduce the time that tour buses are on Koa Avenue, and the reconsideration of limitations of freight loading, both on Koa Avenue and on Kalakaua Avenue.

Conclusions and Recommendations

Existing peak hour traffic volumes are readily accommodated on Kalakaua Avenue between Kaiulani Avenue and Kapahulu Avenue. For future traffic demands, which are not expected to increase over existing volumes, a narrowed Kalakaua Avenue between Kaiulani Avenue and Kapahulu Avenue has been found to have sufficient capacity to provide acceptable peak hour conditions. With one less lane on Kalakaua Avenue, the signalized intersections from Uluniu Avenue to Kapahulu Avenue could operate with acceptable delay.



City and County of Honolulu Department of Public Works

TRAFFIC STUDY

KALAKAUA AVENUE MODIFICATIONS

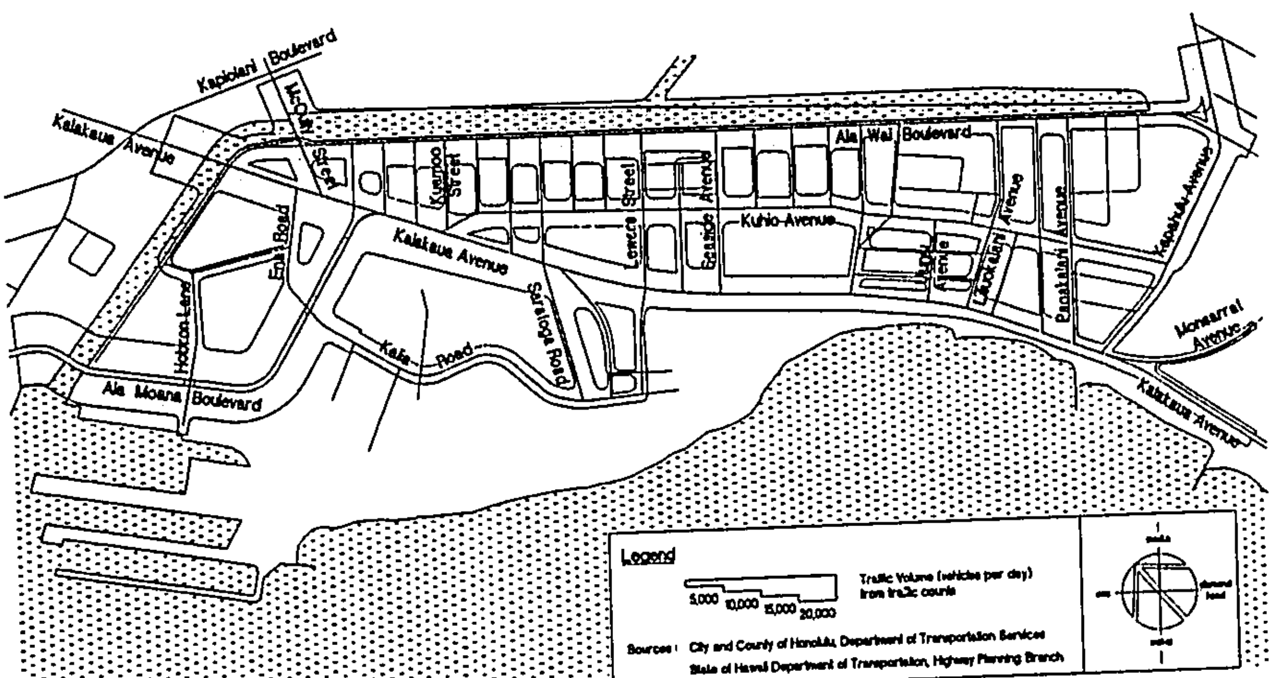
Kaiulani Avenue to Kapahulu Avenue

PROJECT LOCATION
WAIKIKI, OAHU

prepared by: Julian Ng, Inc. January, 1998

Exhibit 1

Not to Scale



City and County of Honolulu Department of Public Works

TRAFFIC STUDY

KALAKAUA AVENUE MODIFICATIONS

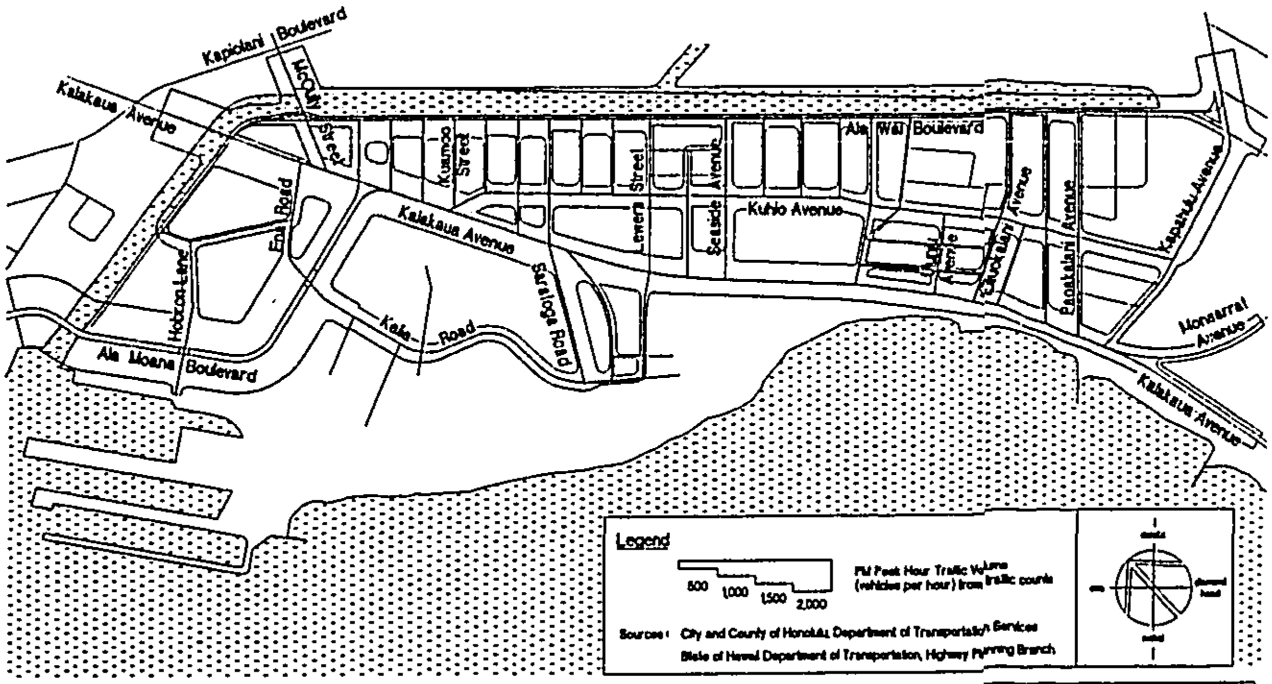
Kaiulani Avenue to Kapahulu Avenue

24-HOUR TRAFFIC
1993 - 1996

prepared by: Julian Ng, Inc. January, 1998

Exhibit 2

Not to Scale

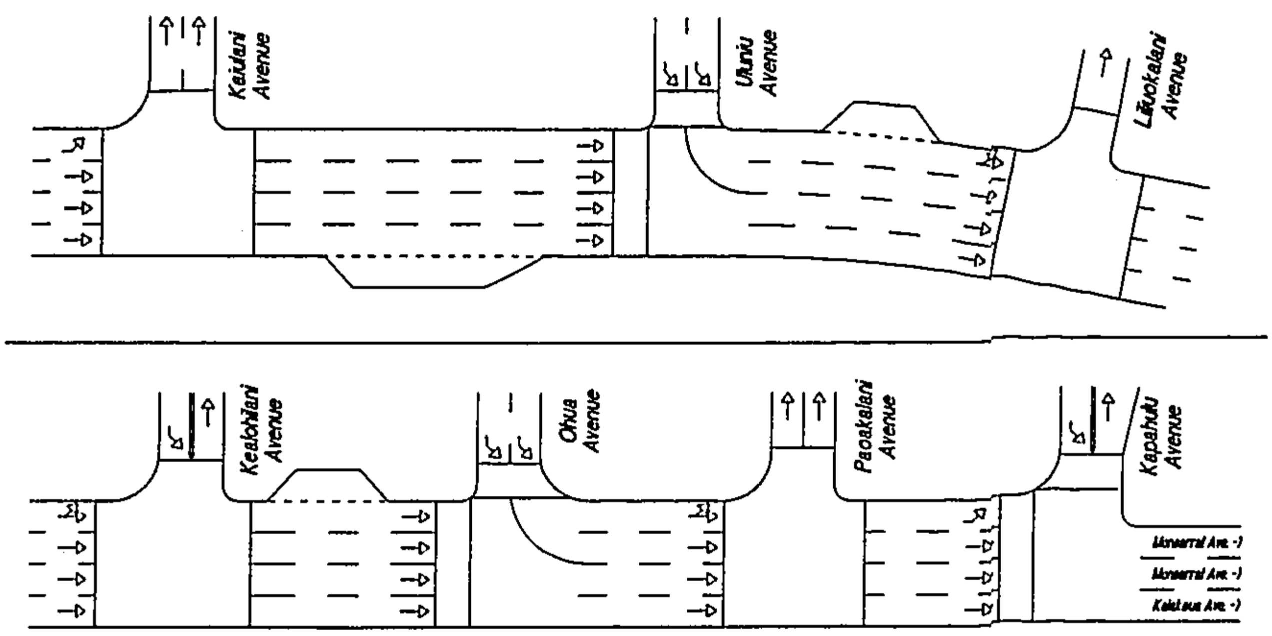


City and County of Honolulu Department of Public Works
TRAFFIC STUDY
KALAKAUA AVENUE MODIFICATIONS
Kaiulani Avenue to Kapahulu Avenue

PM PEAK HOUR TRAFFIC
1993 - 1996

prepared by: Julian Ng, Inc. January, 1998

Exhibit
3
Not to Scale

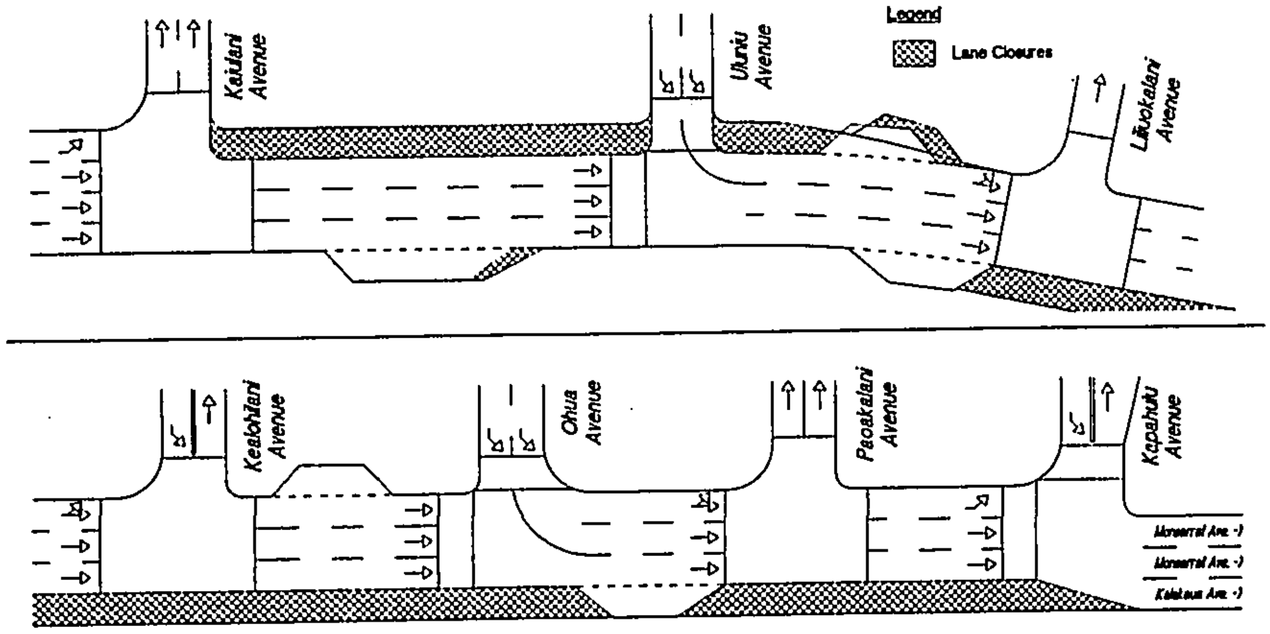


City and County of Honolulu Department of Public Works
TRAFFIC STUDY
KALAKAUA AVENUE MODIFICATIONS
Kaiulani Avenue to Kapahulu Avenue

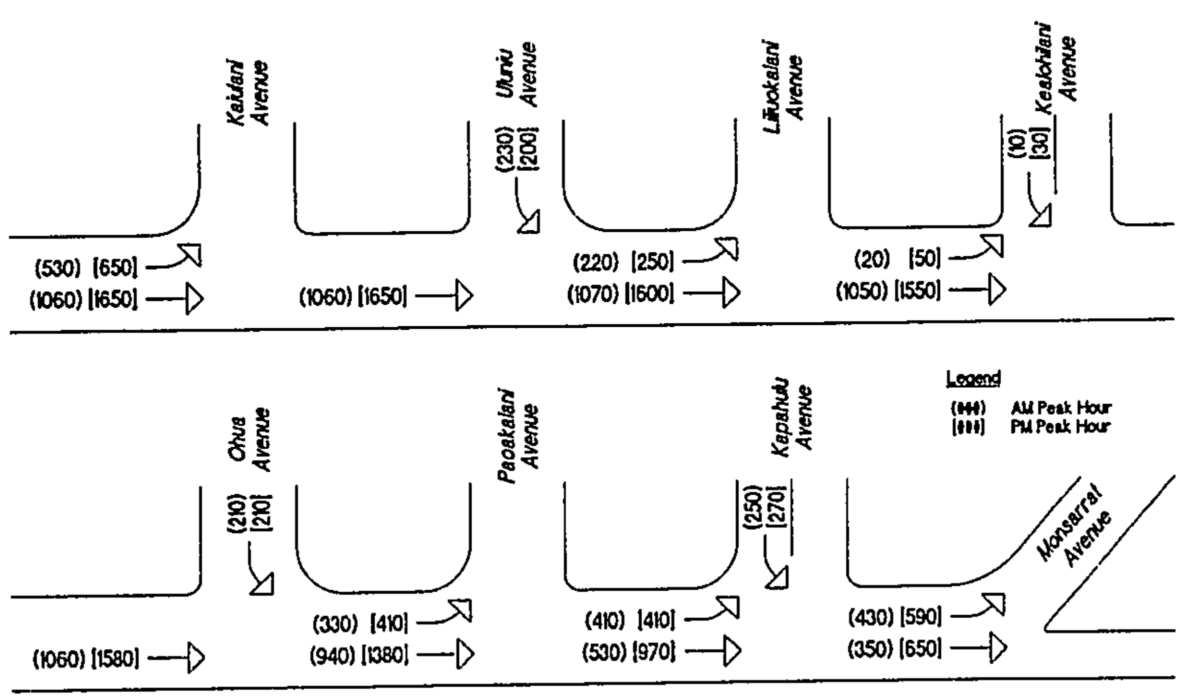
KALAKAUA AVENUE
EXISTING LANEAGE

prepared by: Julian Ng, Inc. January, 1998

Exhibit
4
Not to Scale



City and County of Honolulu Department of Public Works TRAFFIC STUDY KALAKAUA AVENUE MODIFICATIONS Kaiulani Avenue to Kapahulu Avenue	KALAKAUA AVENUE PROPOSED LANEAGE	Exhibit 5
	prepared by: Julian Ng, Inc. January, 1998	Not to Scale



Based on counts by: City and County of Honolulu Department of Transportation Services

City and County of Honolulu Department of Public Works TRAFFIC STUDY KALAKAUA AVENUE MODIFICATIONS Kaiulani Avenue to Kapahulu Avenue	PEAK HOUR TRAFFIC VOLUMES	Exhibit 6
	prepared by: Julian Ng, Inc. January, 1998	Not to Scale

Appendix B

COMMENTS AND RESPONSES TO THE DRAFT ENVIRONMENTAL ASSESSMENT

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

'98 AUG 17 AM 8 29
DEPT OF PLANNING AND PERMITTING
CITY & COUNTY OF HONOLULU

In Reply Refer To: KF

Jan Naoe Sullivan
Director of Planning and Permitting
Department of Planning and Permitting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

Re: Draft Environmental Assessment for the Kuhio Beach Park Expansion & Kalakaua Avenue Promenade

Dear Jan Naoe Sullivan:

The U.S. Fish and Wildlife Service (Service) has reviewed the Draft Environmental Assessment (DEA) for the above referenced action. The DEA was prepared by R. M. Towill Corporation for the City and County of Honolulu. The applicant is the City and County of Honolulu. This letter has been prepared under the authority of and in accordance with provisions of the National Environmental Policy Act of 1969 [42 U.S.C. 4321 *et seq.*; 83 Stat. 852], as amended, the Fish and Wildlife Coordination Act of 1934 [16 U.S.C. 661 *et seq.*; 48 Stat. 401], as amended, the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq.*; 87 884], as amended, and other authorities mandating Service concern for environmental values. Based on these authorities, the Service offers the following comments for your consideration.

The purpose of the project is to effect facilities improvements for a 3.4 acre stretch of beach park, and modifications to sections of Kalakaua Avenue (between Kaiulani and Kapahulu Avenues), within the Waikiki Special District. Refurbishment activities involve expanding existing recreational areas of the park by converting Kalakaua Avenue from four to three lanes; installing loading bays for service vehicles and a promenade for pedestrians; demolishing and replacing plaza facilities at the western end of the beach park. Construction-related activities will involve excavating between 2,000 and 10,000 cubic yards of street pavement, rubble and sand at the project site.

GENERAL COMMENTS

The Service is concerned that the DEA does not include a description of the Waikiki Marine Life Conservation District, fronting the Waikiki Aquarium, and in the vicinity of the proposed project. A discussion of the coral reef resources within the Waikiki Marine Life Conservation District is integral to implementing measures to reduce impacts to coral reef resources within this area. The institutional significance of coral reefs has been established through their formal designation as "special aquatic sites" (40 CFR Part§230.44/FRv.45n.249). Though the DEA generally

describes the project-related construction activities, it does not articulate the amount of silt or sediment that might be expected to runoff into the marine environment during the construction phase, or ensuing beach replenishment activities. Also, there is no discussion of the potential transport of silt or sediment into the general vicinity of the Waikiki Marine Life Conservation District. Therefore, the Service recommends that the Final Environmental Assessment incorporate a description of the Waikiki Marine Life Conservation District, potential impacts and appropriate mitigation measures.

Page 4-2; Section 4 MITIGATION MEASURES

The DEA lists several potential short-term impacts and mitigation measures in section 4. The Service recommends that the following measures to minimize the degradation of water quality and impacts to fish and wildlife resources and habitats be incorporated into the project:

a. Turbidity and siltation from excavation activities should be minimized and contained to the immediate vicinity of the excavation site through the use of effective silt containment devices and curtailment of work during adverse weather conditions.

b No construction materials should be stockpiled in the marine environment.

c. No contamination of the marine environment (trash or debris disposal, etc.) should result from project-related activities; and

d. A contingency plan to control petroleum products accidentally spilled during construction should be developed. Absorbent pads and containment booms should be stored on-site to facilitate the clean-up of petroleum spills.

The Service believes that the incorporation of these measures into the project will greatly minimize the potential for project-related adverse impacts to fish and wildlife resources. Provided that the DEA is conditioned to reflect our recommendations, we will not object to a Finding of No Significant Impacts.

The Service appreciates the opportunity to provide comments on the proposed project. If you have questions regarding these comments, please contact Fish and Wildlife Biologist Kevin Foster at 808/541-3441 (fax: 808/541-3470).

Sincerely,

for Robert P. Smith
Pacific Islands Manager

cc: NMFS-PAO, Honolulu
USEPA-Region IX, Honolulu
DAR-State of Hawaii
CZMP-State of Hawaii
CWB-State of Hawaii

DEPARTMENT OF PLANNING AND PERMITTING

CITY AND COUNTY OF HONOLULU

August 25, 1998

Mr. Robert P. Smith
Pacific Islands Manager
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawaii 96850

Re: Your Letter of August 14, 1998 Regarding the Draft Environmental Assessment for Kuhio Beach Park Expansion and Kalakaua Avenue Promenade, Honolulu, Oahu

Dear Mr. Smith:

Thank you for reviewing the Draft Environmental Assessment (EA) for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade.

The Final EA will include a description of the Waikiki Marine Life Conservation District, potential impacts and mitigation measures. Also, best management practices will be employed to prevent any potential discharge of dredged or fill materials from entering the ocean.

Your comments will be reflected in the Final EA for the proposed project. If you have further questions, please contact Art Challacombe at 523-4107.

Sincerely,

for JAN NAOE SULLIVAN
Director of Planning and Permitting

cc: Colette Sakoda, RMTC
Tomo Murata, RMTC

PHONE (808) 594-1888 FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPIOLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

98 JUL 27 AM 8:09

July 20, 1998

Ms. Jan Naoe Sullivan
Director of Planning and Permitting
City & County of Honolulu
650 South King, 7th Floor
Honolulu, HI 96813

Subject: Environmental Assessment (EA) for Kuhio Beach Park Expansion & Kalakaua Avenue Promenade, Honolulu, Island of Oahu

Dear Ms. Sullivan:

Thank you for the opportunity to review the Environmental Assessment (EA) for Kuhio Beach Park Expansion & Kalakaua Avenue Promenade, Honolulu, Island of Oahu. The City & County of Honolulu is proposing improvements for 3.4 acres of Kuhio Beach Park and modifications to a portion of Kalakaua Avenue between Kaiulani and Kapahulu Avenues. Because the aforementioned modifications will be performed within the City & County's special management area (SMA) and will cost in excess of $125,000, approval of a major SMA use permit is required. Also a shoreline setback variance is required for the proposed improvements at the beach park.

The Office of Hawaiian Affairs (OHA) has reviewed the EA and has no major concerns at this time. The project site is located in the heart of Waikiki and has been substantially modified over the years. Thus, it is unlikely that indigenous flora and fauna species exist or that cultural resources could be uncovered during the improvements.

Letter to Ms. Jan Naoe Sullivan
July 20, 1998
Page 2

But OHA is concerned with the proposal to close one traffic lane at Kalakaua Avenue. OHA believes this reduction in traffic lanes will increase congestion and disrupt loading activities. Appendix A describes a traffic study assessing the impacts of the Kalakaua Avenue modifications. Koa Avenue is mentioned several times as one alternative to absorb loading activities from Kalakaua Avenue. Koa Avenue, however, is not depicted in any of the maps of the EA. This oversight precludes OHA from assessing the role of Koa Avenue in easing loading activities and traffic congestions.

Please contact Colin Kippen (594-1938), LNR Officer, or Luis Manrique (594-1758), should you have any questions on this matter.

Sincerely yours,

Randall Ogata
Administrator

Colin Kippen
Officer,
Land and Natural
Resources Division

cc: Board of Trustees
OEQC

DEPARTMENT OF PLANNING AND PERMITTING

CITY AND COUNTY OF HONOLULU

August 25, 1998

Mr. Randall Ogata, Administrator
Office of Hawaiian Affairs
State of Hawaii
711 Kapiolani Boulevard, Suite 500
Honolulu, Hawaii 96813

Subject: Your Letter of July 20, 1998 Regarding the Draft Environmental Assessment for Kuhio Beach Park Expansion and Kalakaua Avenue Promenade, Honolulu, Oahu

Dear Mr. Ogata:

Thank you for reviewing the Draft Environmental Assessment (EA) for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade.

We acknowledge that the State OHA has "no major concerns" on the proposed development in Waikiki. With respect to your concerns on the traffic impacts from the proposed Kalakaua Avenue lane closure on Koa Avenue and the role of Koa Avenue, the following statement is prepared.

> Koa Avenue provides access to the surrounding commercial and residential buildings. Koa Avenue is actively used for freight and passenger loading for the adjoining hotels. No alternatives or plans have been made for Koa Avenue to absorb loading activities from Kalakaua Avenue. In fact, the traffic study in "Appendix A" suggests that the relocation of shuttle bus loading and unloading activity from Koa Avenue to the proposed loading areas along Kalakaua Avenue would reduce the activity on Koa Avenue and ease some of the congestion that is presently occurring on Koa Avenue during busy times.

Should you have further questions, please do not hesitate to call Art Challacombe at 523-4107. We will be happy to answer any questions you may have.

Sincerely,

JAN NAOE SULLIVAN
Director of Planning and Permitting

cc: Colette Sakoda, RMTC
Tomo Murata, RMTC

DEPARTMENT OF THE ARMY

August 3, 1998

98 AUG -7 PM 2:11

Operations Branch

Ms. Jan Naoe Sullivan
Department of Planning and Permitting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

Dear Ms Sullivan:

Thank you for the opportunity to review the Kuhio Beach Park Expansion and Kalakaua Avenue Promenade project. Based on the information provided, all of the construction activity will take place above the high tide line and will not require a Department of the Army permit. It is recommended that best management practices be employed to prevent any potential discharge of dredged or fill materials from entering waters of the U.S.

If you have any further questions, please contact Mr. Alan Everson of my staff at 438-9258, extension 11 and refer to File No. 980000263.

Sincerely,

George P. Young, P.E.
Chief, Operations Branch

DEPARTMENT OF PLANNING AND PERMITTING

CITY AND COUNTY OF HONOLULU

August 25, 1998

Mr. George P. Young, P.E.
Chief, Operations Branch
Department of the Army
U.S. Army Engineering District, Honolulu
Ft. Shafter, Hawaii 96858-5440

Subject: Your Letter of August 3, 1998 Regarding the Draft Environmental Assessment for Kuhio Beach Park Expansion and Kalakaua Avenue Promenade, Honolulu, Oahu

Dear Mr. Young:

Thank you for reviewing the Draft Environmental Assessment for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade.

We acknowledge that the DA permit will not be required for this project. Your recommendation, regarding the preparation of the best management practices, will be taken under advisement.

If you have further questions or comments, please contact Art Challacombe at 523-4107.

Sincerely,

Jan Naoe Sullivan
Director of Planning and Permitting

cc: Colette Sakoda, RMTC
Tomo Murata, RMTC

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING
235 South Beretania Street, 6th Fl., Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Tel (808) 587-2846
Fax (808) 587-2824

Ref. No. P-7615

July 31, 1998

Ms. Jan N. Sullivan
Director
Department of Planning and Permitting
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Ms. Sullivan:

Subject: Chapter 343, HRS and Chapter 25, ROH, Environmental Assessment for a Project Within the Special Management Area, Shoreline Setback and Waikiki Special District for the Kuhio Beach Park Expansion and Kalakaua Avenue Promenade

We have reviewed the above referenced document, which indicates that the City is proposing to construct major improvements at the Kuhio Beach Park and Kalakaua Avenue. Included in the proposal is a reconstruction of the existing facilities, adding more landscaping on the beach and along Kalakaua Avenue. The proposal will reduce Kalakaua Avenue from four lanes to three lanes. The plaza area will be improved by new buildings and facilities to house the police substation, food concession, comfort station, surfboard lockers, and beachboy concessions.

We note that the proposal will result in a complete redevelopment of the Kuhio Beach Park, and an overall expansion of the beach area. This would be accomplished by the reduction of area allotted to these facilities, which would be reduced from the current 13,500 square feet to just 4,220 square feet. Also, the reduction of the roadway on Kalakaua Avenue will allow for the addition of landscaping and widening of the beach park. We also understand that certain areas of the beach will be fenced off during construction for safety reasons or facilities closed or relocated, as necessary. However, the construction activity will be phased to mitigate adverse impacts to visitors and other users of the park. Overall construction time is estimated to be six to nine months. According to the document, the proposed project will cost about $13.5 million.

We have the following additional concerns and comments:

1. Page 1-4, and page 5-3. The document indicates that some work will be done within the shoreline setback area, and it also indicates that there is a 100-foot shoreline setback. According to the document, all of the proposed work is within the 100-foot shoreline setback. However, it does not specify where the shoreline is on the attached maps and schematic drawings. It is difficult to determine whether all of the work is within the shoreline setback area. The document should clarify this proposal through maps and written documentation as necessary.

Ms. Jan N. Sullivan
Page 2
July 31, 1998

2. The State Department of Land and Natural Resources, Boating Division, is proposing to reconstruct the Kuhio Beach Park "slippery walls", and replenish the sand along the beach. This project should be coordinated with the Boating Division.

3. Page 4-2, no. 3. The construction will include grubbing and grading activities. The document indicates that adequate soil erosion control measures and silt screens and/or sand bags may be used to prevent silt and materials from leaving the construction site. We also note that the project will require a NPDES permit from the Department of Health. Best management practices should be utilized to prevent adverse impacts on the beach and marine life. Dust from construction activities could also adversely impact the beach sand. Care should be taken to prevent the discoloration of the sand and other adverse impacts to the beach and nearshore waters.

The project will improve Kuhio Beach Park, and the City should be commended for proposing a project which will allow for the expansion and more efficient use of the Park area. If you have any questions, please contact Lorene Maki of my staff at 587-2888.

Sincerely,

Rick Egged
Director
Office of Planning

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU

August 25, 1998

Mr. Rick Egged, Director
Office of Planning
Department of Business, Economic Development & Tourism
235 South Beretania Street, 6th Floor
Honolulu, Hawaii 96804

Subject: Your Letter of July 31, 1998 Regarding the Draft Environmental Assessment for Kuhio Beach Park Expansion and Kalakaua Avenue Promenade, Honolulu, Oahu

Dear Mr. Egged:

Thank you for reviewing the Draft Environmental Assessment for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade.

The following has been prepared to address your concerns:

1. Shoreline Setback Area
A shoreline survey has been prepared for this project. The plan graphics that will be included in the Final EA will indicate the high tide lines and 40-foot setback lines. Also, a brief description of justification for the variance will be presented in the final EA.

2. DLNR, Boating Division "Slippery Walls" Reconstruction
The project will take place mauka of the beach park. The proposed project is not anticipated to impact "slippery walls" or the shoreline configuration. Also, the project will be scheduled to be completed prior to commencement of "slippery walls" project. We will be coordinating with the State DLNR, Boating Division regarding the referenced project.

3. NPDES Permit
The Department of Design and Construction will be applying for coverage under the State of Hawaii General NPDES Permit for construction storm water, for the referenced project.

Your comments will be reflected in the Final EA for the proposed project. If you have further questions, please contact Art Challacombe at 523-4107.

Sincerely,

for JAN NAOE SULLIVAN
Director of Planning and Permitting

cc: Colette Sakoda, RMTC
Tom Morita, RMTC

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL

August 19, 1998

Mr. Randall K. Fujiki, Director
Department of Design and Construction
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Fujiki:

Subject: Draft Environmental Assessment for the Kuhio Beach Park Expansion and Kalakaua Avenue Promenade, Oahu

Thank you for the opportunity to review the subject document. We have the following comments.

1. Please describe the measures that will be taken during design and construction to maintain the existing architectural style of the park.

2. Please indicate in a site plan the certified shoreline and shoreline setback line. Show any structures that are proposed to be built within the shoreline setback area. Please justify why these structures need to be located within this area. To the extent possible, structures should located mauka of the shoreline setback area. Describe alternative site plans that would locate structures mauka of this area.

3. According to the conceptual site plan, a landscaped area is proposed Diamond Head of the Kapahulu Groin near a sandy area where international professional volleyball tournaments arw held. Please describe the impact of the project on the volleyball tournament site.

4. Kalakaua Avenue will be converted from 4 lanes to 3 lanes with makai passenger loading and emergency and service vehicle turnouts. Please describe how these improvements will affect bicyclist travelling along Kalakaua Avenue towards Waikiki Aquarium. Please consider establishing a separate bicycle lane along Kalakaua Avenue.

5. We recommend that the City design, construct, and operate the park in a manner that would:
   - Promote mass transportation, bicycling, and pedestrian access
   - Use renewable energy sources, and reduce energy consumption
   - Use non-potable water for irrigation and minimize water usage
   - Use recycled and non-toxic materials during construction, promote recycling activities during operations, and reduce waste
   - Preserve and promote the cultivation of native Hawaiian plants

   Please list any specific measures that the City will implement to achieve the above goals.

6. Under the listing of permits and approvals, please include "shoreline setback variance."

7. Please consult with nearby groups (neighborhood boards, user groups, businesses, etc.) and individuals who may be affected by the proposed project.

Should you have any questions, please call Jeyan Thirugnanam at 586-4185. Thank you.

Sincerely,

for Gary Gill
Director

c: R.M. Towill

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU

August 25, 1998

Mr. Gary Gill, Director
Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, Hawaii 96813

Dear Mr. Gill:

Subject: Your Letter of August 19, 1998 Regarding the Draft Environmental Assessment for Kuhio Beach Park Expansion and Kalakaua Avenue Promenade, Honolulu, Oahu

Thank you for reviewing the Draft Environmental Assessment (EA) for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade. Your letter to Randall Fujiki, dated August 19, 1998, was forwarded to our department.

The following has been prepared to address your concerns:

1. Towards maintaining the identity of Waikiki, development of the proposed project will be undertaken to provide open space relief, landscaping, and low-rise building forms to complement existing developed properties and the surrounding environment.

   The planting and landscaping are integral elements of the design. The proposed building structure will be designed to blend with the surrounding area through the use of landscape and architectural features, materials, and colors that are similar to the existing design elements. The building style will be similar to the early 1900's territorial style, and consistent with the existing City and County buildings at the Kapiolani Park district.

   During construction, the site will be maintained in safe and clean conditions. Measures will be taken to expedite construction.

2. The plan graphics that will be included in the Final EA will indicate the high tide lines and 40-foot setback lines. Also, a brief description of justification for the variance will be presented in the final EA.

3. The project will not curtail any use of international professional volleyball tournaments. Access to the sand beach area will be maintained at all times. The construction activities will be scheduled to avoid conflict with any permitted events or activities at the park.

4. The project will not curtail any use by bicyclists. The project will continue to accommodate passage for bicycles along the makai side curb on Kalakaua Avenue.

5. While reducing the makai curbside lane, turnout areas for police parking, shuttle bus stop, passenger loading zone, bus loading zone, and city vehicle loading zone, will be provided along the makai side of Kalakaua Avenue. Also, as earlier stated, the project will accommodate passage for bicycles along the makai side curb on Kalakaua Avenue.

   The proposed modifications on Kalakaua Avenue would allow additional space for sidewalk and landscape improvements between the roadway and the beach. Therefore, the project will encourage the use of mass transportation, bicycling, and pedestrian access.

   The major improvements proposed at the existing beach park area include the plaza area renewal. The facilities located within the existing plaza area (approximately 3,000 square feet) at the western end of the beach park will be demolished and replaced with a new HPD Police Substation, comfort station, food concession, bike racks, surfboard concession, and beach shower. The new facilities at the plaza area will occupy 700 square feet less area than the ones that will be demolished, which will reduce energy consumption.

6. The Environmental Assessment Section 9, Item 9.1 is revised to reflect your comments.

7. Section 10 of the Final EA will include the list of groups and agencies contacted during the preparation of the plan.

Your comments will be reflected in the Final EA for the proposed project. If you have further questions, please contact Art Challacombe at 523-4107.

Sincerely,

for JAN NAOE SULLIVAN
Director of Planning and Permitting

cc. Colette Sakoda, RMTC
Tomo Murata, RMTC

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

98 AUG 11 PM 2:06

REF:HP-JE

AUG 10 1998

LOG NO: 22035
DOC NO: 9808an01

Jan Naoe Sullivan
Director of Planning and Permitting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

Dear Ms. Sullivan:

SUBJECT: Environmental Assessment for Kuhio Beach Park Expansion and Kalakaua Avenue Promenade
TMK: 2-6-01: 02,03,04 and 18

Thank you for your Environmental Assessment submittal dated July 16, 1998 for the Kuhio Beach Park Expansion and Kalakaua Avenue Promenade. This project will occur in an area that has been disturbed in the past primarily through other beach improvement projects. No known significant historic resources lie within the specified project boundaries. Thus we concur that this undertaking will have "no effect" on any known historic structures.

Because your project will remove and landscape one existing lane of Kalakaua Avenue, there is the possibility that burials might be encountered during your construction activities. Should this happen, work shall cease immediately in the immediate vicinity of the find. The contractor shall immediately contact the State Historic Preservation Division at 587-0013 which will assess the significance of the find and recommend an appropriate mitigation measure.

Aloha,

MICHAEL D. WILSON, Chairperson and
State Historic Preservation Officer

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU

August 25, 1998

Mr. Michael D. Wilson
Chairperson and State Historic Preservation Officer
Department of Land and Natural Resources
State Historic Preservation Division
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

Subject: Your Letter of August 10, 1998 Regarding the Draft Environmental Assessment for Kuhio Beach Park Expansion and Kalakaua Avenue Promenade, Honolulu, Oahu

Dear Mr. Wilson:

Thank you for reviewing the Draft Environmental Assessment (EA) for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade. We acknowledge that the State HPD has determined that the development of the proposed project will have "no effect" on any known historic structures. The Final EA will include the provisions that the proper steps will be taken in case any remains are encountered during the course of the project.

If you have any questions, please contact Art Challacombe at 523-4107.

Sincerely,

JAN NAOE SULLIVAN
Director of Planning and Permitting

cc: Colette Sakoda, RMTC
Tomo Murata, RMTC

FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU

July 28, 1998

98 JUL 31 AM 8:11

TO: JAN NAOE SULLIVAN, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

FROM: ATTILIO K. LEONARDI, FIRE CHIEF

SUBJECT: ENVIRONMENTAL ASSESSMENT
CHAPTER 343, HRS AND CHAPTER 25, ROH
PROJECT WITHIN THE SPECIAL MANAGEMENT AREA, SHORELINE SETBACK AND WAIKIKI SPECIAL DISTRICT
PROJECT NAME : KUHIO BEACH PARK EXPANSION AND KALAKAUA AVENUE PROMENADE
LOCATION : 2453 KALAKAUA AVENUE, WAIKIKI, OAHU
TMK : 2-6-01: 02, 03, 04, 18 AND KALAKAUA AVENUE
STAFF PLANNER : ART CHALLACOMBE
HFD INTERNAL NO. OL 98-268

We received your memorandum of July 15,1998, regarding the environmental assessment for the subject project and do not foresee any adverse environmental impact for the affected area if this project is approved.

Should you need additional information, please contact Battalion Chief Charles Wassman of our Fire Prevention Bureau at 831-7778.

ATTILIO K. LEONARDI
Fire Chief

AKL/CW.bh

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU

August 25, 1998

TO: ATTILIO K. LEONARDI, FIRE CHIEF
FIRE DEPARTMENT

FROM: JAN NAOE SULLIVAN, DIRECTOR

SUBJECT: YOUR LETTER OF JULY 28, 1998 REGARDING THE DRAFT ENVIRONMENTAL ASSESSMENT
CHAPTER 343, HRS AND CHAPTER 25, ROH
PROJECT NAME: KUHIO BEACH PARK EXPANSION AND KALAKAUA AVENUE PROMENADE
LOCATION: 2453 KALAKAUA AVENUE, WAIKIKI OAHU
TMK: 2-6-01 02, 03, 04, 18 AND KALAKAUA AVENUE
STAFF PLANNER: ART CHALLACOMBE
HFD INTERNAL NO OL98-268

Thank you for reviewing the Draft Environmental Assessment for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade. We acknowledge that the Fire Department does not foresee any adverse environmental impact for the affected area if this project is approved.

If you have any questions, please contact Art Challacombe at 523-4107.

Sincerely,

JAN NAOE SULLIVAN
Director of Planning and Permitting

cc: Colette Sakoda, RMTC
Tomo Murata, RMTC

POLICE DEPARTMENT

CITY AND COUNTY OF HONOLULU

OUR REFERENCE CS-DL

August 6, 1998

98 AUG 11 AM 8:18

TO: JAN NAOE SULLIVAN, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

FROM: LEE D. DONOHUE, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

SUBJECT: ENVIRONMENTAL ASSESSMENT
CHAPTER 343, HRS, AND CHAPTER 25, ROH
PROJECT WITHIN THE SPECIAL MANAGEMENT AREA,
SHORELINE SETBACK AND WAIKIKI SPECIAL DISTRICT
2453 KALAKAUA AVENUE, WAIKIKI, OAHU
TAX MAP KEYS 2-6-01: 02, 03, 04, 18 AND KALAKAUA AVENUE

Thank you for the opportunity to review and comment on the subject document.

The proposed project during its construction phase will have a definite impact on the services to be provided by the Honolulu Police Department. In spite of the stated mitigation measures, construction dust and noise will inevitably generate complaints which patrol officers will have to respond to.

Please note that the District 6 staff are currently in the process of addressing the impact that the reduction from four lanes of traffic to three lanes on Kalakaua Avenue will have. However, during the construction phase, any reduction to two lanes of traffic will cause traffic delays, as tour bus operators and tourists in private vehicles slow down or stop along the way. We would like to recommend that special duty officers be posted along the route to minimize these anticipated delays.

It is difficult to determine the exact impact at this time, but there is the possibility that blind spots in and around the construction sites could be ideal venues for drug transactions and other criminal activity. In addition, tourists and residents will not have the convenience of "walking-in" to the substation to file complaints or to ask questions.

Further, we would like to recommend that the principles of crime prevention through environmental design be used as a means of minimizing criminal activity after the proposed project is completed.

If there are any questions or comments, please call me at 529-3175 or Major John Kerr or Captain Karl Godsey of District 6 at 529-3361.

LEE D. DONOHUE
Chief of Police

By [signature]
JAMES FENIX
Assistant Chief
Administrative Bureau

cc: District 6

DEPARTMENT OF PLANNING AND PERMITTING

CITY AND COUNTY OF HONOLULU

August 25, 1998

TO: LEE D. DONOHUE, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

FROM: JAN NAOE SULLIVAN, DIRECTOR

SUBJECT: YOUR LETTER OF AUGUST 6, 1998 REGARDING THE DRAFT ENVIRONMENTAL ASSESSMENT
CHAPTER 343, HRS AND CHAPTER 25, ROH
PROJECT NAME: KUHIO BEACH PARK EXPANSION AND KALAKAUA AVENUE PROMENADE
LOCATION: 2453 KALAKAUA AVENUE, WAIKIKI OAHU

Thank you for reviewing the Draft Environmental Assessment for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade. We acknowledge that the District 6 is currently undertaking traffic impact analyses for the reduction from four lanes of traffic to three lanes on Kalakaua Avenue. Also, we acknowledge that any reduction to two lanes of traffic will cause traffic delays, as tour bus operators and visitors in private vehicles slow down or stop along the way, and that special duty officers should be posted along the route to minimize these anticipated delays.

With respect to the crime prevention methods during and after construction, the following has been prepared to address your concerns.

1. Uninterrupted access to the Kuhio Beach Police Substation will be maintained except during the plaza reconstruction. While the plaza is being reconstructed, an appropriate sign will be posted on site to indicate locations of other substations within the Waikiki area. The substation at the Royal Hawaiian Shopping Center will be in closest proximity to the site, and police service will be provided primarily on-foot patrols during the time.

2. The proposed pedestrian promenade is intended to encourage pedestrian circulation and increase visibility. The planting and landscaping will be designed to maintain visual penetration along the beach park.

Your comments will be reflected in the Final EA for the proposed project. If you have further questions, please contact Art Challacombe at 523-4107.

Sincerely,

[signature]
for JAN NAOE SULLIVAN
Director of Planning and Permitting

cc: Colette Sakoda, RMTC
Tomo Murata, RMTC

CITY AND COUNTY OF HONOLULU

SWO 98-13

August 14, 1998

98 AUG 14 AM 8:05

MEMORANDUM

TO: JAN NAOE SULLIVAN, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

FROM: KENNETH E. SPRAGUE, DIRECTOR [initials]
DEPARTMENT OF ENVIRONMENTAL SERVICES

SUBJECT: DRAFT ENVIRONMENTAL ASSESSMENT (FILE NOS. 98/SMA-064 AND 98/SV-006) FOR KUHIO BEACH PARK EXPANSION AND KALAKAUA AVENUE PROMENADE, 2453 KALAKAUA AVENUE, TMK: 2-6-0: 02, 03,04, 18, AND KALAKAUA AVENUE

We have no comments on the draft environmental assessment for the project.

If you have any questions, please call Gerald Takayesu at local 6104.

DEPARTMENT OF PLANNING AND PERMITTING

CITY AND COUNTY OF HONOLULU

August 25, 1998

TO: KENNETH E. SPRAGUE, DIRECTOR
DEPARTMENT OF ENVIRONMENTAL SERVICES

FROM: JAN NAOE SULLIVAN, DIRECTOR

SUBJECT: YOUR LETTER OF AUGUST 14, 1998 REGARDING THE DRAFT ENVIRONMENTAL ASSESSMENT FOR KUHIO BEACH PARK EXPANSION AND KALAKAUA AVENUE PROMENADE (FILE NUMBERS 98/SMA-064 AND 98/SV-006)

Thank you for reviewing the Draft Environmental Assessment (EA) for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade.

We acknowledge that you have no comments, for the referenced EA. If you have any questions, please contact Art Challacombe at 523-4107.

Sincerely,

[signature]
for JAN NAOE SULLIVAN
Director of Planning and Permitting

cc: Colette Sakoda, RMTC
Tomo Murata, RMTC

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96843

98 AUG 10 PM 2:11

JEREMY HARRIS, Mayor

FORREST C. MURPHY, Vice Chairman
KAZU HAYASHIDA
JAN M. L. Y. AMII
JONATHAN K. SHIMADA, PhD
BARBARA KIM STANTON
CHARLES A. STED

CLIFFORD S. JAMILE
Manager and Chief Engineer

August 7, 1998

TO: JAN SULLIVAN, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

FROM: CLIFFORD S. JAMILE, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: YOUR MEMORANDUM OF JULY 14, 1998 REGARDING THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED KUHIO BEACH PARK EXPANSION AND KALAKAUA AVENUE PROMENADE, WAIKIKI, OAHU, TMK: 2-6-01: 02, 03, 04, 18 AND KALAKAUA AVENUE

Thank you for the opportunity to review and comment on the Draft Environmental Assessment for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade.

We have the following comments.

1. The existing water system is presently adequate to accommodate the park expansion. Construction drawings should be submitted for our review and approval.

2. Please verify that the tax map keys encompass the entire project area.

3. There are one 2-inch, two 2½-inch and one 3-inch meters currently serving TMK: 2-6-1: 2, 3, 4, 8. There are no existing water services to TMK: 2-6-1: 15, 18 and 19.

4. The availability of water will be confirmed when the building permit application is submitted for our review and approval. When water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission and daily storage.

5. If a 3-inch or larger meter is required, the construction plans showing the installation of the water meter should be submitted for our review and approval.

6. The proposed project is subject to Board of Water Supply cross connection control requirements prior to the issuance of the building permit application.

If you have any questions, please contact Barry Usagawa at 527-5235.

Pure Water ... man's greatest need – use it wisely.

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU

August 25, 1998

TO: CLIFFORD S. JAMILE, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

FROM: JAN NAOE SULLIVAN, DIRECTOR

SUBJECT: YOUR LETTER OF AUGUST 7, 1998 REGARDING THE DRAFT ENVIRONMENTAL ASSESSMENT
CHAPTER 343, HRS AND CHAPTER 25, ROH
PROJECT NAME: KUHIO BEACH PARK EXPANSION AND KALAKAUA AVENUE PROMENADE

Thank you for reviewing the Draft Environmental Assessment (EA) for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade.

We acknowledge that the existing water supply is presently adequate for the proposed park expansion. Construction drawings will be submitted for your review and approval. We will confirm the availability of water to your office prior to issuance of building permits. The project will ensure that the proposed improvements will be in conformance with Board of Water Supply cross-connection control requirements. The project will comply with applicable BWS guidelines and requirements.

Your comments will be reflected in the Final EA for the proposed project. If you have further questions, please contact Art Challacombe at 523-4107.

Sincerely,

JAN NAOE SULLIVAN
Director of Planning and Permitting

cc Colette Sakoda, RMTC
Tomo Murata, RMTC

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU

98/SMA-064(AC)
98/SV-006(AC)

August 24, 1998

Ms. Colette Sakoda
R.M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817

Dear Ms. Sakoda:

Draft Environmental Assessment (EA) For
Kuhio Beach Park Expansion and Kalakaua Avenue Promenade
Waikiki, Oahu
Tax Map Keys: 2-6-1: 2, 3, 4, 8, 15 and 18

Thank you for your submittal on the above-referenced Draft EA document. We offer the following comments:

1. The proposed project requires approval of a Shoreline Setback Variance as well as a Special Management Area Use Permit. As such, the EA should include information regarding the structures proposed to be placed within the shoreline setback. In addition, the EA should provide justification for the variance. Generally, a justification of "hardship" or "unique circumstances" associated with the project development is needed in order for an approval of a variance to occur.

2. Are plans for a bike path to be included in the proposal? If not, how will existing bicycle users be accommodated with the proposed project?

3. A certain amount of grading and excavation is assumed to be required during construction of the project. The EA should describe in detail, the location and amount of fill and excavation to be performed and the mitigation measures which will be taken to ensure that nearshore coastal waters will not be adversely impacted during construction.

4. The EA states that sand will replace existing hardscape along the makai side of Kalakaua Avenue. While this concept is consistent and beneficial in meeting Special Management Area objectives and policies, we are curious as to where the sand source is located which will implement the beach widening.

5. We understand that the Department of Transportation Services (DTS) is in the process of evaluating the results of a demonstration project for the subject project. We will defer any detailed comments until the findings of the evaluation is completed.

6. During the progress of this project, subject to the findings of the evaluation, definitive plans specifying the language and use of the various sections of Kalakaua Avenue should be coordinated with the DTS, prior to submittal of the construction plans for this project to our department.

7. The municipal wastewater system is available and adequate to accommodate the proposed project. The project will expand the landscaped ambiance of Kapiolani Park along Kuhio Beach and Kalakaua Avenue, enhance the mauka pedestrian link to Kuhio Beach, and improve public facilities and services. Existing facilities will be demolished and replaced by a new HPD Police Substation, comfort station, food concession, bike racks, surfboard concession, and beach shower. The floor area of the proposed facilities will be 700 square feet less than the existing facilities.

8. Attached is a map showing the existing sewer lines within the subject area. Plans to relocate the existing wastewater collection system should be coordinated with our department.

9. This statement shall not be construed as confirmation of sewage capacity reservation. Sewage capacity reservation is contingent on submittal and approval of a "Sewer Connection Application" form. The applicant will also need to submit an Industrial Wastewater Discharge Permit application.

10. Please show typical site sections and a complete site plan with contours that show proposed mounds, terraces and steps.

11. Discuss how the proposed street lamps will affect the surrounding areas with any light and glare impacts. Will there be any proposed mitigation measures?

12. When processing the Special District Permit application, provide schematic design drawings of the proposed structures, promenade, and landscaping improvements. Provide existing

Ms. Colette Sakoda
Page 3
August 24, 1998

12. When processing the Special District Permit application, provide schematic design drawings of the proposed structures, promenade, and landscaping improvements. Provide existing site plans showing property lines, setback lines, existing grades, finish floor elevations, street trees, landscaping, street lamps, street furniture, and paved surfaces; floor plans showing room names, dimensions, and floor area; building sections and elevations showing building heights and building finish materials; and planting materials (species, size, and spacing).

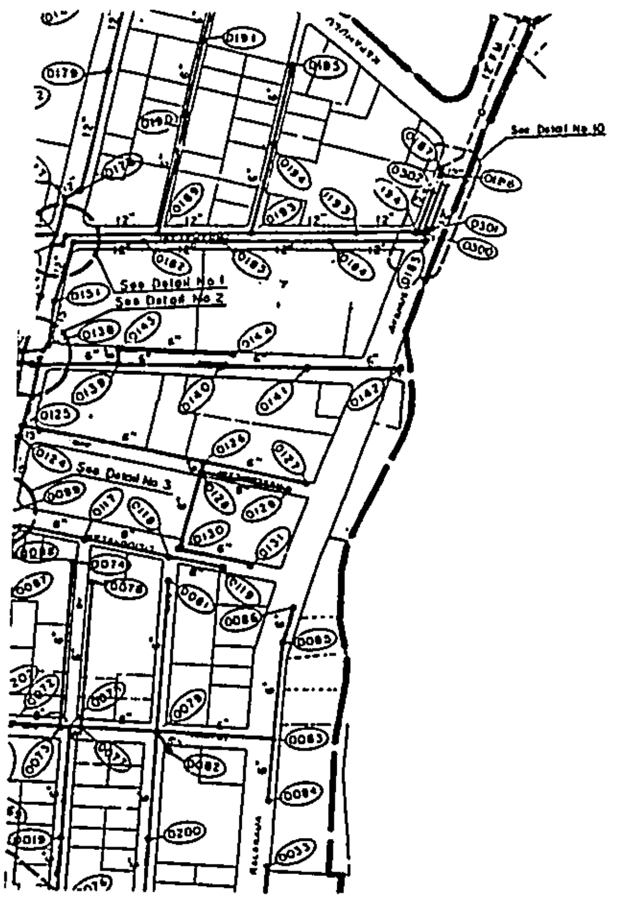
13. Please submit street tree plans for review by our Urban Design Branch.

We appreciate the opportunity to comment on the project. Should you have any questions, please call Mr. Art Challacombe of our staff at 523-4107.

Very truly yours,

for JAN NAOE SULLIVAN
Director of Planning
and Permitting

JNS:am
attach.
cc: Department of Design and Construction



R. M. TOWILL CORPORATION

August 25, 1998

Ms. Jan Naoe Sullivan
Director of Planning and Permitting
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

Subject: Your Letter of August 18, 1998 Regarding the Draft Environmental Assessment for Kuhio Beach Park Expansion and Kalakaua Avenue Promenade, Honolulu, Oahu

Dear Ms. Sullivan:

Thank you for reviewing the Draft Environmental Assessment (EA) for the proposed Kuhio Beach Park Expansion and Kalakaua Avenue Promenade

The following has been prepared to address your concerns.

1. Shoreline Setback:
The plan graphics that will be included in the final EA will indicate the high tide lines and 40-foot setback lines. Also, a brief description of justification for the variance will be presented in the Final EA

2. Bike Plans
The project will not curtail of Kalakaua Avenue use by bicyclists. The existing levels of the bike activities will be maintained. The project will continue to accommodate bicyclists along the makai side curb on Kalakaua Avenue

3. Grading and Excavations
Clearing and grubbing will only take place within the areas that have already been paved and heavily developed. The project will require limited grading and excavation in order to convert the paved area into landscaped environment. Best management practices will be employed to prevent any potential discharge of dredged or fill materials from entering the shoreline area

4. Sand Source
The sand source has not yet been determined. Information on such will be provided before the start of construction

5. DTS Demonstration Project
The DTS is currently conducting the traffic analyses of the project area. The results will be available by the end of September, 1998, upon completion of the Department's study

Ms. Jan Naoe Sullivan
Director of Planning and Permitting
Page 2

6. Coordination with DTS
The language and use of various sections of Kalakaua Avenue will be coordinated with DTS, prior to submittal of construction plans to DPP.

7. Municipal Wastewater System
We acknowledge that the municipal wastewater system is available and adequate to accommodate the proposed project.

8. Wastewater Collection System
The Department of Design and Construction (DDC) will be coordinating with the DPP, Wastewater Branch, regarding any plans to relocate to the existing wastewater collection system

9. Sewage Capacity
The DDC will submit a Sewer Connection Application as well as an Industrial Wastewater Discharge Permit application

10. Site Plan
The detailed site plans and elevations will be submitted to the Urban Design Branch for staff review when the SDP is sought

11. Street Lights
Any light and glare impacts from the proposed street lamps will be mitigated through proper design of the lighting system by restricting height and number of light fixtures, the use of appropriate shielding, and orienting the light toward the ground

12. Special District Permit (SDP)
We will be furnishing all necessary information when the SDP is submitted

13. Street tree plans
The detailed tree plans will be submitted to the Urban Design Branch for staff review when the SDP is sought

Your comments will be reflected in the Final EA for the proposed project. If you have further questions, please contact me or Tomo Murata at 842-1133.

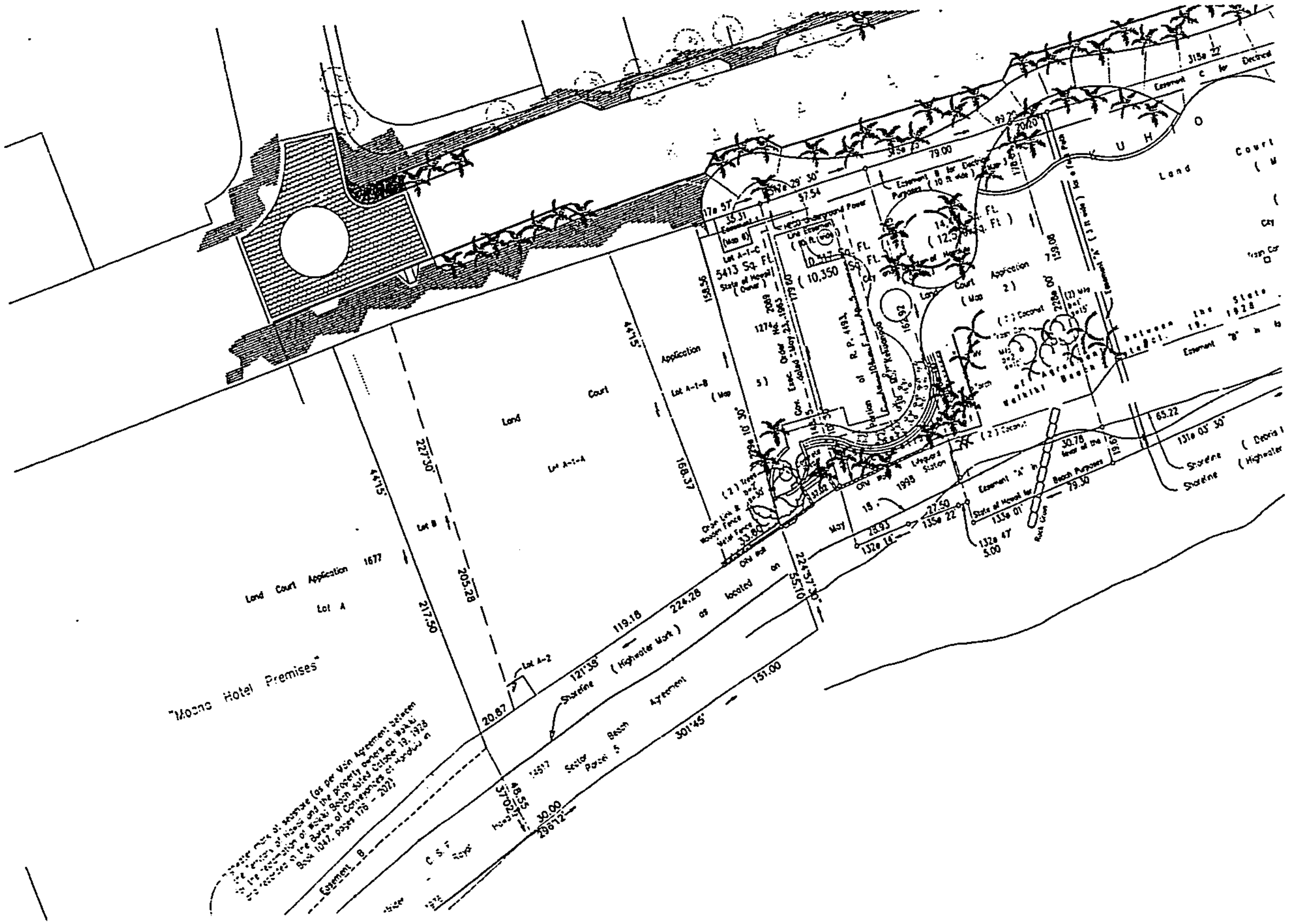
Sincerely,

Colette Sakoda
R M Towill Corporation

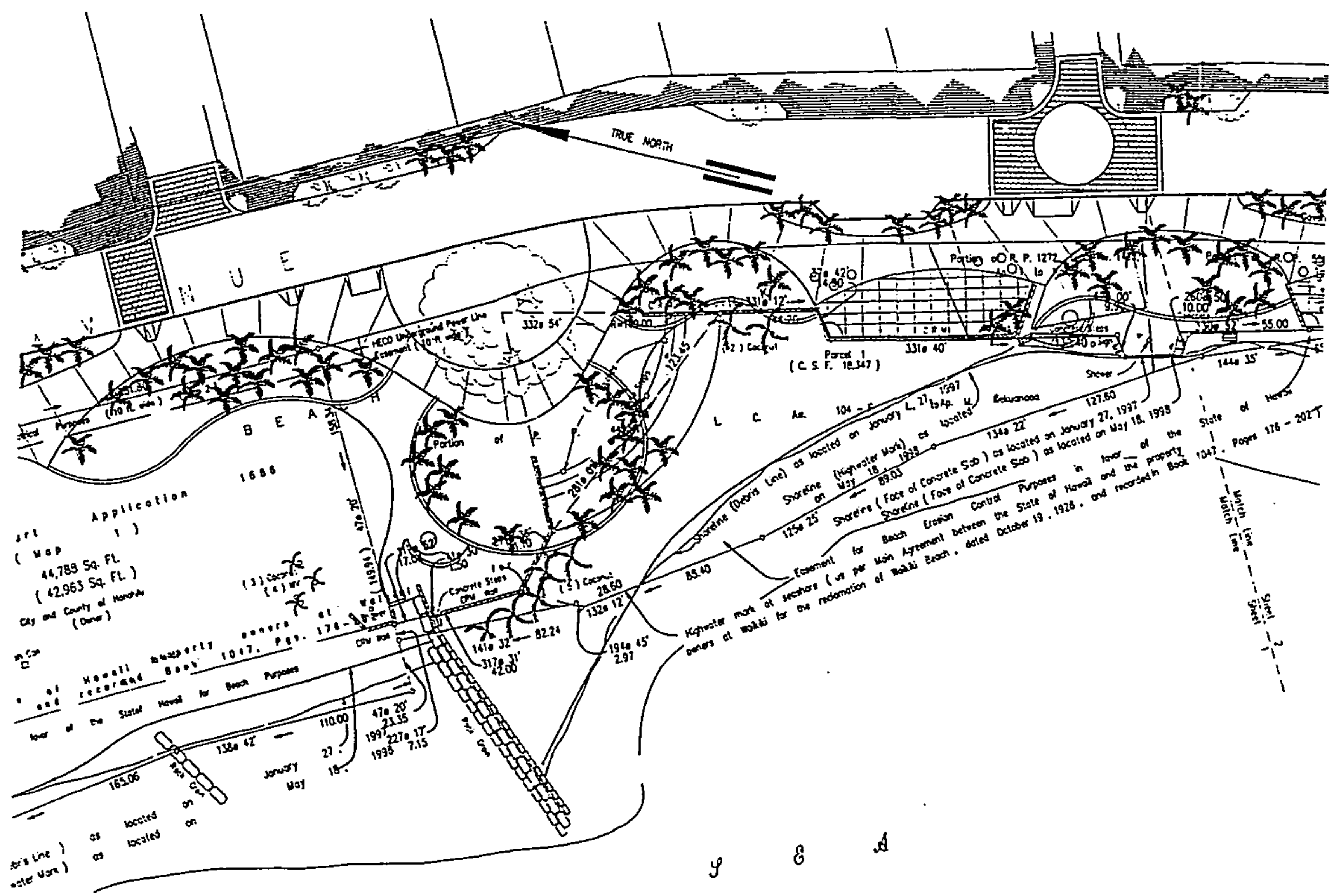
cc Tomo Murata, RMTC

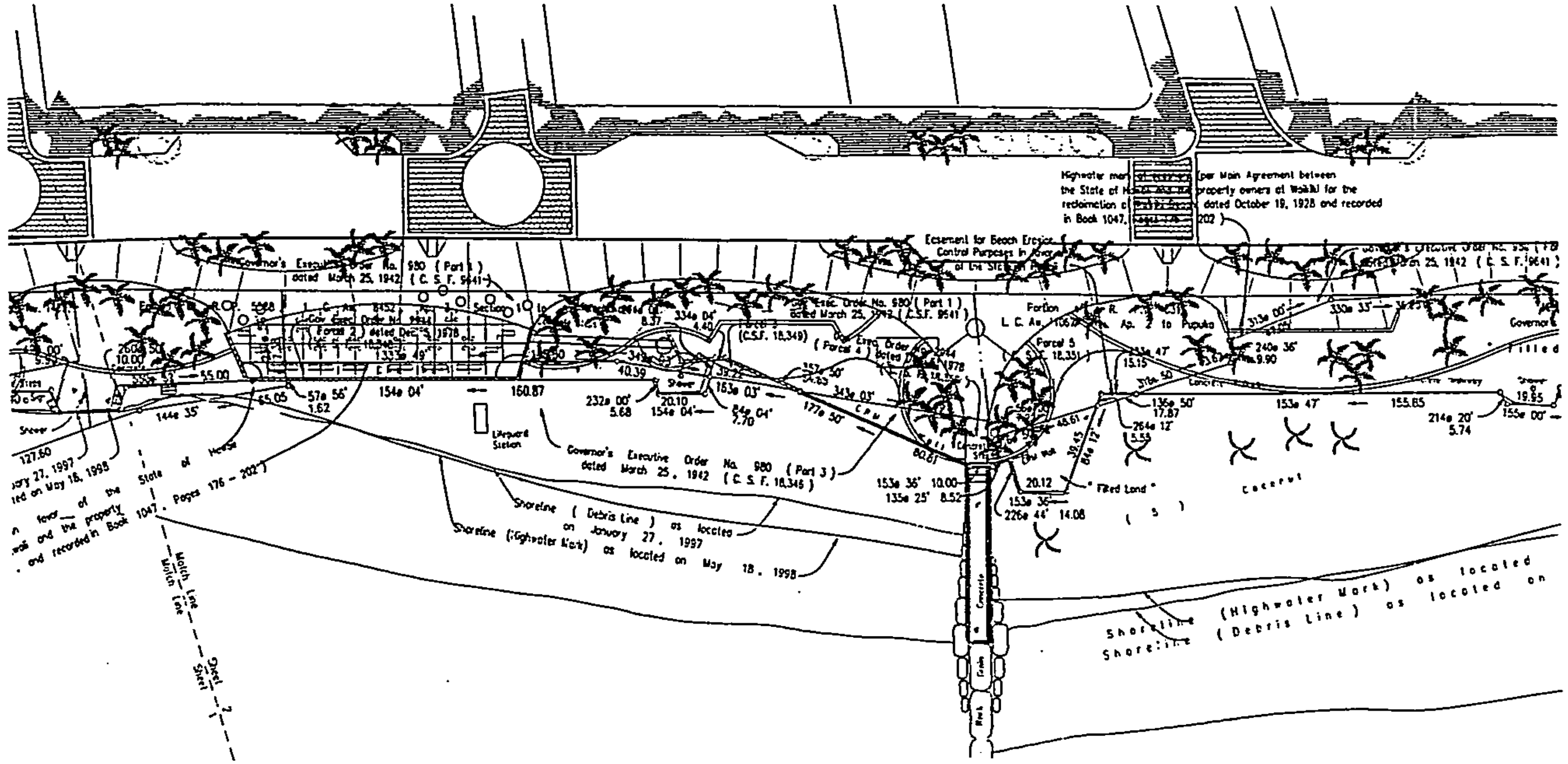
Appendix C

SITE PLANS



Land Court Application 1877
Lot A
"Moana Hotel Premises"
Land Court
Lot A-1-A
Lot B
Lot A-2
Shoreline (Highwater Mark) as located on
Sector Beach Agreement
Lifeguard Station
Easement "A" in State of Hawaii for Beach Purposes
Land Court Application
5413 Sq. Ft.
(10,350 Sq. Ft.)
R. P. 4193
217.50
205.28
168.37
224.28
151.00


TRUE NORTH
S E A
Parcel 1
(C. S. F. 18,347)
HECO Underground Power Line Easement
Shoreline (Debris Line) as located on January 27, 1997
Shoreline (Face of Concrete Slab) as located on January 27, 1997
Shoreline (Face of Concrete Slab) as located on May 18, 1998
Easement for Beach Erosion Control Purposes in favor of the State of Hawaii
Highwater mark at seashore (as per Main Agreement between the State of Hawaii and the property owners at Waikiki Beach for the reclamation of Waikiki Beach, dated October 19, 1928, and recorded in Book 1047, Pages 176 - 202)
Match Line
Match Line
Sheet 2
Sheet 1
Concrete Steps
Shower
44,788 Sq. Ft.
(42,963 Sq. Ft.)
City and County of Honolulu
(Owner)
Portion of R. P. 1272
Rock Groin

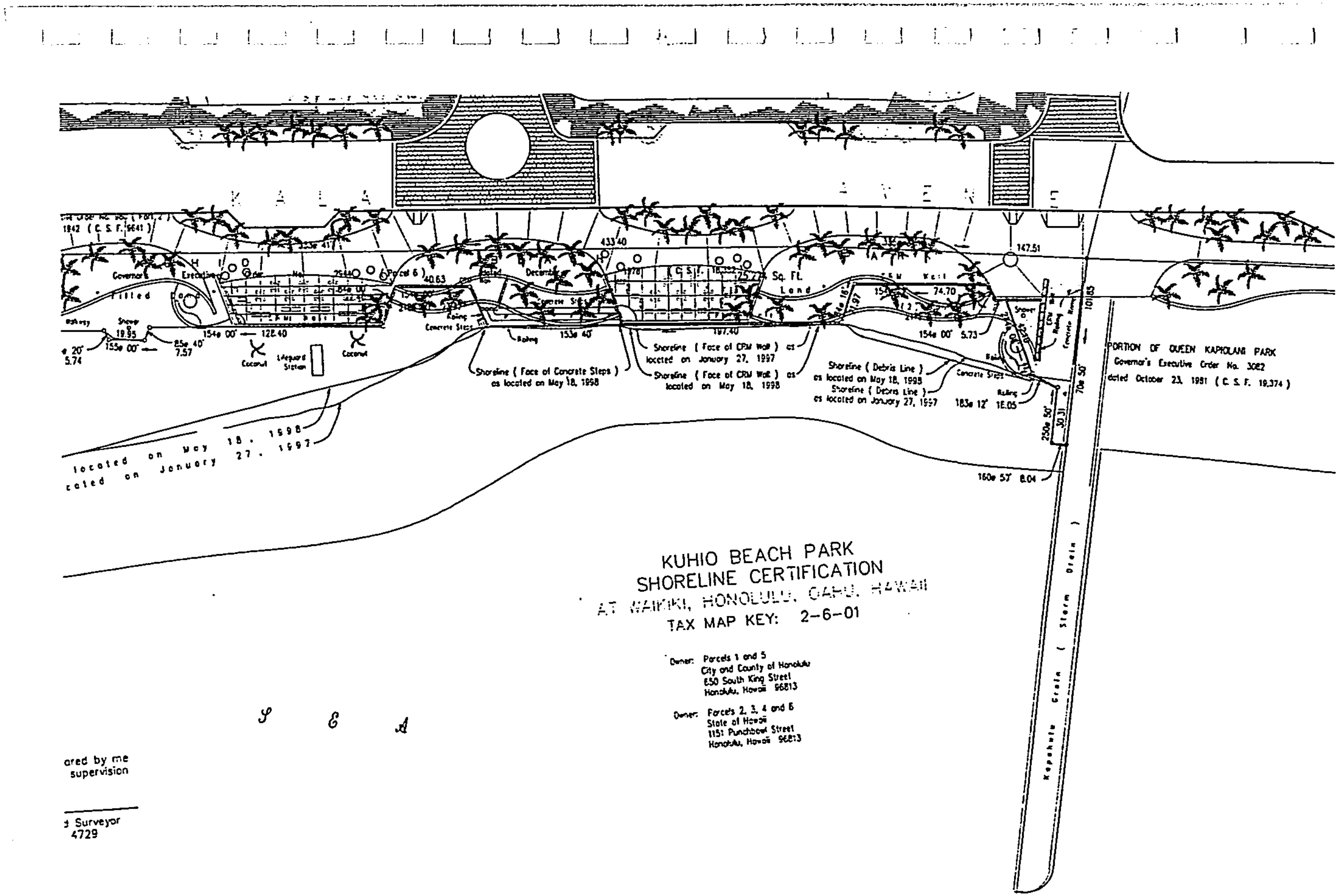


Notes:

Coordinates and azimuths are referred to Government Survey Triangulation Station "Leahi" △

This work was prepared by me or under my direct supervision

Registered Licensed Surveyor
Certificate Number 4729


KUHIO BEACH PARK
SHORELINE CERTIFICATION
AT WAIKIKI, HONOLULU, OAHU, HAWAII
TAX MAP KEY: 2-6-01
Owner: Parcels 1 and 5
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813
Owner: Parcels 2, 3, 4 and 6
State of Hawaii
1151 Punchbowl Street
Honolulu, Hawaii 96813
PORTION OF QUEEN KAPIOLANI PARK
Governor's Executive Order No. 3082
dated October 23, 1981 (C.S.F. 19,374)
Shoreline (Face of Concrete Steps) as located on May 18, 1998
Shoreline (Face of CRM Wall) as located on January 27, 1997
Shoreline (Face of CRM Wall) as located on May 18, 1998
Shoreline (Debris Line) as located on May 18, 1998
Shoreline (Debris Line) as located on January 27, 1997
Kapahulu Groin (Storm Drain)
Lifeguard Station
Coconut
Concrete Steps
Railing
Shower
S E A
ared by me
supervision
d Surveyor
4729

Appendix D

BEST MANAGEMENT PRACTICES

BEST MANAGEMENT PRACTICES (BMP)

City and County of Honolulu
Department of Design and Construction (DDC)
KUHIO BEACH PARK EXPANSION & KALAKAUA
AVENUE PROMENADE, HONOLULU, HAWAII

In accordance with requirements for Best Management Practices to be applied before, during, and after potential pollution-producing activities, the following methods, measures and practices will be applied to the construction of the Kuhio Beach Park Expansion & Kalakaua Avenue Promenade, between Kaiulani and Kapahulu Avenues, TMKs: 2-6-01: 02, 03, 04, 08, 15, 18, and 19.

PROJECT DESCRIPTION

Development of the project will require excavation, filling, grading, general construction, and planting and landscaping. All construction work will take place within the area that is presently covered with the impervious surface. No new structures will be added to the existing sand areas. Fill materials will be placed to convert the areas that are currently covered with the impervious surface into landscaped strips.

Construction activities will include:

- Demolition, clearing and grubbing
- Reconstructing the plaza area and beach support facilities
- Improving beach access
- Providing drainage and grading
- Landscaping

A detailed work schedule will be provided, following approval of this permit application and selection of the construction contractor. Development of the project will commence upon receipt of necessary permits. Overall construction time required is estimated at 6 to 9 months. The total area for the project will be approximately five (5) acres. The project will be constructed in phases to minimize the areas that may be left exposed at any one time. Time to construct each phase will be dependant on the construction contractor.

Construction stormwater management and erosion control mitigation measures will be required and reviewed by the DDC and the State Department of Health (DOH) prior to the start of construction. Such design measures will be prepared in accordance with State and City rules and regulations.

BEFORE CONSTRUCTION

The following practices will be observed, in particular, along the makai boundary of the project:

1. Some portions of the makai project boundary lies adjacent to the sand beach areas. It is anticipated that silt fences will be used to mitigate potential discharges of turbidity to the Pacific Ocean. The construction contractor will assess onsite preconstruction conditions and decide at that time, if the use of a silt curtain or sand bag is feasible. Such control measures would be installed prior to the start of construction and removed following completion of construction periods.

2. The contractor and construction crew will be instructed to avoid use of unstable or sand areas for staging of construction equipment and materials. During construction activities near the sand areas, construction equipment and materials will be kept adjacent to the site within the work area protected by silt curtains and/or sand bags.

DURING CONSTRUCTION AND INSTALLATION

During construction the potential for release of sediments into Kuhio Beach will be carefully controlled. In order to mitigate any potential for turbidity, control measures such as silt fences will be placed around the work sites.

A site specific plan will be provided by the construction contractor undertaking demolition and grading work. The following is a generic description of controls and practices that will be employed as part of the construction effort.

1. Construction Management Technique
   - 1a. Clearing and grubbing will be held to the minimum necessary for grading and equipment operation.
   - 1b. Construction activities will be sequenced to minimize the exposure time of cleared surface area. Areas of one phase will be stabilized before starting another phase. Both vegetative and structural controls will be in place to stabilize the areas by temporarily and permanently protecting disturbed soil surface from rainfall impacts and runoff. After completing the work in one area, the area will be cleared of construction related trash and debris, and equipment mobilized to the next phase.

   - 1c. Erosion and sedimentation control measures will be in place and functional at each work site before construction operations begin, and will be maintained throughout the construction period.
   - 1d. The construction contractor's assigned individual will make sure all erosion and sedimentation controls are maintained and functional throughout all phases of the project.
   - 1e. The stock pile will be covered with vinyl or similar materials to prevent it from being washed off by the storm water. Construction debris and excavated materials that will not be used for construction will be disposed of at permitted facilities.

2. Vegetative Controls
   - 2a. Existing ground cover will not be destroyed, removed or disturbed more than twenty (20) calendar days prior to the start of grading operations.
   - 2c. Areas that remain unfinished for more than 30 calendar days will be hydromulched to provide temporary soil stabilization.
   - 2d. After achieving finished grades, all slopes and exposed areas will be permanently stabilized, as required, by hydromulching with grass seed as soon as practicable.

3. Structural Controls
   - 3a. Storm water flowing toward the construction materials area will be diverted as much as practicable using the appropriate controls such as berms, as determined by the project contractor depending on the site conditions. Storm water flowing toward exposed sections will similarly be diverted using the aforementioned controls such as berms.
   - 3b. Silt fences/curtains and/or sand bags will be installed along the construction site. The purpose of the such measures is to filter the runoff flowing across the work site.

AFTER CONSTRUCTION

Upon completion of construction the following will be executed:

1. New planting and landscaping areas will be backfilled and covered with appropriate specified plant and soil materials.

2. The barriers will remain in place, where necessary, to facilitate drying of the concrete materials and ensure safety of the pedestrians and beach goers.

3. The area will be cleared of construction related trash and debris.

4. Equipment mobilized to the site will be removed.

5. Excess material not utilized for fill will be removed and disposed of in accordance with applicable County and State Regulations.

6. All excess materials will be removed. No new discharge materials will be added to the existing shoreline.

Appendix E

Comments and Responses Regarding the Draft Environmental Assessment

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET • HONOLULU, HAWAII 96813
PHONE (808) 523-4414 • FAX (808) 527-6743

JEREMY HARRIS
MAYOR

JAN NAOE SULLIVAN
DIRECTOR

LORETTA K.C. CHEE
DEPUTY DIRECTOR

1999/CLOG-937(AC)
'99 EA Comments Zone 2

March 18, 1999

Mr. Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation
Department of Land and
Natural Resources
State of Hawaii
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Gehring:

Draft Environmental Assessment (EA) For
Kuhio Beach Improvements

Thank you for the opportunity to comment on the above-referenced beach nourishment project. We support this project as it will enhance the beach recreation opportunities for our visitors and residents alike. The reconstruction of the offshore crib wall and the restoration of Kuhio Beach will complement the City's initiatives in upgrading the infrastructure at Kuhio Beach Park. We have the following specific comments:

1. The final EA should include discussion of the project with regard to the City's Primary Urban Center Development Plan.

2. We note that heavy truck traffic will occur as a result of the project. The final EA should describe the location where the traffic will take place. Any impacts to the use of Kuhio Beach Park should be described in the final EA. We suggest that you coordinate your operation timing with the Department of Design and Construction as well as the Department of Parks and Recreation.

3. Please describe where the sand sources for periodic nourishment will be obtained.

4. The project is supported by the Joint Waikiki Task Force. The Task Force is responsible for coordinating governmental and private activities in the Waikiki area and developing recommendations to the 2000 Hawaii State Legislature.

Should you have any questions, please contact Art Challacombe of our Coastal Lands Branch at 523-4107.

Very truly yours,

for JAN NAOE SULLIVAN
Director of Planning
and Permitting

JNS:am

cc: Office of Environmental Quality Control
✓Elaine Tamaye, Edward K. Noda & Associates, Inc.

posse doc no. 3102

RECEIVED
MAR 19 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0967.99

Ms. Jan Naoe Sullivan
Director
Department of Planning and Permitting
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Ms. Sullivan:

Subject: Draft Environmental Assessment (EA)
<u>Kuhio Beach Improvements, Waikiki, Oahu, Hawaii</u>

This is in response to your letter dated 18 March 1999 regarding the draft Environmental Assessment (EA) for proposed improvements to Kuhio Beach. The following addresses your comments in the order presented in your letter.

1. The final EA will include discussion of the project with regard to the City's Primary Urban Center Development Plan. Please note that the proposed project does not change the designated use of the site as a public beach park.

2. As stated in the draft EA, the quantity of rock required for the breakwater segments should only result in about 5 truck loads of rock to be delivered to the site per day. The proposed route is via Kapahulu Avenue, which should not significantly affect traffic flow within the study area. The draft EA also states: *Phasing of the construction will be performed to the extent possible in order to minimize the area of beach that will be closed due to the construction activities. Because all work will be conducted seaward of the existing seawalls, only the beach and water areas within the existing crib wall system will be closed to the public during construction. Public access along the sidewalk promenade and Kalakaua Avenue would not be impacted.* The project is being coordinated with the Department of Design and Construction and the Department of Parks and Recreation. However, because construction funding for the City's Kuhio Beach Park Expansion project is available but construction funding for our project is <u>not</u> presently available, it is unlikely that work can be timed to coincide.

3. The proposed project will result in a more stable beach planform and profile than at present, however, there will still be the potential for storm wave erosion damage. The frequency and intensity of storm wave attack at Waikiki is not predictable, but fortunately infrequent. Any future beach maintenance/restoration will depend on the future wave climate and beach response, and subject to availability of funding. The nearshore sand pockets directly offshore Kuhio Beach, which are proposed as the sand source for the present project, has sufficient quantity for future nourishment efforts.

4. The support of the Joint Waikiki Task Force will be noted in the Final EA.

If you have any further questions, please contact Mr. Manuel Emiliano, our division's Engineering Branch Chief, at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator

c: √ Elaine Tamaye, Edward K. Noda and Associates, Inc.

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 2ND FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 523-4564 • Fax: (808) 523-4567

JEREMY HARRIS
MAYOR

RANDALL K. FUJIKI, AIA
DIRECTOR

ROLAND D. LIBBY, JR., AIA
DEPUTY DIRECTOR

March 8, 1999

Mr. Howard B. Gehring
Acting Administrator
Division of Boating and Ocean Recreation
Department of Land and Natural Resources
State of Hawaii
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Gehring:

Subject: Draft Environmental Assessment (EA) for Kuhio Beach Improvements
Waikiki, Oahu, Hawaii

We have reviewed the draft EA for your project and offer the following comments.

The solution to correcting the shoreline erosion with the proposed rock breakwater to replace the concrete breakwater crib wall is endorsed.

It is recommended that the final EA include a recommendation for future, periodic maintenance to re-form the beach contours for both the onshore and offshore areas within the breakwater. It is expected that there will be a tendency for a sand build up to drift into the swimming areas over time.

Thank you for the opportunity to comment. If there are any questions, please contact Mr. Donald Griffin of our Planning and Programming Division at 527-6324.

Sincerely,

RANDALL K. FUJIKI
Director

RKF:ei

c: Mr. Gary Gill, Office of Environmental Quality Control
Ms. Elaine Tamaye, Edward K. Noda and Associates, Inc.

RECEIVED
MAR 10 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0969.99

Mr. Randall K. Fujiki
Director
Department of Design and Construction
City and County of Honolulu
650 South King Street, 2nd Floor
Honolulu, Hawaii 96813

Dear Mr. Fujiki:

Subject: Draft Environmental Assessment (EA)
Kuhio Beach Improvements, Waikiki, Oahu, Hawaii

Thank you for your letter dated 8 March 1999 regarding the draft Environmental Assessment (EA) for proposed improvements to Kuhio Beach. We note your endorsement of the proposed plan of improvement.

With respect to recommendations for periodic maintenance of the beach, the proposed improvements will result in a more stable beach planform and profile than at present. The wide gaps between the breakwater segments will allow incoming swell wave energy to maintain the beach slope, similar to the adjacent beach areas outside the crib walls. As stated in the Draft EA, sand presently migrates off the dry beach area into the water area under constant foot traffic, and there is insufficient swell wave energy to transport sand back onto the beach slope. This is particularly true in the Diamond Head Basin where the crib walls are nearly continuous above the high tide water level. While the proposed breakwater segments will remedy this problem and result in a more stable beach configuration, there will still be the potential for storm wave erosion damage. The frequency and intensity of storm wave attack at Waikiki is not predictable, but fortunately infrequent. Any future beach maintenance/restoration will depend on the future wave climate and beach response, and subject to availability of funding.

If you have any further questions, please contact Mr. Manuel Emiliano, our division's Engineering Branch Chief, at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator

c: √ Elaine Tamaye, Edward K. Noda and Associates, Inc.

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0966.99

Mr. William D. Balfour, Jr.
Director
Department of Parks and Recreation
City and County of Honolulu
650 South King Street, 10th Floor
Honolulu, Hawaii 96813

Dear Mr. Balfour:

Subject: Draft Environmental Assessment (EA)
Kuhio Beach Improvements, Waikiki, Oahu, Hawaii

This is in response to your letter dated 11 March 1999 regarding the draft Environmental Assessment (EA) for proposed improvements to Kuhio Beach. The following addresses your comments in the order presented in your letter.

We note your concurrence that the proposed plan of improvement is the best alternative for addressing the project objectives.

With respect to the question regarding the various wave types that affect Waikiki Beach, the draft EA states that *the nearshore wave patterns in the Kuhio Beach sector of Waikiki are relatively consistent because of the bathymetry contours. Wave refraction effects cause both sea and swell waves to approach nearly perpendicular to bathymetry contours, which is from the southwest direction for Kuhio Beach...Exhibit 11 shows a composite of all wave fronts that could be discerned from aerial photographs dating from 1952.* Large sea and swell waves break offshore of the Kuhio Beach crib walls - the offshore locations where these large waves break are the surf sites for which Waikiki is famous. The waves that break landward of the surf sites at the Kuhio Beach crib walls and shoreline are limited in height by the shallow nearshore water depths. The physical model study verified that the nearshore waves are depth-limited. While large waves could be generated by the wave maker, these waves broke offshore and reformed to much smaller wave heights of 3-4 feet by the time they reached the nearshore water depth of -5.5 feet MLLW (prototype) where the wave gage was located.

The wave heights in the study area are described using standard coastal engineering

definitions based on instrumented measurements. Your comment on the reporting of wave height is related to visual observations, not instrumented measurements.

You correctly note that the swimming/wading area would be a smaller area than at present, because some of the existing water area would be replaced with dry beach area. However, the draft EA discusses the fact that the ratio of water area to dry beach area at present is larger than in 1991 because of the erosion of sand from the dry beach area into the water area. The proposed plan will restore and increase the dry beach area only a small amount more than conditions in 1991. There will still be ample sheltered water area to accommodate the users. With respect to potential conflicts between the surfers, swimmers and boogie-boarders, although the draft EA notes that the wide gaps between the breakwater sections will potentially enhance access to the offshore surf and body-board sites, this will not necessarily increase the activity in the landscaped and sand areas compared to present. The activity that presently occurs in Kuhio Beach Park and adjacent Kapiolani Park Beach may be "redistributed" slightly, and there may be additional "mixing" in the areas contained within the crib walls. But the draft EA states that *such mixing would seem to be similar in interaction to that which occurs in other locations along Waikiki's beaches, and in crowded beach parks such as Ala Moana where surfers are constantly crossing beaches and paddling through swimming lanes to the outer reefs and surf.*

The proposed configuration is compared to the Ko Olina lagoons only because the crescent-shaped beaches look similar. However, the fact of the matter is that the existing configuration more closely mimics the problems at Ko Olina with respect to the hazards posed by the strong currents that flow through the narrow gaps. As discussed in the draft EA, one of the objectives of the proposed project is to remedy the hazard caused by strong seaward-flowing currents through the openings in the crib wall. Strong currents develop when the ratio between the enclosed water area to the gap openings is large, because large volume flow through narrow gaps causes high water velocity. The same volume flow through wider gaps causes lower water velocity. By providing wider gaps than at present, and at the same time decreasing the water surface area (because of the wider beach), strong rip currents would not occur. The proposed configuration for both basins will be similar to the existing configuration in the Ewa Basin, where there is presently a 200-foot wide gap with a "sill" at 0 feet MLLW. The only difference would be that the 200-foot wide gap in the reconstructed wall would have no sill (i.e. the existing wall would be removed to the depth of the fronting reef, which is about -2 feet MLLW), and the rock wall sections would be about 2 feet higher than existing.

Your comment, that the absence of the current crib wall will increase the likelihood of Box Jellyfish reaching the shoreline, is true with respect to the Diamond Head basin that is enclosed by the present crib walls. Providing a 200-foot wide gap will potentially allow more jellyfish to reach this section of beach. However, this section of beach is relatively small in comparison to the entire Waikiki Beach shoreline that is affected by the jellyfish. The same precautionary measures applicable to all beaches in Waikiki and Ala Moana would apply to Kuhio Beach.

Mr. William D. Balfour, Jr.
Page 3
April 19, 1999

BOR-E 0966.99

If you have any further questions, please contact Mr. Manuel Emiliano, our division's Engineering Branch Chief, at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator

c: ✓Elaine Tamaye, Edward K. Noda and Associates, Inc.

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 3RD FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 527-6663 • FAX: (808) 527-6675

JEREMY HARRIS
Mayor

KENNETH E. SPRAGUE, P.E., Ph.D.
Director

CHERYL K. OKUMA-SEPE, ESQ.
Deputy Director

ENV 99-22

FEB 17 1999

Mr. Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation
Department of Land and Natural Resources
State of Hawaii
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Gehring:

Subject: Draft Environment Assessment (DEA)
Kuhio Beach Improvements
TMK: (1) 2-6-01

We have reviewed the subject DEA and have no comments to offer at this time.

Should you have any questions, please contact Mr. Alex Ho, Environmental Engineer, at 523-4150.

Sincerely,

CHERYL K. OKUMA-SEPE
KENNETH E. SPRAGUE
Director

cc: OEQC (Gary Gill)
Edward K. Noda & Associates, Inc. (Ms. Elaine Tamaye) ✓

RECEIVED
FEB 1 ? 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

KAZU HAYASHIDA
DIRECTOR

DEPUTY DIRECTORS
BRIAN K. MINAAI
GLENN M. OKIMOTO

IN REPLY REFER TO:
STP 8.8976

February 10, 1999

TO: THE HONORABLE TIMOTHY E. JOHNS, CHAIRPERSON
DEPARTMENT OF LAND AND NATURAL RESOURCES

ATTENTION: MR. HOWARD B. GEHRING
DIVISION OF BOATING AND OCEAN RECREATION

FROM: KAZU HAYASHIDA
DEPARTMENT OF TRANSPORTATION

SUBJECT: KUHIO BEACH IMPROVEMENTS -- DRAFT ENVIRONMENTAL ASSESSMENT

Thank you for your transmittal requesting our comments on the subject Draft Environmental Assessment.

The subject project will not impact our State transportation facilities.

We appreciate the opportunity to provide comments.

c: OEQC
Edward K. Noda and Associates, Inc.

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FEB 1 1 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION
79 SO. NIMITZ HWY. • HONOLULU, HAWAII 96813-4898

KAZU HAYASHIDA
DIRECTOR

DEPUTY DIRECTORS
BRIAN K. MINAAI
GLENN M. OKIMOTO

IN REPLY REFER TO
HAR-EP
6237.99

February 18, 1999

Ms. Elaine E. Tamaye, Vice President
Edward K. Noda and Associates, Inc.
615 Piikoi Street, Suite 300
Honolulu, Hawaii 96814-3139

Dear Ms. Tamaye:

Subject: Draft Environmental Assessment (EA) of Kuhio Beach Improvements

Thank you for providing the subject EA for our review. We have no comments to offer other than to wish you success in the project.

Please call Mr. Glenn Soma at 587-2503 if there are any questions.

Very truly yours,

Thomas T. Fujikawa
Harbors Administrator

RECEIVED
FEB 2 5 1999
EDWARD K. NODA & ASSOCIATES

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET 10TH FLOOR • HONOLULU HAWAII 96813
PHONE (808) 523-4182 • FAX (808) 523-4054

JEREMY HARRIS
MAYOR

WILLIAM D. BALFOUR, JR.
DIRECTOR

MICHAEL T. AMII
DEPUTY DIRECTOR

March 11, 1999

Mr. Howard B. Gehring, Acting Administrator
Department of Land and Natural Resources
Division of Boating and Ocean Recreation
State of Hawaii
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Gehring:

Re: Draft Environmental Assessment
Kuhio Beach Improvements
Waikiki, Oahu, Hawaii

Thank you for the opportunity to review the above-referenced document.

Exhibit 3 of the proposed Kuhio Beach (Plan of Improvement) appears to be the better solution of the three configurations for addressing the sand replenishment under the guidelines of the study.

We were unable to determine from the draft if any consideration was given to the various ocean swells that affect Waikiki Beach. These swells include the summer south and southwest swells, the winter west swells, the tradewind swells, and the south and southeast swells that occasionally reach a height of up to 20 feet in the winter. The draft indicated that a wave generator was used for the study.

Since January 1999, the National Weather Service has required the reporting of wave height to be more accurate by reporting the full "face" of the wave height and not just the mean height. The draft does not mention this consideration which could affect the wave action study relating to overtopping and sand migration.

The swimming/wading area, enjoyed by the elderly and the very young, is diminished in this proposal. The access to the surf area, while a benefit to surfers, may become a safety hazard to others using the shoreline/ocean areas. Access to the surf sites will increase activity in the landscaped and sand areas. Further impact may be realized in the "No-Surfing" area known as Graveyards, just off the Kapahulu groin. More accidents could be expected from conflicts of activities between the surfers, swimmers and boogie-boarders.

The proposed configuration is very similar to the Ko Olina lagoons. The Ko Olina lagoons have a very fast (six knots) rip current that requires a safety rope to be available to swimmers as an aide to prevent themselves from being pulled out of the lagoon into the open ocean. This may be an unexpected result in Waikiki. Strong currents may also be exhibited around the groin edges. We recommend that the Emergency Services Department be consulted on these matters.

The absence of the current crib wall will increase the likelihood of Box Jellyfish reaching the shoreline. The Box Jellyfish visit Waikiki two to three days every month. The partial (two-foot) crib wall will allow more jellyfish to enter the smaller beach area, and, in turn, the frequency of jellyfish encounters may increase.

Should you have any questions, please contact Mr. Craig Mayeda, Park Maintenance and Recreation Services Administrator, at 527-6333.

Sincerely,

W.D. Balfour Jr.

WILLIAM D. BALFOUR, JR.
Director

RECEIVED
MAR 16 1999
EDWARD K. NODA & ASSOCIATES

WDB:cu
(99-0283CT)

cc: Mr. Gary Gill, Office of Environmental Quality Control
✓Ms. Elaine E. Tamaye, Edward K. Noda and Associates, Inc.

In addition our Department's Division of Aquatic Resources has review the DEA and has the following comments:

1. No significant long-term impacts to aquatic life is expected from the project although pumping of offshore sand may cause some turbidity and disturbance in the area and certain benthic organisms may be temporarily displaced during the implementation of this project. The immediate impact upon aquatic resources is envisioned to be minimal and mitigation measures have been proposed to prevent or limit any adverse effects to aquatic resource values in public waters.

2. Modifying beach platform behavior should prevent or limit sand transport from the area and the sand replacement will expand and enhance the recreational opportunities for the public along this shoreline.

Please feel free to call Sam Lemmo of the Planning Section at 587-0381, should you have any questions on this matter.

Aloha,

Dean Y. Uchida, Administrator
Land Division

cc: Chairperson
DOBOR
Engineering Branch

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0972.99

MEMORANDUM

TO: Dean Y. Uchida, Administrator
Land Division

FROM: Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation

SUBJECT: Draft Environmental Assessment (EA)
Kuhio Beach Improvements, Waikiki, Oahu, Hawaii

This is written in response to your letter dated 11 March 1999 addressed to Ms. Elaine Tamaye of Edward K. Noda and Associates regarding the draft Environmental Assessment (EA) for the proposed improvements to Kuhio Beach. We note the support of your Land Division Planning Branch, Coastal Lands Program, for implementation of the proposed project. The following responds to comments in the order presented in your letter.

Regarding the elevation of the proposed breakwater segments, the elevation of +5 feet MLLW was determined after much coastal engineering analysis and testing. Contained in the draft EA is a report on the physical model study that was conducted to evaluate the structural stability of the breakwater design, the wave runup and overtopping characteristics of the breakwater, and the planform behavior of the beach protected by the segmented breakwater system. As discussed in the draft EA, the potential problem of visual intrusion is reduced by keeping the breakwater height low, the same elevation as the existing crib wall segment next to the Kapahulu Storm Drain. *If the breakwater was designed to prevent wave overtopping from hurricane waves, it's crest elevation would likely obscure the horizon from a viewing point on-shore. The proposed project addresses this issue by maintaining an elevation similar to the existing crib wall, and it also provides larger gaps which further accommodate views.* Exhibits 7 through 10 in the draft EA demonstrate that the proposed breakwater segments will have little impact on seaward views compared to existing.

We note your concerns about the extent of impacts on nearshore reefs. For the proposed Kuhio Beach project, sand from the offshore area will be "recycled" back to the beach, reducing

potential impacts that off-site sand may have on the littoral environment. It is not the intent of the EA to provide comprehensive perspective of issues other than site specific impacts associated with the proposed project. The issue of periodic sand nourishment and the potential effects on reef ecology and surf sites due to erosion and movement of sand from the beach to offshore areas must be evaluated on a site-specific and project-specific basis.

The draft EA identifies the potential impacts to the marine environment offshore Waikiki from sand that had been placed along the shoreline over the past 50 years in attempts to create and maintain continuous beachfront. *It appears that the dominant environmental factor shaping the nearshore benthic and reef fish communities off Waikiki is the movement of sand, much of which originated in large part from prior beach replenishment projects.* For the areas offshore Kuhio Beach where extensive deposits of sand have accumulated in pockets on the limestone reef platform, the benthic community is limited because of the scouring action of wave-driven sand. Surveys conducted offshore Kuhio Beach reported 0% coral coverage at the 10-foot depth (surf zone), 12% at 20-foot depth, and 2% at the 40-foot and 60-foot depths. Coral coverage was higher offshore the Aquarium and highest offshore the northern sector of Waikiki (up to 33% at 20 foot depth offshore the Hilton Hawaiian pier), where vertical relief provides settling surfaces above the level of sand movement. Therefore, even in Waikiki where hundreds of thousands of cubic yards of sand have been brought in to artificially nourish the beach, and tens of thousands of cubic yards of sand have eroded and settled in offshore areas[1], probable impacts to the marine environment are dependent on site specific characteristics, with some sectors being impacted more than others because of the physiographic differences.

We note the concurrence of your department's Division of Aquatic Resources with respect to the EA's determination that the proposed project will not result in significant impacts to aquatic life.

If you have any further questions at this time, please contact Manuel Emiliano at 587-0122.

c: ✓ Elaine Tamaye, Edward K. Noda and Associates, Inc.

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[1] The U.S. Army Corps of Engineers' 1963 report on the Cooperative Waikiki Beach Erosion Control Study suggests that about 157,000 cubic yards of sand artificially placed on the shoreline from Kuhio Beach to the Natatorium had eroded between 1951 and 1960.

use of the habitat. We conclude that the removal of some portion of the sand from these areas will have no significant impact on invertebrate or fish habitat utilization.

If you have any questions, please contact me at our offices.

Sincerely,

David Ziemann /LRC

David A. Ziemann, Ph.D.

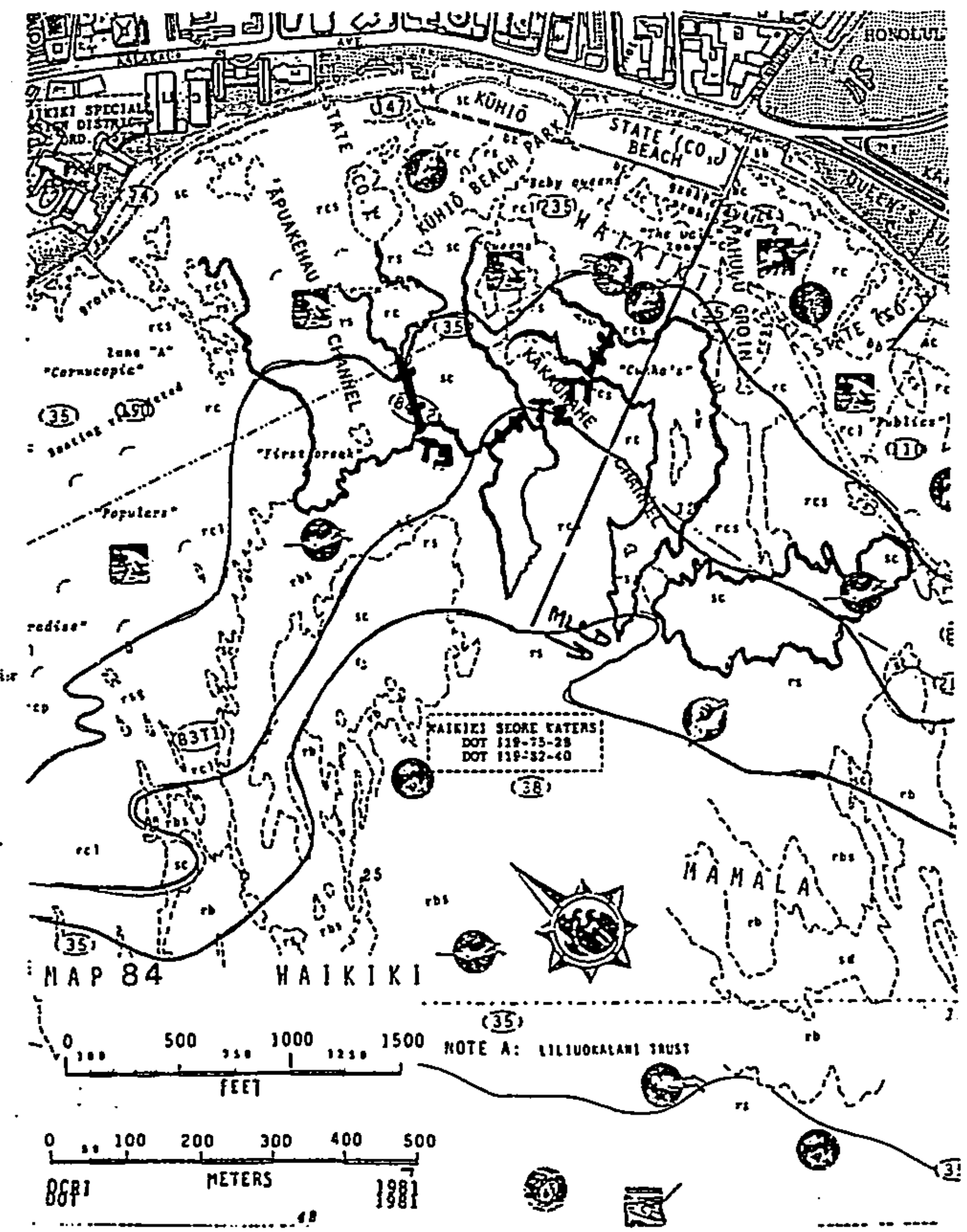

Figure 1. Transect Locations

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P O BOX 621
HONOLULU HAWAII 96809

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND DIVISION
STATE PARKS
WATER RESOURCE MANAGEMENT

Ref.:PB:SL

MAR 11 1999

RECEIVED
MAR 12 1999
EDWARD K. NODA & ASSOCIATES

Ms. Elaine Tamaye
Edward K. Noda and Asscciates. Inc.
615 Piikoi Street
Suite 1000
Honolulu, Hawaii 96814

Dear Ms. Tamaye:

Subject: Draft Environmental Assessment for the Kuhio Beach Improvements, Waikiki, Oahu, Hawaii

The Land Division Planning Branch, under the authority of the Coastal Lands Program (CLP), has reviewed the draft EA for the Kuhio Beach Improvements Project and has the following comments.

The CLP supports the implementation of the subject project. The beach improvements will improve recreational opportunities for both residents and tourists. We believe that this project will provide economic benefits to Waikiki businesses and the Hawaii State economy in general. The beach at Waikiki, although contrived, is a major, if not "the" major visitor amenity in the Waikiki Special District.

It appears that environmental impacts can be sufficiently mitigated during different phases of the project such as demolition and construction of crib walls, pumping of offshore sand, transport and beach nourishment. More specific construction methods will need to be reviewed and evaluated to ensure that the most environmentally benign methods are employed to the greatest extent practical. If impacts can be mitigated during construction, the project will result in beneficial environmental impacts to marine fauna. Sand used in the project will be stabilized by the new crib walls resulting in less sand loss into nearshore waters. The new structures should provide opportunistic habitat for marine organisms.

During the final design phase, we would ask that the crib wall elevations be scrutinized to determine the optimal elevation when considering possible infringement upon makai views and potential wave overtopping.

Finally, we are concerned over the author's discussion of the effects of sand on marine organisms and surf sites. While no one would doubt that sand has affected the biological communities in the nearshore waters of Waikiki, the issue must be placed within its proper context, only after objective scientific inquiry. We believe that the issue of reef degradation and the impact on surf sites is somewhat more complex than represented in the report and could involve a number of interrelated factors such the effects of Hurricane Iwa (1982) and Iniki (1992) on marine substrate. Also, there is no substantive historical discussion of the nature and extent of the biological communities off Waikiki in the report so there is nothing to compare present conditions with conditions that predate sand nourishment or for that matter, the development of the Waikiki area. In addition, has the impact of foot traffic, at least in the nearshore area, been considered?

One reason we are raising this concern is because the CLP is involved in several beach nourishment projects statewide that will ultimately involve sand placement within the marine environment. People who are critical of beach nourishment as a coastal erosion management option, often point to Waikiki (i.e., the loss of coral and impact to surf sites) to illustrate its negative site. While this is a valid concern, one that is worthy of in-depth scientific analysis, we believe that the discussion which focuses solely on the degradation of Waikiki's marine environment and world renowned surf sites, as a result of periodic sand nourishment, has been treated somewhat anecdotally, without the requisite scientific rigor. We would prefer to see a more in-depth analysis of the Waikiki situation than is currently given to provide a clearer perspective on the issue of reef degradation and the interrelated factors causing it in Waikiki.

This being said, we believe that the project as proposed will protect and improve existing aquatic resources and an in-depth analysis is not necessarily warranted on this project given the project objectives and design, which are sound. Removing sand from the offshore reef pockets, while immediately displacing some marine organisms that thrive there, should restore, to some extent, reef habitat by restoring vertical relief which is important for coral growth and fish aggregation. The new crib wall design should also serve to reduce the amount of sand that may re-enter the nearshore aquatic environment, thereby partially correcting a long standing problem as discussed by the consultant.

While we agree that the issue of beach nourishment and its effects on reef ecology and surf sites warrants additional attention, any environmental documentation provided for public/agency review should refrain from drawing conclusions that have not yet been adequately studied and tested, because associating reef and surf site degradation with the practice of beach nourishment may not provide reviewers with a comprehensive perspective on the issue.

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0970.00

MEMORANDUM

TO: Francis G. Oishi, Aquatic Biologist
Division of Aquatic Resources

FROM: Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation

SUBJECT: Draft Environmental Assessment (EA)
Kuhio Beach Improvements, Waikiki, Oahu Hawaii

Thank you for your comments dated 22 January 1999 on the in-house draft EA for proposed improvements to Kuhio Beach. Unfortunately, your comments were not provided in time to be incorporated into the draft EA prior to publication in the OEQC Bulletin and distribution for formal review/comment. However, the following will be reflected in the final EA in response to your comments.

With respect to your comment regarding the importance of sand biotopes as a functional habitat, generally speaking this may be true, but the sand deposits proposed to be used as a source of sand for Kuhio Beach restoration is truly depauperate of marine life. As discussed in the draft EA: *Size distribution analyses of sand samples indicate that the existing sand deposits are well sorted and probably undergo constant movement. Such sorting and movement would result in interstitial waters of the sand deposits containing nutrient levels similar to overlying waters...The well sorted nature of the sand results in little organic material being incorporated into the deposits, and the lack of organic detritus in the sand limits the numbers of infaunal organisms that can be supported.* However, because it has been almost 9 years since the marine biota survey was performed, we conducted a biological and sediment infaunal survey of the sand deposits offshore Kuhio Beach on 11 February 1999. Attached are the results of the survey performed by the Oceanic Institute, which describes the sand deposits as barren in terms of infaunal organisms. Also, no large benthic invertebrates or bottom-feeding fish were observed in the sand habitats. They conclude that: *The sand habitat does not appear to support sufficient biological resources to serve as an important feeding area for large invertebrates or fish. While the sand habitat may be used as resting areas by certain species of fish, the removal of some portion of the sand is not expected to impact this use of the habitat.*

With respect to the Waikiki Marine Life Conservation District (MLCD) located directly adjacent to the project site on the Diamond Head side, we will provide additional information in the final EA describing the boundaries and prohibited activities. The proposed reconstruction of the crib walls will not impact on the MLCD, and the removal of sand from the deposits offshore Kuhio Beach for beach restoration purposes will be restricted to areas that are not within the MLCD.

Construction activities are not expected to impact fishing, spearfishing, snorkeling, or other offshore activities that occur in the vicinity of Kuhio Beach. However, any activities that occur within the present limits of the crib-walled area would be temporarily restricted during the period of construction for safety reasons.

If you have any further questions, please contact Mr. Manuel Emiliano at 587-0122.

Enclosure

c: √Elaine Tamaye, Edward K. Noda and Associates, Inc.

Oceanic Institute
CENTER FOR APPLIED AQUACULTURE

March 3, 1999

Ms. Elaine Tamaye
E. K. Noda & Associates, Inc.
615 Piikoi Street, Suite 300
Honolulu, Hawaii 96814-3139

Dear Ms. Tamaye:

Kuhio Beach Improvements

Review comments by the State Division of Aquatic Resources on the Draft Environmental Assessment for the Kuhio Beach Improvement Project raised the issue of the sand channels being potentially important habitat for both infauna (mollusks, crustaceans and other invertebrates) as well as forage and resting habitat for fishes such as juvenile goatfish (weke). Pervious surveys for this project did not focus on the sand habitat, but rather focused on the hard bottom, coral reef habitat. In order to address the concerns raised by the DAR, we conducted a biological and sediment infaunal survey of the sand habitat.

Materials & Methods

Biological surveys were conducted on February 11, 1999, during a period of light winds and calm (1 ft) seas. Fish transects were conducted across the offshore sand channels (Figure 1) by a diver using SCUBA equipment. Observations of fish species, abundance and size were recorded within a 3 m band on each side of the transect line, between the surface and the bottom. Transects, across the total width of each sand channel, were between 96 and 118 m in length.

On Transects 2 and 3 there were rows (0.5 to 1 m wide and up to 10 m long) of loose *Sargassum echinocarpum* covering 10% to 30% of the sand bottom. The loose Sargassum was searched extensively for fish, but none were observed within the Sargassum drifts.

At two stations along each transect, grab samples of bottom sediment were taken, held in 2.5 l plastic containers, and transported back to the laboratory. Sand samples were gently floated through a 1 mm mesh sieve to collect small benthic organisms. The supernatant was also examined for organisms.

Results

Results of the three fish survey transects are presented in the table below.

The fish species seen on Transect 1, *Hyporhampus acutus*, also known as iheihe or acute halfbeak, is a surface-dwelling species, feeding on floating bits of algae, zooplankton and small fish. The only other fish seen over the sand channel but outside the transect area was a small school of 20 akule (*Selar crumenophthalmus*) about 0.17 m in length. Akule rest in schools over sandy areas during the day and feed primarily on zooplankton at night.

No large benthic invertebrates were observed on the transects. One solitary burrow (10 mm diameter) was seen, as well as a few worm casts on Transect 2. Only one organism was found in the sand samples.

	Transect 1	Transect 2	Transect 3
Depth (m)	2.1 – 3.0	3.7	3.9
Visibility (m)	7.6	9.1	6.1
Transect Length (m)	118	96	115
Biomass (grams m^{-2})	0.22	0	0
		No Fish	No Fish
Hyporhampus acutus	4 indiv. @ 0.3 m		
	No invertebrates observed	No invertebrates observed	No invertebrates observed

The results of the separation and microscopic analysis of sand samples are presented below. Only one living organism, a post-larval goby, was found in the sand samples.

Sample ID	Total vol. / >1mm frac.vol. (ml)	Live organisms	% mollusk fragments	% coral fragments and sand	% other (crab fragments, urchin spines, worm casing)
Transect 1A	1780 / 20	0	95	4	1<
Transect 1B	1500 / 200	1 (18 mm Gobidae)	30	70	1<
Transect 2A	1850 / 10	0	75	25	1<
Transect 2B	2095 / 20	0	70	30	1<
Transect 3A	1902 / 2	0	80	20	1<
Transect 3B	1410 / 10	0	75	25	1<

Examination of sediment samples collected from six locations along the three transects revealed no evidence of use of the habitat by small infauna. While the sediment samples contained from 30-95% mollusk fragments, no live mollusks of any size were found in the samples. Also absent were small crustaceans and polychaete worms, although fragments of crustacean carapace and worm castings were found in low numbers.

Summary

Our examination of the sand channel habitats off Kuhio Beach which are proposed as the source of sand for beach replenishment revealed the areas to be very barren in terms of infaunal organisms which could serve as food for larger invertebrates or fish. No large benthic invertebrates or bottom-feeding fish were observed in the sand habitats during the surveys. The sand habitat does not appear to support sufficient biological resources to serve as an important feeding area for large invertebrates or fish. While the sand habitat may be used as resting areas by certain species of fish, the removal of some portion of the sand is not expected to impact this

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
COMMISSION ON WATER RESOURCES MANAGEMENT
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS

January 22, 1999

JAN25'99PM 3:53BOR DIV

Mr. Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation

Re: Comments to draft Environmental Assessment on Kuhio Beach Improvement Project.

Dear Mr. Gehring:

First of all I apologize for not getting these comments on the proposed project by the stipulated deadline. I will agree with the assessment in the draft document that the area offshore of Kuhio Beach is a disturbed area because of past beach replenishment activities. However, the proposed project will alter the marine environment, whatever that may be at this time.

The survey cited in the environmental assessment for baseline water quality and marine assemblages inventory is old (9 years) and does not indicate the importance of sand biotopes as a functional habitat, serving various shelled molluscs, crustaceans, other marine invertebrates important to the marine food web and certain reef fishes. The summer months are especially significant time for juvenile fishes like weke (goatfish) which use sandy bottoms as forage and resting areas. Therefore, any construction methods selected to dredge and transport sand landward should take entrainment into consideration and to try and avoid this.

The proposed construction site is adjacent to the Department's Waikiki Marine Life Conservation District (MLCD), established under Hawaii Administrative Rule Chapter 13-36 (attached). The boundary for the MLCD extends from the shoreline out seaward for a distance of 500 yards, where sand deposits exist. Specifically the adminstrative rule prohibits the take, altering, and the removal of sand, coral, rock, or other geological features. A sand replenishment project such as the one proposed, might infringe on area within the MLCD, and so this rule provision needs to be taken into account.

Any proposed construction activity offshore needs to take into account, fishing activity that may occur there, eg. fishing, spearfishing, snorkeling, etc.. Some pole fishing at night occurs along this section of beach.

Thank you for this opportunity to provide comments.

Sincerely,

Francis G. Oishi

Francis G. Oishi, aquatic biolgist
Division of Aquatic Resources

Attachment

cc: W. Devick

HAWAII ADMINISTRATIVE RULES

TITLE 13

DEPARTMENT OF LAND AND NATURAL RESOURCES

SUBTITLE 4 FISHERIES

PART I MARINE LIFE CONSERVATION DISTRICTS

CHAPTER 36

WAIKIKI MARINE LIFE CONSERVATION DISTRICT, OAHU

§13-36-1 Boundaries. The Waikiki Marine Life Conservation District shall include that portion of the submerged lands and overlying waters offshore of Kapiolani Beach Park beginning at the high water mark on the shoreline to a seaward distance of five-hundred yards (457.2 meters) or to the seaward edge of the fringing reef if one occurs beyond five-hundred yards (457.2 meters), between the western boundary delineated by a straight line drawn seaward extending the ewa (western-most) edge of the groin located seaward of the Kalakaua-Kapahulu avenues junction and the eastern boundary delineated by a straight line seaward extending the ewa (western-most) edge of the wall of the Waikiki War Memorial Natatorium, as delineated in "Map of the Waikiki Marine Life Conservation District, Oahu 10/29/87" attached at the end of this chapter. [Eff: MAY 27 1988] (Auth: HRS §190-3) (Imp: HRS §§190-1, 190-2, 190-3)

§13-36-2 Prohibited activities. No person shall engage in the following activities in the Waikiki Marine Life Conservation District:

(1) Fish for, catch, take, injure, kill, possess, or remove any finfish, crustacean, mollusk including sea shell and opihi, live coral, algae or limu, or other marine life, or eggs thereof;
(2) Take, alter, deface, destroy, possess, or remove any sand, coral, rock, or other geological feature, or specimen; or
(3) Have or possess in the water, any spear, trap, net, crowbar, or any other device that may be used for the taking or altering of marine life, geological feature, or specimen. [Eff: MAY 27 1988] (Auth: HRS §190-3) (Imp: HRS §§190-1, 190-3)

§13-36-3 Exceptions; permits. The department may issue permits to engage in activities otherwise prohibited by law or section 13-36-2 under such terms and conditions it deems necessary to carry out the purpose of chapter 190, Hawaii Revised Statutes:

(1) To take for scientific, propagation, or other purposes any form of marine life or eggs thereof otherwise prohibited by law, or engage in any other prohibited activity; and provided that:
(2) The board may revoke any permit for any infraction of the terms and conditions of the permit, and a person whose permit is revoked shall not be eligible to apply for another permit until the expiration of a specified period from the date of revocation as provided by law. [Eff: MAY 27 1988] (Auth: HRS §190-3) (Imp: HRS §§187A-6, 190-4)

§13-36-4 Penalty. A person violating the provisions of this chapter, or the terms and conditions of any permit issued as provided by this chapter, shall be punished as provided by section 190-5, Hawaii Revised Statutes. [Eff: MAY 27 1988] (Auth: HRS §190-3) (Imp: HRS §190-5)

UNOFFICIAL SIZE

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0973.99

MEMORANDUM

TO: David W. Blane, Director
Office of Planning

FROM: Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation
Department of Land and Natural Resources

SUBJECT: Draft Environmental Assessment (EA)
Kuhio Beach Improvements, Waikiki, Oahu, Hawaii

Thank you for your comments dated 10 March 1999 on the draft EA for the proposed improvements to Kuhio Beach. We note your support of the proposed project. We also note the support of the Waikiki Working Planning Group, and the Joint Waikiki Task Force.

Although construction funds for the project are not yet available, funding for detailed design and engineering have recently been released by the Governor. The design and construction phase of the project will be administered by DLNR's Land Division, Engineering Branch. The department will strive to obtain construction funding in the next legislative session.

If you have any further questions at this time, please contact Mr. Manuel Emiliano at 587-0122.

c: ✓ Elaine Tamaye, Edward K. Noda and Associates, Inc.

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EDWARD K. NODA & ASSOC., INC.

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801

BRUCE S. ANDERSON, Ph.D., M.P.H.
DIRECTOR OF HEALTH

In reply, please refer to:
File:

April 5, 1999

99-025/epo

TO: Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation
Department of Land and Natural Resources

FROM: Gary Gill
Deputy Director for Environmental Health

SUBJECT: DRAFT ENVIRONMENTAL ASSESSMENT (DEA)

Kuhio Beach Improvements
Waikiki, Oahu
TMK: 2-6-1

Thank you for allowing us to review and comment on the subject request. We do not have any comments to offer at this time.

c: OEQC
Edward K. Noda
and Assoc., Inc.

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APR 0? 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION

TIMOTHY E. JOHNS, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
JANET E. KAWELO

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND RESOURCES
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS
WATER RESOURCE MANAGEMENT

February 23 1999

MEMORANDUM

LOG NO: 22865
DOC NO: 9902EJ24

TO: Howard B. Gehring, Acting Administrator
Boating and Ocean Recreation

FROM: Don Hibbard, Administrator
Historic Preservation Division

SUBJECT: Chapter 6E-8 Historic Preservation Review -- Draft Environmental Assessment Kuhio Beach Improvements
Waikiki, Kona, O'ahu
TMK: 2-6-01

A review of our records shows that there are no known historic sites at the offshore location proposed for the Kuhio Beach improvements. A historic site, the Waikiki Wizard Stones, which is located between the beach and Kalakaua Avenue, will not be affected by the improvements proposed in this project. Therefore we believe that this project will have "no effect" on historic sites.

If you have any questions please call Elaine Jourdane at 692-8027.

EJ:jk

c: OEQC, 235 S. Beretania Street, Room 702, Honolulu, HI 96813
√ Elaine Tamaye, Edward K. Noda and Associates, Inc. 615 Piikoi Street, Suite 300, Honolulu, HI 96814

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MAR 02 1999
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BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
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TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0971.99

MEMORANDUM

TO: Don Hibbard, Administrator
Historic Preservation Division

FROM: Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation

SUBJECT: Draft Environmental Assessment (EA)
Kuhio Beach Improvements, Waikiki, Oahu, Hawaii

Thank you for your review and comments dated 23 February 1999 on the draft EA for proposed improvements to Kuhio Beach. We note your determination of "no effect" on historic sites.

If you have any further questions, please contact Manuel Emiliano at 587-0122.

c: √ Elaine Tamaye, Edward K. Noda and Associates, Inc.

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
PACIFIC PARK PLAZA • 711 KAPIOLANI BOULEVARD SUITE 1200 • HONOLULU HAWAII 96813
PHONE (808)523-4529 • FAX (808)523-4730

JEREMY HARRIS
MAYOR

CHERYL D. SOON
DIRECTOR

JOSEPH M. MAGALDI, JR
DEPUTY DIRECTOR

TPD2/99-00625R

March 8, 1999

Mr. Howard B. Gehring, Acting Administrator
Department of Land and Natural Resources
State of Hawaii
Division of Boating and Ocean Recreation
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Gehring:

Subject: Draft Environmental Assessment (EA)
Kuhio Beach Improvements, Waikiki

This is in response to the February 8, 1999 letter from Ms. Elaine Tamaye of Edward K. Noda and Associates requesting the review of the subject document.

The Department of Transportation Services requests the earliest notification of construction and other beach work which involve transporting of materials and/or submittal of a traffic control plan to the Traffic Division (Street Usage).

Should you have any questions, please contact Ms. Faith Miyamoto of the Transportation Planning Division at 527-6976.

Sincerely,

Cheryl D. Soon

CHERYL D. SOON
Director

cc: Mr. Gary Gill, Office of Environmental Quality Control
✓Ms. Elaine Tamaye, Edward K. Noda and Associates

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MAR 1 0 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0968.99

Ms. Cheryl D. Soon
Director
Department of Transportation Services
City and County of Honolulu
711 Kapiolani Boulevard, Suite 1200
Honolulu, Hawaii 96813

Dear Ms. Soon:

Subject: Draft Environmental Assessment (EA)
Kuhio Beach Improvements, Waikiki, Oahu, Hawaii

This is in response to your letter dated 8 March 1999 regarding the draft Environmental Assessment (EA) for proposed improvements to Kuhio Beach.

Your letter requests notification of construction which involve transporting of materials and/or submittal of a traffic control plan to the Traffic Division. Please note that construction funds are not yet available for the project, however, your department will be apprised as soon as practicable regarding the anticipated start of construction and other beach work. The design and construction phase of the project will be administered by our Land Division, Engineering Branch.

If you have any further questions at this time, please contact Mr. Manuel Emiliano, our division's Engineering Branch Chief, at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator

c: ✓ Elaine Tamaye, Edward K. Noda and Associates.

To: Mr. Howard Gehring, Acting Administrator, DOBOR, DLNR

From: The Waikiki Surfing Ohana, Waikiki, HI
POC--Jordan Jokiel
3364 Kaau St., Honolulu, HI 96816

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MAR 1 0 1999
EDWARD K. NODA & ASSOCIATES

Members of the Waikiki Surfing Ohana have reviewed the Draft Environmental Assessment for the Kuhio Beach Improvements Project. The Ohana is a diverse yet close-knit group made up of over 400 members from the local community who share a love for the ocean and a passion for surfing in Waikiki. Kuhio Beach has long been a gathering place for the Ohana where, for generations, family and friends have met to surf, talk story, relax and enjoy life "Hawaiian style". The following comments outline some of the concerns and questions raised by DLNR's proposed Waikiki project.

The EA states that "Surfing and surf sites in the vicinity of the project will not be adversely affected..."(page 8). On page 18 it goes on to say that "Sand from past beach nourishment projects have degraded the reefs in Waikiki. Siltation and infilling of nearshore reef areas from sand eroded off the beaches have caused detrimental impacts to the reef life and surfing sites." What is so different about this project? How can we be assured that this will not happen again.?

On page 13 the EA states "it is probable that at least some of the sand found in the nearshore areas originated on Waikiki beaches during previous beach replenishment projects." What guarantees are there that sand from this project will not again be deposited in nearshore waters--especially in areas that ruin or degrade surf breaks.

On page 53 the plan states, "No irrevocable commitment to loss or destruction of any natural or cultural resource would result (from this project)."
In the Environmental Assessment surf breaks and the beach area within the project site should be treated as cultural resources or Traditional Cultural Properties as outlined by Parker and King in the National Register Bulletin #38, National Park Service. This designation would afford these culturally rich areas the additional protection and consideration they deserve. The Environmental Assessment refers to these areas simply as "recreational" areas. In fact the only cultural resource recognized in the EA is the Wizard Stones. Also, in its EA <u>Kuhio Beach Park Expansion and Kalakaua Avenue Promenade</u>, the City and County of Honolulu ironically recognizes the Duke Statue as a cultural feature yet fails to recognize the living culture that surrounds it.

On page 7 the EA says that the project benefits beach-goers by improving the quality and quantity of beach at the public Kuhio Beach Park. In what ways will surfers benefit? Will surfers lose surf-breaks at the expense of tourist sunbathers?

If the surf breaks are adversely affected what impact will this have on the economy associated with the surf—ie. canoe rides, surfboard lessons, board rentals, etc.

Will taller crib walls create more "backwash" in near shore waters, thereby ruining surfbreaks like "Queens", the "Wall" and "Canoes"?

Simply maintaining the existing alignment of the crib walls does not guarantee that the new walls won't adversely affect surf (page 8). The new walls will be taller, have a larger footprint, and have larger gaps in-between the sections.

According to the EA the sand dredging process could take upwards of 40 days (2 working months) to complete. What limits will be placed on Waikiki surfers during that period. Will they have access to their surf breaks.

Where exactly will sand be pumped from. The EA identifies sand pockets located in "nearshore waters"—this term is too vague. In what proximity to surf breaks will sand be pumped from? How will this sand removal affect surf in the immediate area? In adjacent areas?--What role does this sand have in recharging existing sandbars and breaks up and down the coast.

What is the intent of the demonstration project mentioned on page 6. Why pump sand into the Diamond Head basin prior to constructing the new crib walls. What is being tested—the pump or the new crib walls.

The surfing community was not adequately represented during early stages of the project planning process. Only 2 surfers are cited as having provided input in the project (page 40). The Waikiki Surfing Ohana and members of the surfing community at large request an additional informational meeting with a question/answer session where the project designs can be discussed and complicated terms and mathematical models used in the planning process can be clarified.

<u>Additional comments from John Bridenbaugh, Environmental Engineer:</u>

Removal of 10-20K square yards of sand from within 2000 feet of shore—Plan does not say where sand will be collected. Suggest details be added to reference figure E-12 to specify exactly where proposed sand dredging will occur.

Insufficient detail on proposed dredging activity. Request details of type, size, and location of dredge. Will surfing sites be blocked? How noisy will the motor be? How will dredge be anchored? How long will dredge be located offshore of Kuhio Beach? A design drawing of dredge and pipeline is requested.

If proposed savings of less than .5 M over trucking sand from north shore is all that will be saved, is the potential cost savings worth the disruption at Kuhio Beach?

Request an overlay figure (composite of exhibit 3) be added so it will be clear how proposed wall relates in position to existing wall. Composite figure must be to scale and show clearly how much further new wall will extend into ocean.

1201-27F

I have a concern about the addition of sand to Waikiki Beach as part of Phase 1 in the overall improvement plan. Adding sand to the beach may cause more disruption than provide more space for sunbathers. Here's why. The proposed barriers "walls" are shaped like bananas. The concave portion faces the shore and the convex portion toward the ocean. The opening between the barriers is large enough to allow greater flow of water through to the shoreline and cause a natural current to return to the ocean beyond the barriers. Eventually, the additional sand will seek equilibrium and again find a way to disperse into the natural flow of the "new current" created by the barriers. When the summer surf arrives, this mixing of sand and current flow will accelerate the "erosive process" further removing the sand from the beach and depositing it somewhere in the immediate area. Will the present reef system, however fragile and sparse, be victimized in the process? Will the surf breaks in the area, namely "Queens, Canoes, Populars, Paradise, Kunahs, Boneyards, etc." deteriorate or disappear altogether because of the degenerated reef systems and moving sands? The question also arises as to "Global Warming" and the increasing ocean issues. Severe climate has brought about disasters related directly to ocean warming. I think these factors contribute to what nature has in store for us. We shouldn't alter shorelines, breakwaters, current flow, reef systems purposely or inadvertently to maximize the appeal to an out of state dollar. I feel sorry for my friends who want so much to utilize the ocean resources and energy but are wondering if the future is looking hopeless. I like things as they are. Save Waikiki and the ohana that gather to enjoy it.

Mahalo Nui Loa, Scott Houdek

c/o
Leonard D. Jenkins
3614 Crater Rd.
Hon. Hawaii
96816

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MAR 11 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0963.99

Mr. Scott Houdek
c/o Leonard D. Jenkins
3614 Crater Road
Honolulu, Hawaii 96816

Dear Mr. Houdek:

Subject: Draft Environmental Assessment (EA)
<u>Kuhio Beach Improvements, Waikiki, Oahu, Hawaii</u>

This responds to your comments regarding the draft Environmental Assessment (EA) for the proposed improvements to Kuhio Beach. Your comments were delivered to Edward K. Noda and Associates, Inc. by Leonard D. Jenkins on March 11, 1999.

First, it is important to emphasize that the entire Waikiki Beach shoreline has been altered, and that the existing beaches are largely man-made. Hundreds of thousands of cubic yards of sand have been brought in to artificially nourish Waikiki's beaches since the 1930s, in attempts to create and maintain a continuous sandy beach. The Kuhio Beach crib wall system was built so that a beach could be maintained along this section of shoreline adjacent to Kalakaua Avenue. The crib wall system has been marginally successful, but there are still problems with beach stability, strong currents through the gaps, and poor water quality. As described in the draft EA, the proposed project objectives are to remedy these problems.

The larger gaps between the breakwater segments will mitigate the existing problems caused by strong seaward-flowing currents through the narrow openings in the offshore crib wall. The wider openings will reduce the currents, allow swell wave energy to rebuild the beach slope (similar to the adjacent beaches outside of the crib walls), and improve water quality inside of the basins. Physical model testing confirmed that the proposed breakwater design will not cause accelerated erosion. While the proposed project will result in a more stable beach than at present, there will still be the potential for storm wave erosion damage. The frequency and intensity of storm wave attack at Waikiki is not predictable, but fortunately infrequent. The behavior of the reconstructed Kuhio Beach is expected to be similar to the behavior of the adjacent beach areas.

Past beach nourishment activities along Waikiki's shoreline have potentially impacted the marine environment and surf sites. However, for the proposed Kuhio Beach project, sand from the offshore area will be "recycled" back to the beach, mitigating any potential impacts that off-site sand may have on the reef environment. The quantity of sand proposed to be replaced on Kuhio Beach is a relatively small volume compared to the total quantity of sand available in the deposits located directly offshore Kuhio Beach.

If you have any further questions, please contact Mr. Manuel Emiliano, our division's Engineering Branch Chief, at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator

c: √ Elaine Tamaye, Edward K. Noda and Associates, Inc.

1001-27F

DEPARTMENT OF THE ARMY
U S ARMY ENGINEER DISTRICT, HONOLULU
FT. SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF

February 23, 1999

Civil Works Branch

Ms. Elaine E. Tamaye
Vice President
Edward K. Noda and Associates
615 Piikoi Street, Suite 300
Honolulu, Hawaii 96814-3139

Dear Ms. Tamaye: Hi Elaine!

Thank you for the opportunity to review and comment on the Draft Environmental Assessment (DEA) for the Kuhio Beach Improvements Project, Waikiki, Oahu, Hawaii (TMK 2-6-1). The following comments are provided in accordance with U.S. Army Corps of Engineers authorities to provide flood hazard information and to issue Department of the Army (DA) permits.

a. As stated on page 38 of the DEA, a DA permit will be required for the project. For further information, please contact Mr. Alan Everson of our Regulatory Section staff at 438-9258 (extension 11) and refer to file number 990000172.

b. The flood hazard information provided on page 27 of the project assessment report is correct.

Sincerely,

Paul Mizue, P.E.
Chief, Civil Works Branch

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FEB 24 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
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TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0965.99

Mr. Paul Mizue, P.E.
Chief, Civil Works Branch
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Mizue:

Subject: Draft Environmental Assessment (EA)
<u>Kuhio Beach Improvements, Waikiki, Oahu, Hawaii</u>

Thank you for your letter dated 23 February 1999 addressed to Ms. Elaine Tamaye of Edward K. Noda and Associates regarding the draft Environmental Assessment (EA) for proposed improvements to Kuhio Beach.

A Department of the Army permit application was submitted 12 March 1999 for this project. We will coordinate this action with your Regulatory Section staff as requested.

Very truly yours,

Howard B. Gehring
Acting Administrator

c: √ Elaine Tamaye, Edward K. Noda and Associates, Inc.

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

BENJAMIN J. CAYETANO, GOVERNOR
SEIJI F. NAYA, Ph.D., DIRECTOR
BRADLEY J. MOSSMAN, DEPUTY DIRECTOR
DAVID W. BLANE, DIRECTOR, OFFICE OF PLANNING

Telephone: (808) 587-2846
Fax: (808) 587-2824

Ref. No. P-7978

March 10, 1999

MEMORANDUM

TO: Howard B. Gehring, Acting Administrator
Division of Boating and Ocean Recreation
Department of Land and Natural Resources

FROM: David W. Blane, Director
Office of Planning

SUBJECT: Draft Environmental Assessment (EA) - Kuhio Beach Improvements, Honolulu, Oahu, Hawaii

This is in response to your letter of February 8, 1999, requesting comments on proposed improvements to Kuhio Beach. Waikiki is a major tourist destination on Oahu and Kuhio Beach is a part of Waikiki. Our office is in favor of the proposed project.

The EA discusses the plan to demolish the existing offshore crib wall system and replace the wall using basalt stones in a rubble mound construction. The proposed project would improve the stability of the beach, remove a public safety hazard, increase public access, and improve water quality circulation along the shoreline. The project will involve reconstruction of three sections of the crib wall as breakwater segments using basalt stones in a rubble mound construction, similar to the wall segments that currently exist at the ewa end of Kuhio Beach.

The design of the spaces between the breakwater segments will help to replenish and retain the dry beach area. The new rubble mound construction will reduce wave overtopping and wave reflection, and create a more stable beach in the future. Kuhio Beach will be restored to a six foot Mean Lower Low Water (MLLW) or similar to the approximate elevation of the existing dry beach area at the ewa end near the banyan tree. Sand from within the crib walls will be reconfigured to restore the beach and additional sand will be taken from nearby offshore locations to restore Kuhio Beach. Construction of the project will be in phases over a 6-month period of time so that portions of Kuhio Beach will be open and available for recreational use. The project will be coordinated with the City and County of Honolulu, which is also proposing other improvements to Kuhio Beach.

As pointed out in the document on page 17, Section 2.6.2 of the EA, The Waikiki Working Planning Group, which authored the report, Waikiki: Hawaii's Premier Visitor Attraction, March 1998, supports the project, as an important component to enhance Waikiki's recreational resources. This working group has since been superseded by another group

established by the Legislature through Senate Concurrent Resolution 191, CD1, called the Joint Waikiki Task Force. The Task Force comprises of State and County agencies and private citizens, including the Department of Land and Natural Resources. The Joint Waikiki Task Force strongly supports this project.

However, we note on page 6 that construction funds estimated at $2 million are not available for the project. This important matter needs to be resolved as early as possible.

Thank you for the opportunity to comment on the proposed project. Should you have any questions or comments regarding construction funds, please contact Christina Meller of the Coastal Zone Management Program at 587-2845. Any questions regarding the Joint Waikiki Task Force should be directed to Lorene Maki at 587-2888.

cc: Office of Environmental Quality Control
✓Edward K. Noda and Associates, Inc.

RECEIVED
MAR 15 1999
EDWARD K. NODA & ASSOCIATES

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

TIMOTHY E. JOHNS
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

April 19, 1999

BOR-E 0964.99

The Waikiki Surfing Ohana
c/o Mr. Jordan Jokiel
3364 Kaau Street
Honolulu, Hawaii 96816

To Whom It May Concern:

Subject: Draft Environmental Assessment (EA)
<u>Kuhio Beach Improvements, Waikiki, Oahu, Hawaii</u>

This responds to your comments regarding the draft Environmental Assessment (EA) for the proposed improvements to Kuhio Beach. Your comments were transmitted to our department on March 10, 1999.

First, it is important to emphasize that the entire Waikiki Beach shoreline has been altered, and that the existing beaches are largely man-made. Hundreds of thousands of cubic yards of sand have been brought in to artificially nourish Waikiki's beaches since the 1930s, in attempts to create and maintain a continuous sandy beach. The Kuhio Beach crib wall system was built so that a beach could be maintained along this section of shoreline adjacent to Kalakaua Avenue. The crib wall system has been marginally successful, but there are still problems with beach stability, strong currents through the gaps, and poor water quality. As described in the draft EA, the proposed project objectives are to remedy these problems.

Past beach nourishment activities along Waikiki's shoreline have potentially impacted the marine environment and surf sites. The U.S. Army Corps of Engineers' 1963 report on the Cooperative Waikiki Beach Erosion Control Study suggests that about 157,000 cubic yards of sand artificially placed on the shoreline from Kuhio Beach to the Natatorium had eroded between 1951 and 1960. It is expected that the sand eroded from these shoreline areas have settled in the pockets on the limestone reef platform offshore Kuhio Beach. For the proposed Kuhio Beach project, sand from these deposits will be "recycled" back to the beach, mitigating any potential impacts that off-site sand may have on the reef environment. The quantity of sand proposed to be replaced on Kuhio Beach is a relatively small volume compared to the total quantity of sand available in the offshore deposits.

Both physical and numerical model studies were performed to confirm that the proposed project will result in a more stable beach than at present. However, there will still be the potential for storm wave erosion damage. The frequency and intensity of storm wave attack at Waikiki is not predictable, but fortunately infrequent. The behavior of the reconstructed Kuhio Beach is expected to be similar to the behavior of the adjacent beach areas.

Your suggestion that the beach and offshore surf sites should be designated as Traditional Cultural Properties is an interesting concept. The procedure for placing a site on the National Register of Historic Places is beyond the scope of the proposed project. The purpose of the EA is to assess the project's impact on the existing environment and resources. <u>The project has been specifically designed to prevent any potential impacts to the offshore surf sites</u>. We recognize the cultural significance of surfing in Waikiki, and will include more detailed discussion in the final EA regarding this topic.

The proposed project will benefit both residents and tourists alike. The beach area within the crib walls is under-utilized compared to adjacent beaches outside of the crib walls. The proposed improvements to the beach and water areas within the limits of the present crib walls will encourage "redistribution" of activity that presently occurs in Kuhio Beach Park and adjacent Kapiolani Park Beach areas. More people will use the improved Kuhio Beach and this should benefit everyone who frequents this area, by increasing total beach capacity and reducing the density of beach park users in adjacent areas.

The existing crib walls will be reconstructed as rubblemound structures, similar to the existing offshore wall in the Ewa Basin. Even though the reconstructed walls will be about 2 feet higher than the existing walls, the new structures will absorb and dissipate wave energy much more effectively than the existing concrete crib walls. There should be less "backwash" than at present. Physical model studies demonstrated that the proposed project will not affect offshore surf sites. The Exhibit 4 photographic rendering in the draft EA was accomplished by overlaying the Exhibit 3 plan onto the aerial photo. This simulation clearly demonstrates that the proposed plan will not affect the offshore surf sites. Also, the EA cover photograph (taken in April 1997), shows surfers sitting offshore at Queens, Baby Queens and Canoes. By comparing Exhibits 3 and 4 with this cover photo, it is apparent that the proposed reconstructed walls will have no impact on the offshore surf sites.

Exhibit 12 in the draft EA shows the sand deposits located offshore Kuhio Beach. These sand deposits are located in the deeper pockets and depressions on the limestone reef platform shoreward of the 20-foot contour. The sand layer is only about 2-3 feet thick. The higher spots on the reef, above the sandy bottom, define the locations of the surf sites, since it is the high spots that focus wave energy and cause the swells to break. Removing between 10,000 and 20,000 cubic yards of sand will have no effect on the surf sites. The sand pumping activity will be scheduled during the winter months when there is minimal south swell wave activity offshore Waikiki. The dredge cannot work offshore during high swell and surf, therefore, there should be no conflicts with surfers.

Construction funds for the project are not yet available. However, funds for detailed design and engineering have recently been released by the Governor. The "demonstration" sand pumping involves using a portion of the design funds to do a limited beach restoration effort. Reconstruction of the offshore walls and final beach widening cannot be accomplished until sufficient construction funding is available.

Two major public involvement sessions were held during the early stages of the project planning. These sessions were attended by many members of the surfing community and the general public. These included a public workshop and a public information meeting. There will also be additional opportunity for public input during the permitting process. The project will require a permit from the U.S. Army Corps of Engineers, a Section 401 Water Quality Certification from the State Department of Health, and a Conservation District Use Permit from the Board of Land and Natural Resources.

In response to additional comments from John Bridenbaugh:

Sand will be pumped from the closest practicable location in the sand deposit, directly offshore the Kuhio Beach crib walls. Additional information will be provided in the final EA describing the proposed limits of the sand mining area.

The draft EA describes the sand pumping effort. It is not the intent to direct the Contractor's methodology or specify the types of equipment he must use. The Contractor will be required to comply with Best Management Practices plans, and to comply with all local laws, statutes, and requirements related to the construction activities. As pointed out above, there will be no conflicts with surfers and no impacts to surf sites. Because of the relatively small quantity of dredging involved and the thin sand layer, it is expected that the most practical method would be to use a 10" to 12" portable dredge, as described in the draft EA. Noise would be similar to other heavy equipment working on shore.

Trucking sand from the North Shore to Kuhio Beach (1,000 truckloads) will not only be more costly, but will result in significantly more impacts than the proposed option of pumping sand from the nearshore sand deposits. The sand pumping effort will be less disruptive to activities in and adjacent to Kuhio Beach.

Exhibit 6 in the draft EA shows an overlay of the proposed plan on the existing crib wall configuration. Note that this is still a conceptual plan, and minor adjustments may be made during the detailed design phase.

If you have any further questions, please contact Mr. Manuel Emiliano, our division's Engineering Branch Chief, at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator

c: Elaine Tamaye, Edward K. Noda and Associates, Inc.