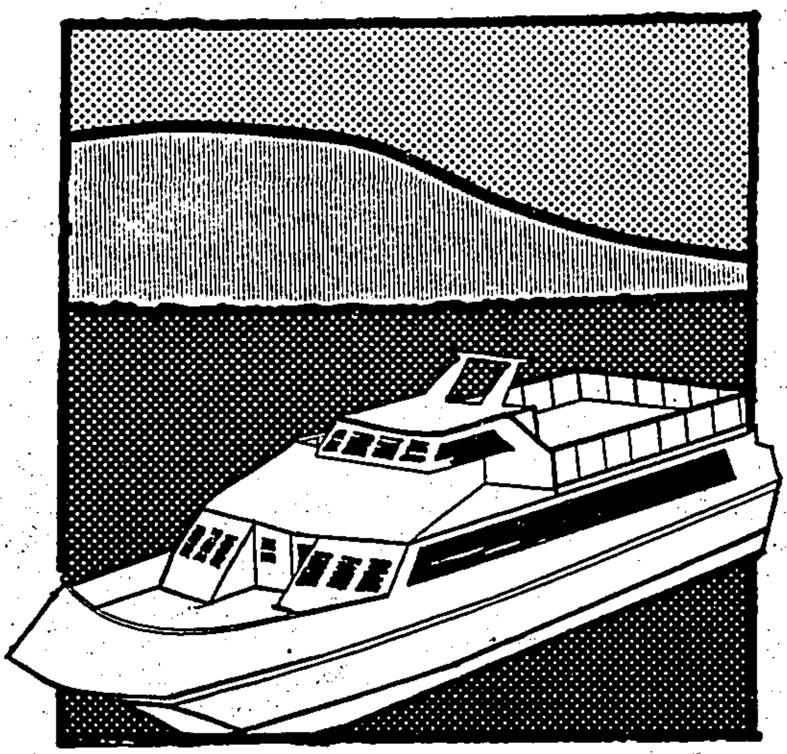
MAUNALUA BAY FERRY TERMINAL



environmental assessment

ENVIRONMENTAL ASSESSMENT
FOR MAUNALUA BAY FERRY TERMINAL

Proposing Agency

State of Hawaii
Department of Transportation
Harbors Division

June 1988

Prepared by:

Wilson Okamoto & Associates, Inc.

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PREFACE

The Department of Transportation, State of Hawaii is proposing to establish an intra-island ferry system serving the southern coastline of Oahu. Seven terminals are planned from Maunalua Bay to Barbers Point Deep Draft Harbor. The Maunalua Bay to downtown Honolulu link will be the first to be implemented.

This study assesses environmental impacts associated with development of the Maunalua Bay terminal. It is prepared pursuant to Section 343-5, Hawaii Revised Statutes, defining actions subject to environmental impact statement requirements. Specifically, the project involves use of State land and funds, a use within a State conservation district, and a use within the shoreline area.

To comply with Section 11-200-7 (Administrative Rules, Department of Health (DOH)), the proposed intra-island ferry system is assessed as a phased action treated as a single action in Appendix A. Inasmuch as the specific sites for each terminal have yet to be determined and individual facilities yet to be designed, the document provides a cursory environmental assessment of envisioned terminal locations. Subsequent environmental assessments for terminals not otherwise exempt from review under Section 11-200-8 (Administrative Rules, DOH) shall be prepared when terminal sites are determined and facilities designed. Further, if deemed necessary, environmental impact statements shall be prepared for individual terminals.

Consultation on the Maunalua Bay Ferry Terminal was conducted through the Intra-Island Ferry Task Force and meetings with agencies having responsibilities and authorities relating to the project See Appendix B.

The improvements for the Downtown terminal at Pier 8 and vessel maintenance at Pier 13 in Honolulu Harbor are deemed an exempt class of action in accordance with Section 11-200-8, "Environmental Impact Statement Rules, Department of Health, State of Hawaii. Specifically, these improvements involve "Construction or placement of minor structures accessory to existing facilities," which in this case, are existing harbor facilities at Honolulu Harbor.

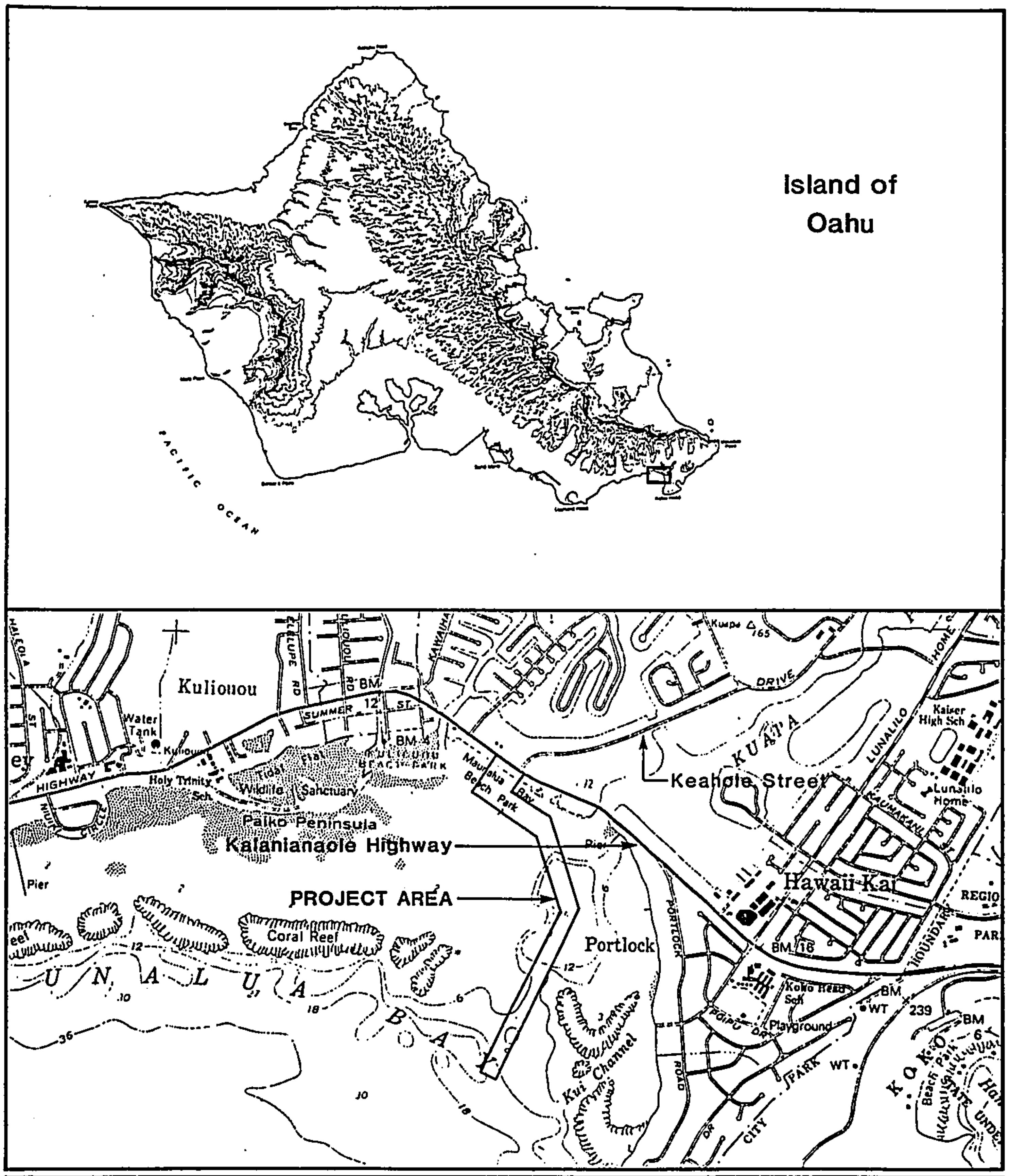
PROJECT DESCRIPTION

Project Location

The proposed Maunalua Bay Ferry Terminal is located adjacent to Maunalua Bay Beach Park, Honolulu District, Island of Oahu, Hawaii. Geographically, the proposed project is situated on the leeward (south) side of Oahu, approximately 10 miles east of downtown Honolulu. See Figure 1. Kuliouou is located to the west and Hawaii Kai is located to the north and east of the site. The project site is makai of Kalanianaole Highway, where it intersects Keahole Street. The existing Department of Transportation Boat Launching Ramp is adjacent to the west of the project site, the developed portion of the City and County of Honolulu Maunalua Bay Beach Park is adjacent to the east, and a strip of park lies between the site and Kalanianaole Highway to the north.

Development of the ferry terminal will primarily encompass a two acre portion of TMK 3-9-07:: 34 which is owned by the State. See Figure 2. Access to the parcel from Kalanianaole Highway will be developed over an existing unpaved access opposite Keahole Street, traversing two thin strips of land under control of the City and County of Honolulu, Department of Parks and Recreation. TMK 3-9-07:08 is owned by the City and County and comprises the strip of park along the makai edge of Kalanianaole Highway. Access is permitted through the parcel where the existing unpaved access traverses it. TMK 9-9-07:11 is owned by the State and controlled by the City and County under Executive Order No. 2626. The eastern portion of the parcel contains the majority of the developed Maunalua Bay Beach Park.

The proposed Maunalua Bay Ferry Terminal will include shoreside improvements for a passenger terminal area as well as off-shore improvements for vessel access and docking. The ferry system will be privately operated and initially will include two ships providing ferry service between the Maunalua Bay terminal and Pier 8 in Honolulu Harbor during the morning and evening commuter rush hours. More vessels may be added to the ferry fleet as other terminals are developed.



Maunalua Bay Ferry Terminal

ISLAND and LOCATION MAP Fig. 1

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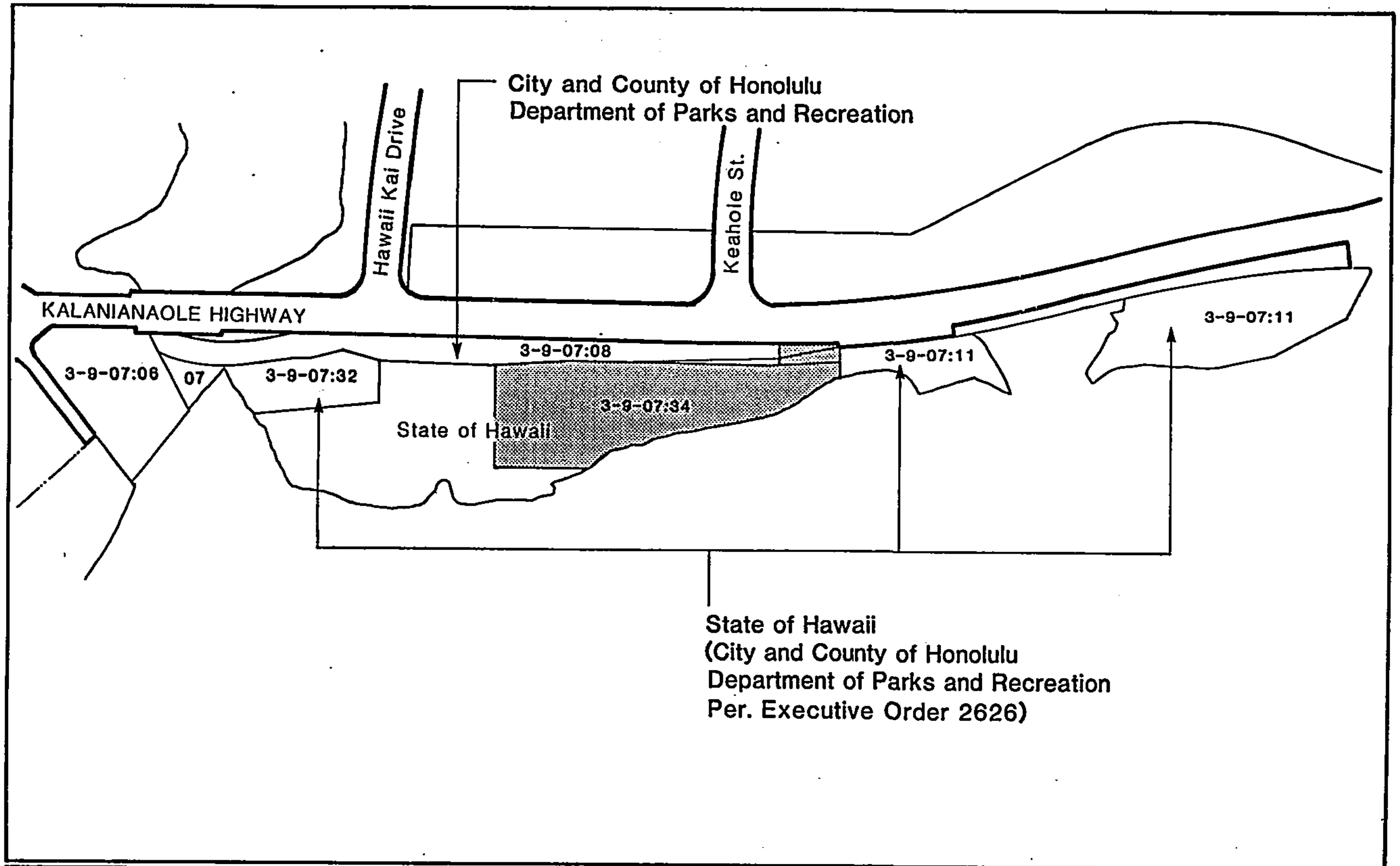

Maunalua Bay Ferry Terminal

LAND OWNERSHIP MAP

Fig. 2

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Shoreside Improvements

Shoreside improvements will include a paved driveway and parking lot, a passenger pick-up and drop-off area, passenger shelter, pier, rock revetment, landscaping and lighting. The paved driveway will be located on Kalanianaole Highway across the signalized intersection from Keahole Street. The driveway loop will provide for queuing of vehicles, including cars and buses, as they approach the passenger loading area. The parking lot will accommodate 200 vehicles. See Figure 3.

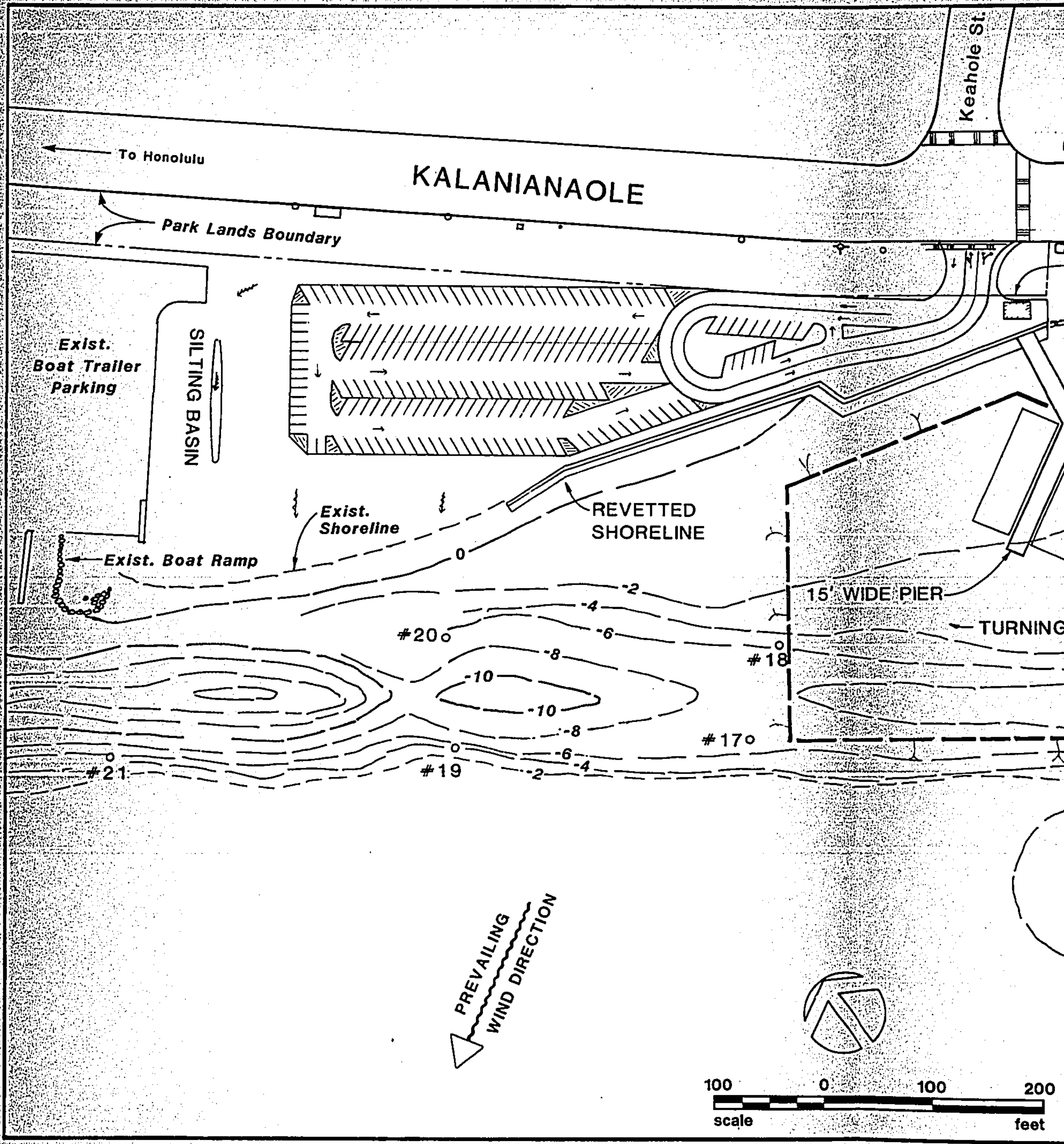
Loading and unloading of ferry passengers will be accomplished from an L-shaped pier, 15 feet wide and 200 feet long. It will be supported by piles driven into the bottom. The pier is designed to accommodate five passengers standing abreast so as to allow simultaneous loading and unloading of the ferry, thereby minimizing the turn-around time for the ferry at the terminal. See Figure 4. The pier will be oriented to allow the ferry to dock into the prevailing wind, to minimize drift during its approach and while loading and unloading passengers.

To protect the shoreline in the vicinity of the pier from erosion, a new shoreline revetment will be constructed. The revetment will consist of rip-rap rocks constructed to tie in with and overlap the existing rock revetment. The crest of the existing shoreline revetment will be raised 2 to 2-1/2 feet to prevent the frequent wave overtopping that now occurs. The revetment will also be extended approximately 500 feet to the west to protect the site improvements. Constructed of 3-foot diameter armor stone and appropriate underlayers, the crest of the new revetment will rise to an elevation of 6 to 7 feet above mean lower low water.

Utility hook-ups to service lines in the Kalanianaole Highway right-of-way will be made for electricity to light the parking area, terminal shelter, and ferry landing; and, water for landscape irrigation, a drinking fountain and hose bib in the terminal shelter area. No sewage service will be required as the existing comfort station at the nearby Maunalua Bay Beach Park will be available. Drainage from the terminal facility and parking area will sheet-flow towards Maunalua Bay. An existing swale providing drainage from the highway will be relocated slightly further west to the proposed edge of the parking lot.

Off-Shore Improvements

Off-shore improvements are designed to accommodate the vessel proposed for use by the apparent low-bid ferry operator. The improvements will include enlarging and deepening existing channels and constructing a new turning basin. See Figure 5. Total estimated volume of dredging is 69,000 cubic yards. Of this, 13,000 cubic yards is estimated to be silt (19%). Dredge spoil production rates during the estimated three to five month construction period are estimated to be 1,000 cubic yards per working day. Blasting may be required on some of the harder bottom material and will be conducted according to prescribed procedures for safety and will be timed to avoid seasonal presence of humpback whales traversing the bay. The contractor will likely dispose of most dredge spoil at the EPA approved



Keahole St.
To Honolulu
KALANIANAOLE
Park Lands Boundary
Exist.
Boat Trailer
Parking
SILTING BASIN
Exist.
Shoreline
Exist. Boat Ramp
REVETTED
SHORELINE
15' WIDE PIER
TURNING
0
-2
-4
-6
-8
-10
-10
-8
-6
-4
-2
#20
#18
#17
#21
#19
PREVAILING
WIND DIRECTION
100
0
100
200
scale
feet

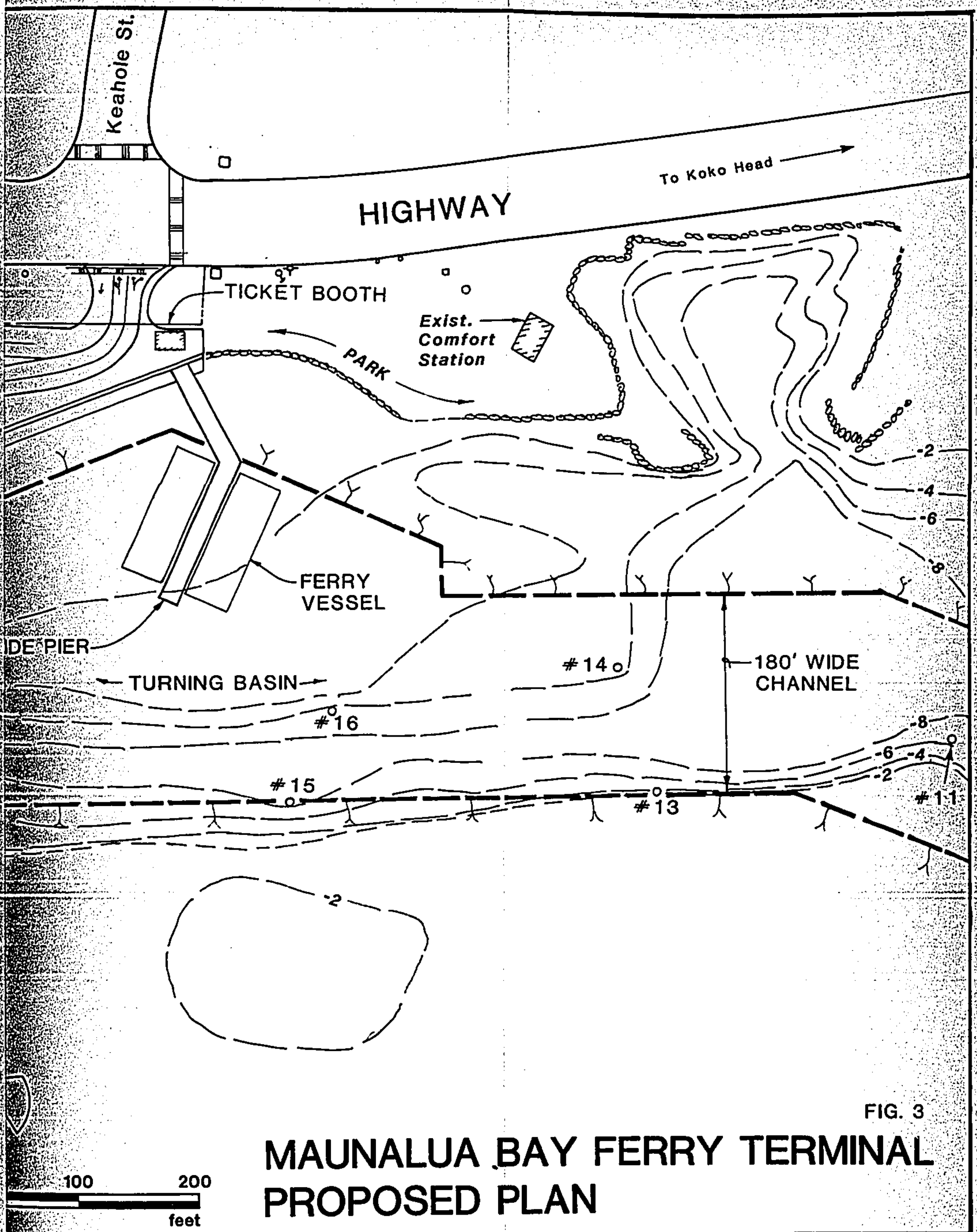
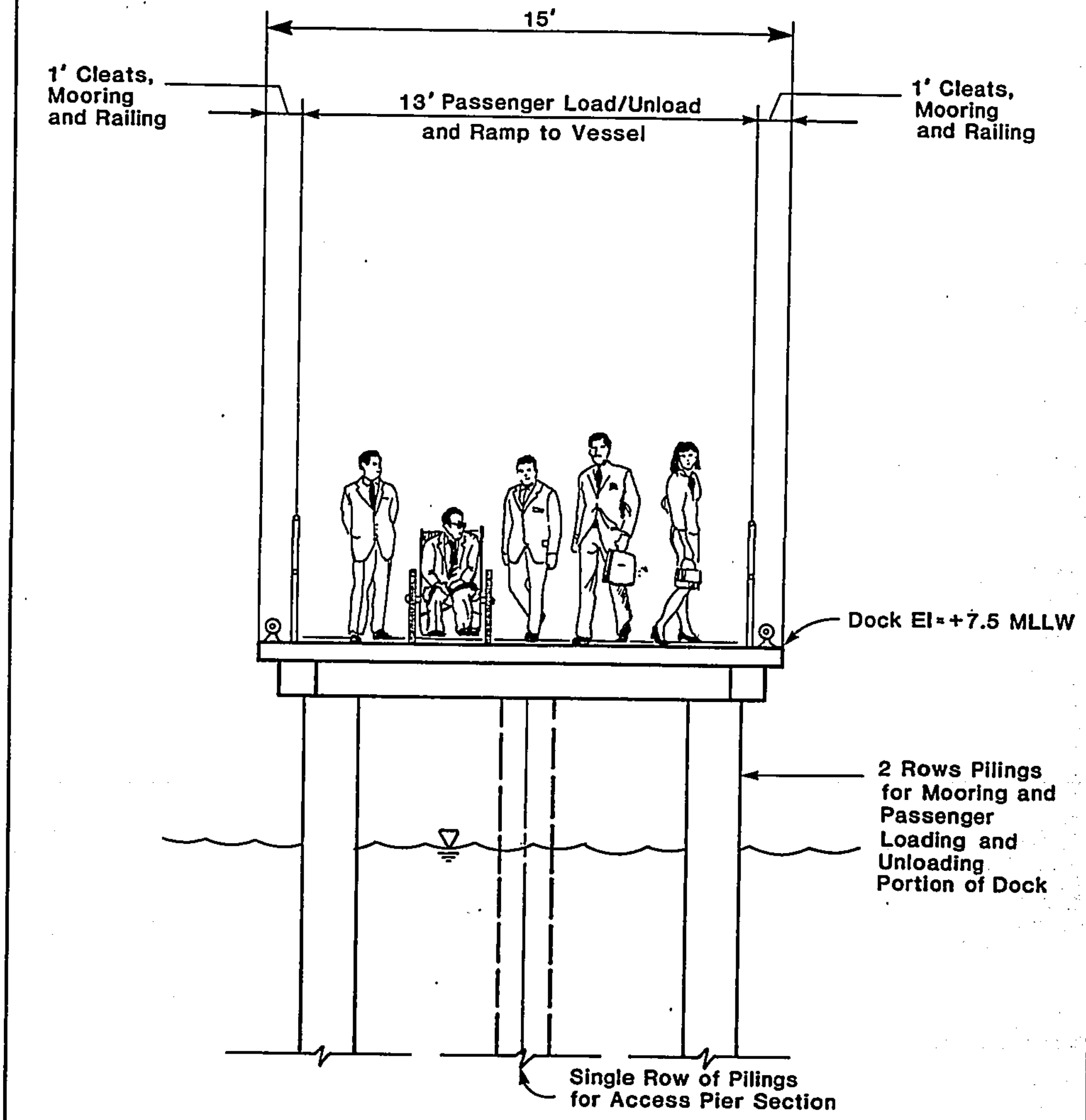


FIG. 3

MAUNALUA BAY FERRY TERMINAL PROPOSED PLAN



Maunalua Bay Ferry Terminal

TYPICAL PIER SECTION

Fig. 4

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Maunalua Bay Ferry Terminal

PROPOSED IMPROVEMENTS AND EXISTING MARINA

Fig. 5

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dump site, seven miles off Honolulu Harbor. Some land disposal is possible. Material dredged from the turning basin may also be used as fill for the parking and bus turnaround areas.

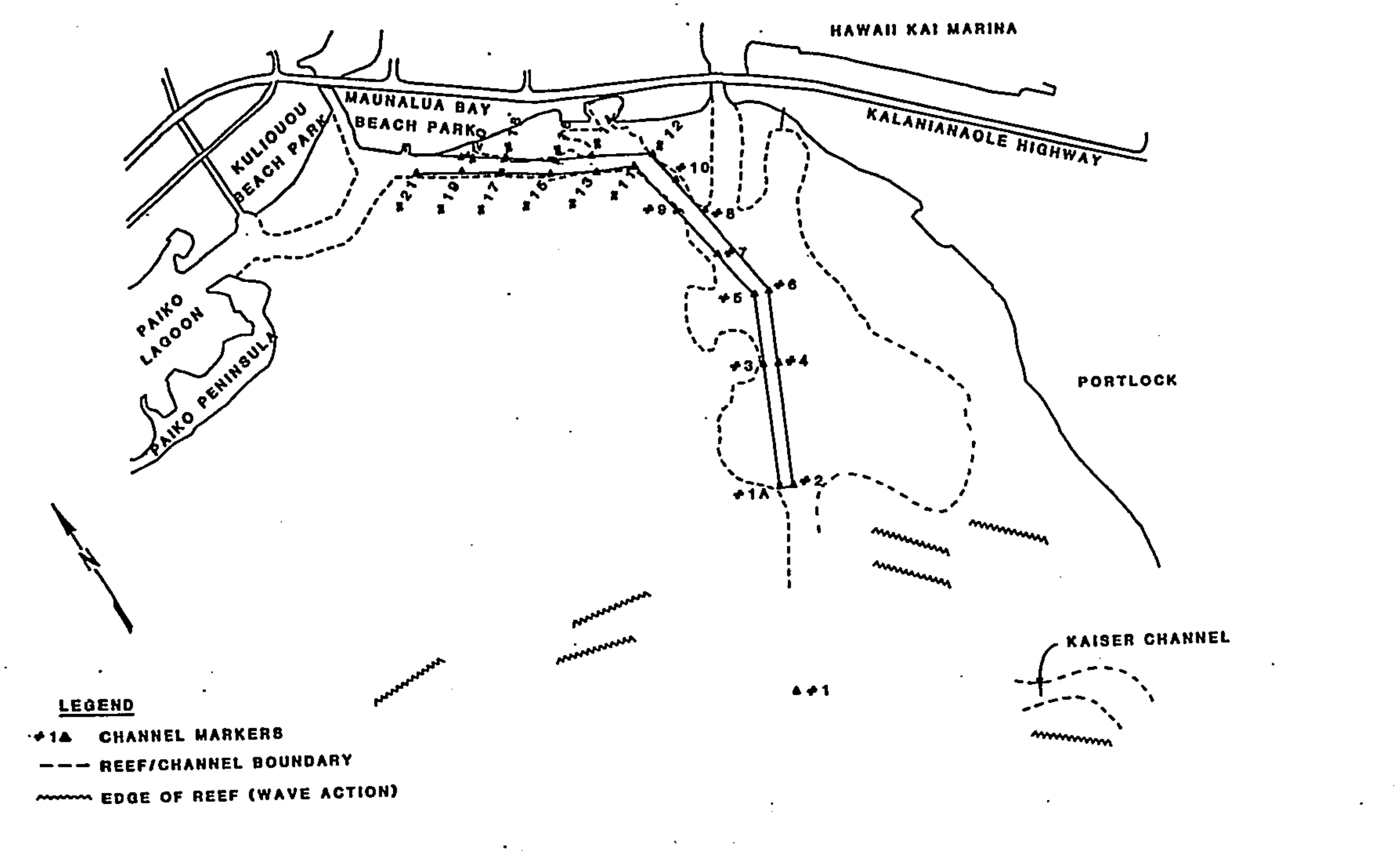
Entrance Channel. The existing entrance channel will be improved from the seaward end near marker #1 to the beginning of the intermediate channel near new markers #5 and #6 which leads to the boat launching area. See Figure 6. This distance of approximately 2,700 feet will be dredged from an approximate existing width of 80 feet at the channel mouth to a width of 200 feet and a depth of 12 feet. Approximately 24,000 cubic yards of material will be removed, primarily from the eastern (Portlock) side of the channel. This side was selected to minimize dredging volumes and impact to the benthic environment. The material to be dredged will consist of either sand or limestone. Little or no silt will be dredged in this area.

The proposed entrance channel width will accommodate simultaneous passage of the ferry and a 40-foot long fishing boat with a 13-foot beam. The proposed 12-foot depth of the channel is designed to accommodate the ferry vessel with additional depth for shoaling known to occur in this area. The portion of the entrance channel from markers #5 and #6 to the Hawaii Kai Marina will not be improved.

Intermediate Channel. The intermediate channel, extending 1,500 feet from channel markers #5 and #6 to markers #11 and #12, is an existing dog-leg leading from the entrance channel to the boat launching ramp. It will be dredged to a width of 180 feet and a depth of 10 feet. Dredging in this area will involve removing silt from the bottom of the existing channel and trimming the edge of the reef flat on the seaward side of the channel. The estimated dredging volume is 10,000 cubic yards, of which approximately 7,000 cubic yards would be silt. The design width of the intermediate channel is also intended to allow simultaneous passage of the ferry vessel and a 40-foot fishing vessel within the calmer interior portion of bay.

Interior Channel and Turning Basin. A 500-foot long interior channel connects the intermediate channel to the turning basin, and extends from markers #11 and #12 to markers #15 and #16. It will be dredged to the same dimensions as the intermediate channel. The estimated dredging volume to deepen and widen the channel to similar dimensions as the intermediate channel is 12,500 cubic yards, of which 3,000 cubic yards would be silt.

The turning basin fronting the terminal is required for the ferry vessel to maneuver into and away from the pier. It will be dredged to a diameter of 200 feet and a depth of 10 feet and will involve removal of approximately 3,000 cubic yards of silt from the bottom of the existing channel and 19,000 cubic yards of limestone and sand from the inshore reef flat. The turning basin is designed to minimize interference with present boat use in the channel.



Maunalua Bay Ferry Terminal

PROJECT AREA

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Sea Engineering

Fig. 6

Ferry Vessel

The vessel proposed for use by the apparent low-bid ferry operator is a "surface effect ship" which will ride on a cushion of air. The vessel will be 118 feet long and have a beam width of 38 feet. It will have a capacity of 300 passengers and will cruise on the open seas at an estimated speed of 42 knots (48 mph).

Two engines will power fans maintaining the air cushion under the ship. The air cushion will be contained by two solid walls on either side of the vessel and by curtains fore and aft. The air cushion can be adjusted by an on-board computer to allow the ship to ride higher within wave troughs and lower over wave crests. This will provide a smoother ride in rough seas. While riding on the air cushion, the ship will have a draft of 1.5 feet. Without the air cushion, the ship will have a draft of 6 feet. A third engine will power two steerable water jets which will propel and steer the ferry. The water jet propulsion system draws water from beneath the ship and discharges it in jet streams to propel and steer the ship. There will be no propellers in the water. The water jet propulsion and steering system will allow the ship to turn 180^{0} within the space of one and one-half its length at dead stop.

Ferry System Operation

The Maunalua Bay to Downtown link of the ferry system will operate between the proposed Maunalua Bay Ferry Terminal and Pier 8 in Honolulu Harbor. Pier 13 at Honolulu Harbor will be used for vessel berthing and maintenance. Two ferry vessels are anticipated to serve the Maunalua Bay to Downtown link. Each of the vessels will make two runs to the Downtown Terminal during the 3-hour morning rush hour and will make two runs each to the Maunalua Bay Terminal during the evening rush hour. The estimated travel time for each direction is 30 minutes. The current estimated fare for each transit is $2.50, one way, for Hawaii Residents with a valid drivers license.

Inasmuch as the proposed commuter service between Maunalua Bay and Downtown is anticipated to operate at a fiscal loss, the Department of Transportation has indicated that the operator may use Honolulu Harbor facilities for commercial operations, however commercial operations to and from the Maunalua Bay Ferry Terminal will not be allowed.

The operator will not be restricted from transporting passengers on return trips from commuter runs. Conceivably, therefore, passengers, including tourists, traveling to East Honolulu in the morning and back to Honolulu in the evening could also use the ferry. They would be transported on a space available basis. No commercial bookings to reserve seats would be allowed.

PROJECT NEED

Over the next eight years, the State Department of Transportation (DOT) and the Federal Highway Administration plan to widen Kalanianaole Highway. The highway will be widened to a six lane configuration between Ainakoa Avenue and Kirkwood Street and four lanes between Kirkwood Street and Hawaii Kai Drive. The proposed improvements include construction of a new, at grade, exclusive and reversible express facility in the median of the existing highway. The median express facility will run the entire length of the corridor and has the option of being used either as a single lane servicing express buses and vanpools, or as two lanes with one lane reserved for carpools. The proposed highway action will provide the much needed improvements to the existing transportation system.

The proposed Hawaii Kai to Downtown ferry service will provide an alternative transportation mode for Hawaii Kai residents wishing to avoid traffic congestion during construction of the road widening project. A supplemental marine bus service between these same points was also one of the proposed alternatives considered, but not pursued by the State Highways Division to reduce the expected increase in traffic congestion associated with the Kalanianaole Highway Improvement Project. The inter-island Ferry System for Oahu will require no Federal Highway Funds and is now considered independent of the Highway Improvement Project. Upon completion of the road widening project, it is envisioned that the intra-island ferry will continue to operate to and from Hawaii Kai.

PROJECT SETTING

History

Regional Development. Since approximately 947 A.D., Hawaii Kai and Maunalua was inhabited by Pacific Islanders. In 1786, Captains Portlock and Dixon, British navigators and explorers, anchored in Maunalua Bay. Captain Portlock's journal described the area as not well populated and the water supply so meager that the natives went to Honolulu to obtain water for the crew.

From 1825 to 1860, Maunalua Bay was an anchorage for whaling ships and inter-island traders. Throughout the early 1900's, Hawaii Kai and Maunalua was predominantly used for cattle ranching and some farming. There was also a fishing company as well as some truck farms operated by Hawaiians.

On April 27, 1961, Henry Kaiser signed a lease with Bishop Estate enabling him to develop the area into a planned residential development. During the past 30 years, Kaiser-Aetna Company and KACOR have been carrying out the plans proposed by Henry Kaiser. The Hawaii Kai development contains low, medium, and high density residential, commercial, recreational and public facility land uses in planned community areas. Other regionally oriented land uses include a marina, the Kuapa Kai and Koko Marina Shopping Centers, the Hawaii Kai Golf Course, Hawaii Kai Corporate Plaza, a high school and public library.

Although Hawaii Kai is generally considered a low-density suburban development, it also contains areas with low and medium-density townhouses and high rise residential apartments and condominiums.

Water-Related Development

The reef and the shoreline in the area have been extensively modified since the 1930's. Kuapa Pond, now Hawaii Kai Marina, was originally a brackish fish pond, separated from Maunalua Bay by a narrow sand spit and rock wall. The rock wall was about 5,000 feet long and was breached by two makahas (openings to the sea). Kuapa Pond was important as a fishpond for the raising of mullet (Mugil cephlus), awa (Chanos chanos) and aholehole (Kuhlia sandvicensis) since prehistoric times and was one of the largest ponds in the Hawaiian Islands.

In the late 1930's, Kalanianaole Highway was built atop the sand spit and rock walls, widening the barrier between the pond and the sea. Two culverts were constructed to provide water exchange between the pond and the bay and the main channel at the site of the present entrance to Hawaii Kai Marina was widened to 40 feet. There existed a small, irregular channel extending seaward from the sandbar at the location of the present entrance channel. This channel was a shallow natural break in the reef, probably a drainage for the brackish water of Kuapa Pond during a lower stand of the sea. In its relatively unmodified state, Kuapa Pond probably served as a settlement basin for materials washed downstream by storm water runoff from the surrounding valleys. By trapping these materials, Kuapa Pond protected the nearby coral reefs of Maunalua Bay from damaging siltation.

During World War II, the existing natural channel was dredged to facilitate landing craft operations and to service the military installation at nearby Koko Crater. No additional dredging in the main channel has been done since that time.

Construction of the Hawaii Kai community resulted in major changes. Work commenced in 1959 with the dredging and filling of portions of Kuapa Pond. This reduced the size of Kuapa Pond from 520 acres to 260 acres; and increased its average depth from 2.5 feet to 6.5 feet. The marina is currently used for recreational boating, canoeing, water sports and fishing, and the filled portions comprise part of the residential development of Hawaii Kai.

Modification of Kuapa Pond also included widening the entrance channel to the marina from 40 feet to 250 feet and construction of the existing bridge over it. The channel width was designed to accommodate runoff from the 100-year storm. An access channel, paralleling the shore, was dredged from the main channel to the mouth of Kuliouou Stream. A secondary channel was also dredged into the west end of the marina. The dredged material was used to construct the present beach park and boat launching area at Maunalua Bay. Presently, these channels serve as collection points for the discharge of saltwater, freshwater and terrigenous materials from Paiko Lagoon, Kuliouou Stream, and Hawaii Kai Marina.

SITE CHARACTERISTICS

Shoreline

Maunalua Bay is approximately eight miles long, extending from Kupikipikio Point at Diamond Head to Koko Head. See Figure 7. In the vicinity of the proposed terminal site, shoreline conditions can be divided into several distinct sectors as described below:

1. Paiko Peninsula, at the east end of the area, is a barrier spit built by sand and rubble transported eastward on the inner reef flat. The spit is separated from land by Paiko Lagoon. The peninsula has been described as the most unstable coastal feature on Oahu. From 1928 to 1961 the peninsula grew 900 feet to the east. The seaward shoreline of the peninsula is a narrow strip of sand and rubble which is almost submerged at high tide.

2. Kuliouou Beach is the shoreline between Paiko Lagoon and the west entrance to Hawaii Kai Marina. The shoreline is a mud flat overlying an old reef area. A channel approximately parallels the shore between Kuliouou Stream and the main entrance to Hawaii Kai Marina.

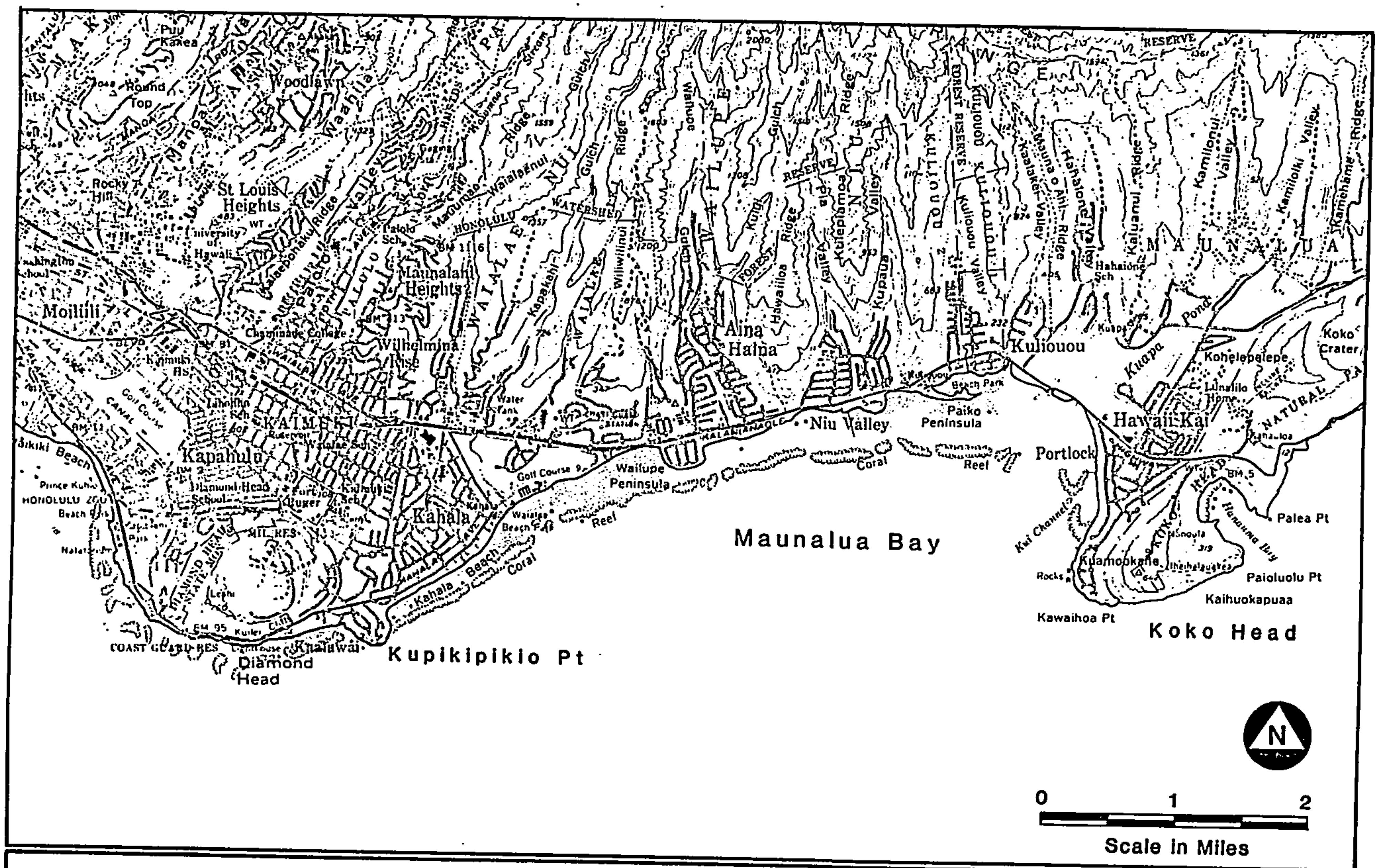
3. Maunalua Bay Beach Park extends from the west to the east entrance of Hawaii Kai Marina, a distance of approximately 2,500 feet. The shoreline is a mixture of coral rubble, mud and sand punctuated by the boat launching ramp and small cove toward its eastern extent. A 600-foot long section west of the cove is protected by a rock revetment.

4. Portlock is a residential area between the Hawaii Kai Marina entrance channel and Portlock Point. A narrow sand beach extends 1,800 feet east of the channel. For the next 3,000 feet the shoreline is stabilized with revetments and seawalls. Beyond that the shoreline consists of low cliffs and benches.

Offshore

A fringing reef extends 3,000 feet offshore through most of the area. Depths on the reef range from zero and five feet, with some areas baring at low tide. The reef consists generally of low relief limestone, with a veneer of sand or silt in several locations. A series of sandbars extends seaward from Paiko Peninsula, some emerging at low tide. There are extensive silt deposits on the reef section off Kuliouou Beach Park and the inner sections of the reef off Maunalua Bay Beach Park. The reef is cut by several dredge channels, as shown in Figure 6. These channels are deeper than the surrounding reef and are subject to silt deposition.

Seaward of the reef, the bottom drops gradually to a wide shelf of sand and scattered limestone formations at depths of 50 to 60 feet.



Maunalua Bay Ferry Terminal

MAUNALUA BAY

Fig. 7

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Harbors Division

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Existing Land Uses

The proposed Hawaii Kai Ferry Terminal site is located adjacent to Kalanianaole Highway, west of the main channel. Existing development includes a beach park and boat launching ramp with a paved trailer parking lot.

The beach park is a 12 acre strip of land created from material dredged out of Kuapa Pond in the 1960's. The Department of Parks and Recreation has developed a small landscaped area with picnic tables and comfort station for public use. Adjacent to the west of the park, the State Department of Transportation operates the boat launching ramp with a paved parking lot accommodating approximately 150 automobiles and boat trailers. At the west end of Maunalua Bay Beach Park, a canoe club store and launches their canoes.

Recreation at Maunalua Bay include public, commercial and commercially promoted activities, including boating, canoeing, fishing, swimming, kayaking, diving, parasailing and jet skiing. Presently, there are five thrill-craft (jet-ski) companies, one diving company and one parasailing company operating in the Maunalua Bay area. Commercial fishing operations are also staged from the boat launching ramp.

Surrounding Land Uses

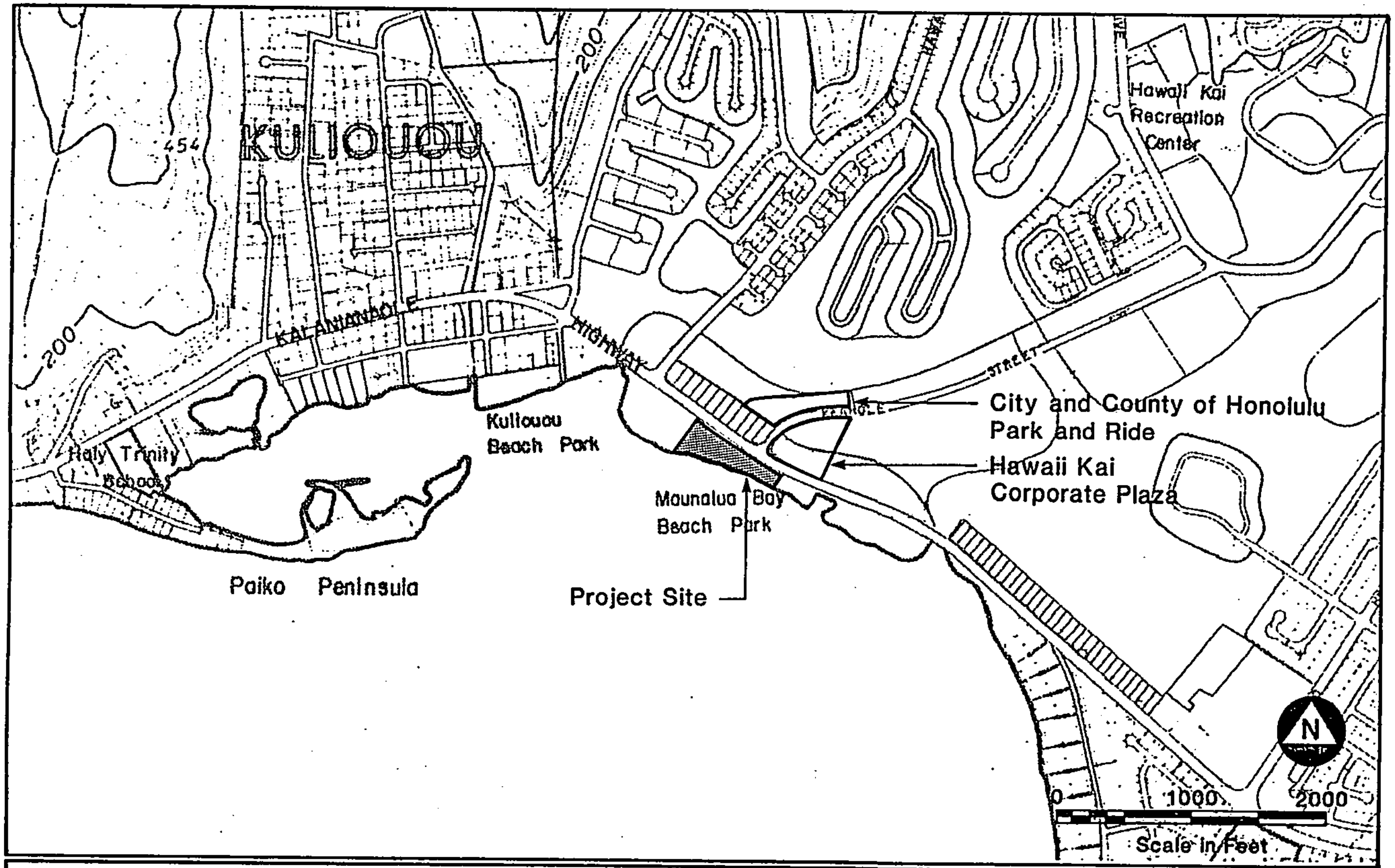
Land uses surrounding the proposed project site has predominantly been open space to the north and single family residences to the east and west. During the past year, KACOR has developed the parcel to the north across Kalanianaole Highway into a retail and business complex. See Figure 8. The Hawaii Kai Corporate Plaza consists of 47,170 square feet of office and retail space as well as parking for approximately 205 automobiles.

The proposed City and County of Honolulu, Department of Transportation Services Park and Ride facility will be located on the five acre parcel to the west of the Hawaii Kai Corporate Plaza across Keahole Street. The proposed project will provide free parking for approximately 140 automobiles. Access to and from the site will be provided by two driveways along Keahole Street.

Climate

The project area is located in the lee of the Koolau Mountains. The climate is characterized by mild and uniform temperatures, moderate amounts of rainfall and prevailing tradewinds. Mean monthly temperatures for February and August, the coolest and warmest months of the year, are 72 and 79 degrees, respectively. The climate is usually sunny and dry most of the year with the wettest periods occurring during the winter. Average annual rainfall is approximately 20 - 30 inches.

The prevailing winds are moderate to strong, predominantly from the north-northeast, and are funneled into the area by the Koko Head land mass and the ridges of the Koolau range. The predominant wind direction in the



Maunalua Bay Ferry Terminal

SURROUNDING LAND USES

Fig. 8

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project area is offshore, with a slight along shore component. Although these tradewinds produce most of the annual precipitation, flood-producing rainfall occurs when Kona winds from the east-southeast prevail, with associated Kona storms. Kona winds at the site are onshore, but also with a slight along shore component.

Geology and Hydrology

The land mass comprising the Maunalua Bay region was first formed during the Tertiary and early Pleistocene eras by successive eruptions of the Koolau Volcano. The area was modified and expanded when a group of volcanic tuff and cindercones erupted from a rift line along the southeast coastline. These eruptions formed the embayment and adjacent land masses comprising Hawaii Kai, Koko Crater, and Koko Head.

Streamflows that were directed southward into the Hawaii Kai embayment and Maunalua Bay severely eroded the relatively smooth dome of the Koolau Volcano and formed the ridge and valley configuration of the area. Alluvial material from the erosion filled the inner valleys of the embayment, forming the coastal plains.

Streams originating in the Koolau Range and discharging into Maunalua Bay include: Kapakahi Gulch, Waialae Iki Stream, Wiliwilinui Stream, Wailupe Gulch, Niu Stream, and Kuliouou Stream.

Soil

Soil series on the Island of Oahu are delineated on maps prepared by the U. S. Department of Agriculture, Soil Conservation Service. Soils within the project area are designated "fill land, mixed". The fill material was dredged from Kuapa Pond and existing channels. The fill material is primarily of alluvium origin which is generally only moderately permeable.

Flora

The existing flora at the project site consist mostly of species that are typical of urban environments on Oahu. Inasmuch as the site has been developed into a park and boat launching facility, there are no rare or endangered plants. A variety of trees and shrubs have been planted in the beach park area, including spider lily, bougainvillaea, naupaka, coco palm, brassaia, autograph tree and banyan.

Fauna

Paiko Lagoon, located to the east of the proposed Maunalua Bay Ferry Terminal, is the most significant natural feature in the general vicinity. Paiko Lagoon and the adjacent Paiko Peninsula are the only remaining waterbird habitat on the Maunalua coast and have been designated as the Paiko Lagoon Wildlife Sanctuary. The State of Hawaii improved the lagoon area as a wildlife habitat in 1970 and the lagoon has been designated as a bird and wildlife sanctuary in a recreation plan for Maunalua Bay.

According to An Ornithological Survey of Hawaiian Wet Lands, U.S. Army, Engineer District, Honolulu (1977), the interest in establishing Paiko Lagoon as a wildlife sanctuary arose from continued observation of the endangered Hawaiian Stilt feeding in the area. Counts have declined dramatically, however, from an average of 37 between 1961-67 to a maximum 6 after dredging activities in 1973. Currently, the State Department of Land and Natural Resources conducts an Annual Stilt Recruitment Survey which include Paiko lagoon. Although these "spot" counts have recorded observations when no stilt were present, it appears that between 2 and 6 stilt feed in the area.

In recent discussions with officials of the State Department of Land and Natural Resources, they expressed concern about the apparent accumulation of oil substances and other trash in the western corner of Paiko Lagoon. It was speculated that wind may be blowing floating substances and trash against the current into the Lagoon.

Mammals likely to inhabit in the region include feral cats, feral dogs, mongoose, rats, and house mice.

Waves

The reef off Hawaii Kai is exposed to the direct approach of two types of waves from the southeast through southwest. The south swell is generated by southern hemisphere storms and is most prevalent during the months of April through October. Their approach is from the southeast through southwest sector. Typical deepwater heights of these waves are from 1 to 6 feet, with periods of 12 to 20 seconds.

Kona waves, on the other hand, are generated by the winds associated with local fronts or low pressure systems. They typically have wave periods ranging from 6 to 10 seconds and heights up to 10 feet or more.

Indirect wave exposure results from tradewind waves which are present in Hawaiian waters throughout most of the year. They are generated by tradewinds blowing over the open ocean northeast of Hawaii. Typical tradewind waves have periods of 6 to 8 seconds and heights of 4 to 8 feet. They approach from the north through east sector, refracting around Koko Head and the Hawaii Kai reef to Maunalua Bay. Although their approach is indirect, tradewind waves are considered a significant factor in the wave climate of the area.

Incoming deepwater waves break on the reef edge approximately 3,000 feet from shore, and as a result, little wave energy reaches the shoreline during typical conditions.

In addition to normal wave conditions, the project area is also exposed to potential severe wave attack from tropical storms and hurricanes passing south of the island. Notable hurricanes in Hawaiian waters have included Dot (1959), Nina (1957) and Iwa (1982). These hurricanes generated deepwater wave heights of approximately 25 feet and are frequently considered "design" storms for shoreline developments.

Tides

The tides in the Hawaiian Islands are semi-diurnal, with diurnal inequalities; that is, two high and two low tides per day with varying elevations. At Honolulu Harbor, the closest tidal reference station, the following tide levels occur:

Tide Level	Feet
Mean Higher High Water (MHHW)	1.9
Mean Sea Level	0.8
Mean Lower Low Water (MLLW)	0.0

Currents

Offshore currents in Maunalua Bay are predominantly wind and tide driven. As the surface layers move in response to the wind, their transport is generally to the southwest, or offshore. Responding to tidal changes, the subsurface layers flow predominantly to the west during flood tide. Ebb tide reverses the flow, with the currents moving to the east. There are times when the ebb current flow is strong enough to counteract the tradewind influence, and even the surface layers will move to the east. This condition is sometimes indicated by a slightly discolored plume of water originating from the Hawaii Kai marina outflow and extending off Hanauma Bay or Lanai Lookout.

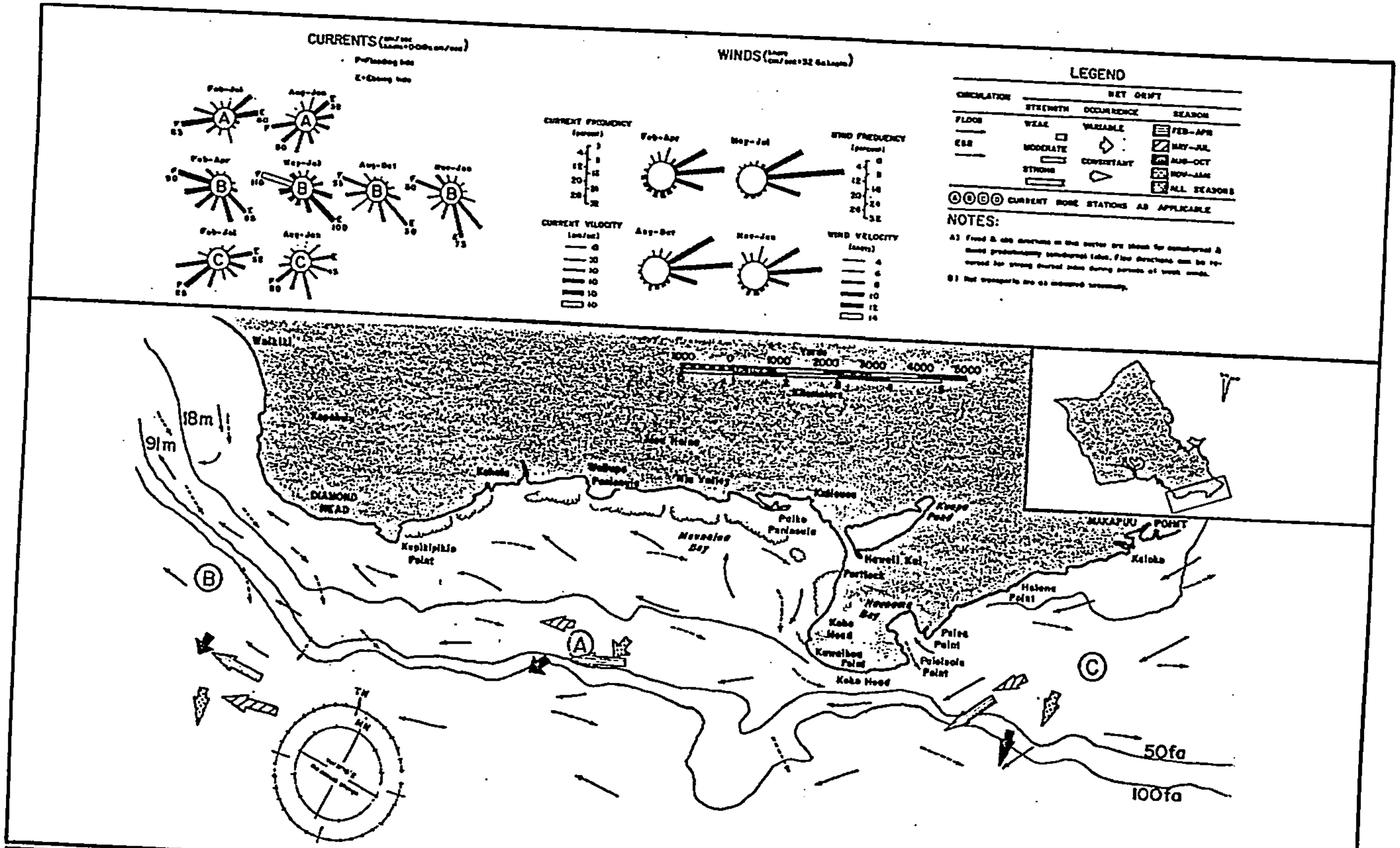
Figure 9 shows a generalized summary of the circulation in Maunalua Bay. Notable is a flood tide eddy directly off the Hawaii Kai entrance channel. The ebb tide flow around Koko Head is also pronounced, and also follows the pattern shown in Figure 9. The overall net transport is to the west or southwest.

There is limited current data available for the inshore area. Currents in this area are driven by the wind, the mass transport of water due to breaking waves, and tidal effects on the reef flat, Paiko Lagoon and Hawaii Kai Marina.

Flood Hazard and Tsunami Inundation

The Hawaiian Islands are subject to tsunamis generated throughout the Pacific Basin. Eighty-six tsunamis have been observed in the islands since 1813; 22 resulting in significant damage. Tsunami waves approaching the shoreline are influenced by refraction, shoaling, bottom friction, local bathymetry and coastal configuration.

According to the Flood Insurance Rate Map issued by the Federal Emergency Management Agency under the National Flood Insurance Program dated September 4, 1987, the proposed Maunalua Bay Ferry Terminal is designated within the 100 year flood area (Zone AE). See Figure 10. This flooding is associated with tsunami although the area is not threatened by the forces of "wave action."



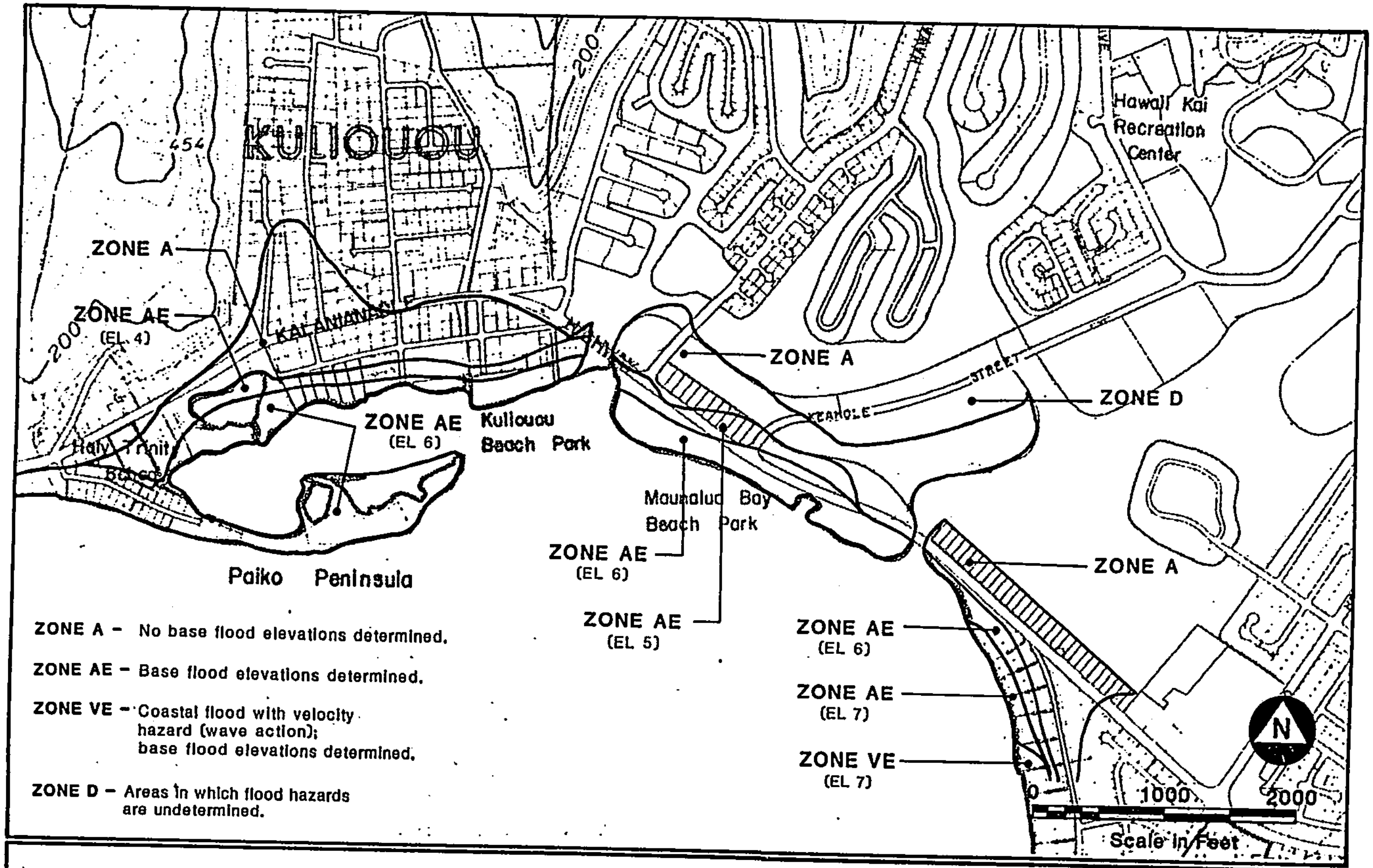
Maunalua Bay Ferry Terminal

MAUNALUA BAY CIRCULATION

Fig. 9

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Sea Engineering



Maunalua Bay Ferry Terminal

FLOOD HAZARD MAP

Fig. 10

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Wilson Okamoto & Associates, Inc.

Using the recommended methods, tsunami wave elevations at the project shoreline were calculated for various return periods:

Return Period (Yrs)	Runup Elevation Above MSL (ft.)
10	2.5
25	2.5
50	4.3
100	6.2

There are no records of bore formation in the area, so tsunamis should have the form of non-breaking fluctuations in the water level, much like rapid tidal changes. Structures in the project area may be subject to temporary inundation, and also the water velocities associated with the backflow of water during the trough periods.

Water Quality

The water quality in Maunalua Bay is influenced by exchange with the Hawaii Kai Marina, the shallow bathymetry of the reef flat and by exchange with open coastal waters beyond the reef. The Department of Health, State of Hawaii classifies Hawaii Kai Marina as an "artificial basin" and in a subclass of "shallow draft recreational harbors." Maunalua Bay is classified as a "Class II nearshore reef flat" where "existing or planned harbors may be located within nearshore reef flats showing degraded habitats and only where feasible alternatives are lacking and upon written approval by the Director of Health considering environmental impact and the public interest pursuant to HRS 342-6."

The water quality parameter most directly related to specific benthic criteria is turbidity. An analysis of present turbidity levels was conducted for a comparison with historical values. See Appendix C. The results, as indicated by the geometric mean values, are presented in Table 1. In general, water quality conditions in 1973 were worse than at present. This may be due to more extensive subdivision construction and consequent exposure of erodible land in 1973 than at present. Notably, turbidity values for 1988 are likely to be higher than usual due to the continuing influence of the January 1, 1988 storm which resulted in severe runoff into Maunalua Bay. Nevertheless, the historical effect of sediment on the Maunalua Bay reef flat has been and continues to be too great for the maintenance of a normal coral reef community.

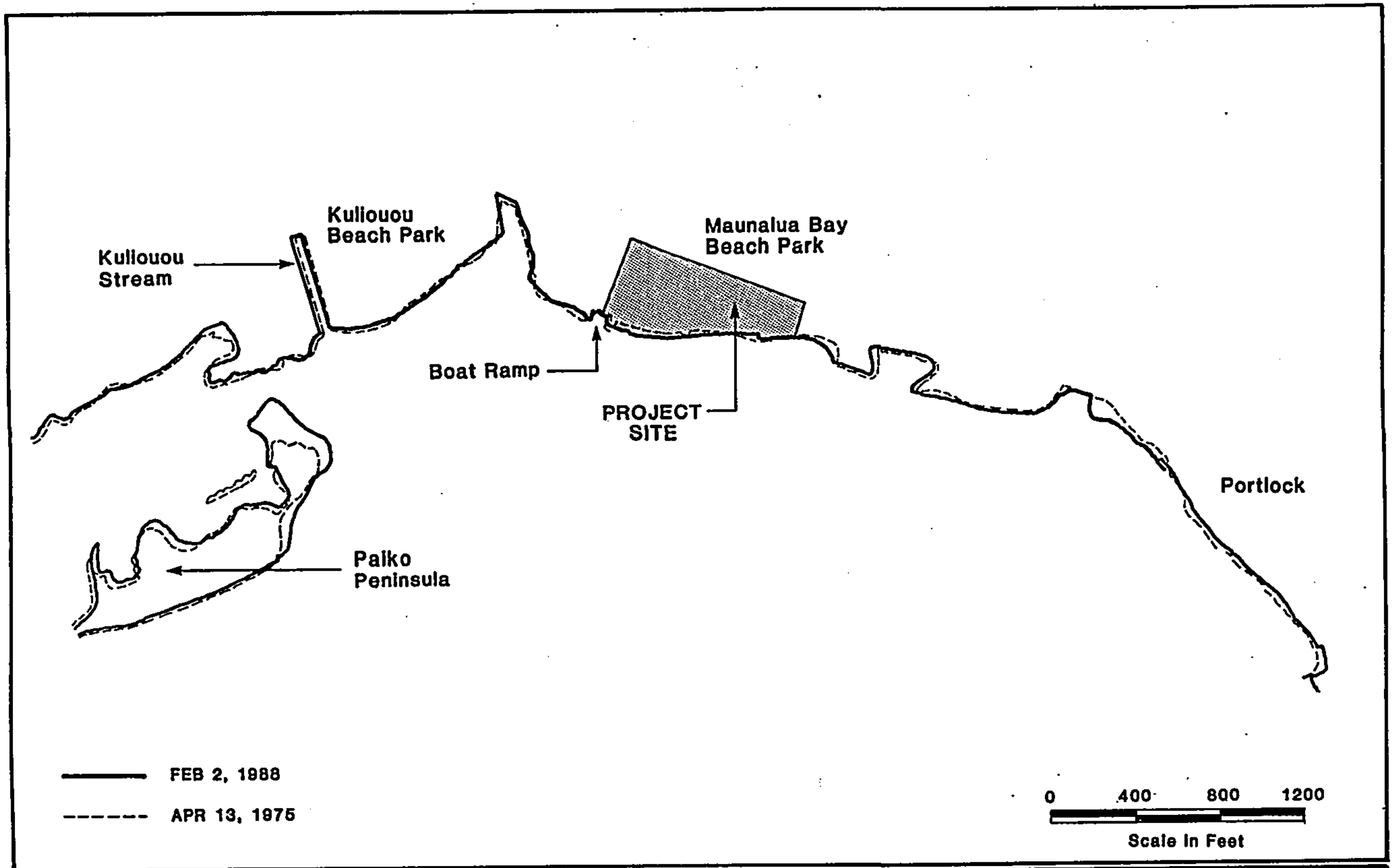
Shoreline Process

The shoreline of Maunalua Bay in the vicinity of the project site has been subject to changes in configuration as depicted in Figure 11, which is based on a computer-corrected digitized tracing of aerial photographs in 1974 and 1988, respectively.

TABLE 1

MAUNALUA BAY TURBIDITY COMPARISON 1973-1988

	Geometric Mean Turbidity in (TU)	
Area	1973	1988
Maunalua Bay Seaward Reef	0.88	0.87
Maunalua Bay Channel	5.40	2.70
Maunalua Bay Reef Flat	----	3.00
Hawaii Kai Marina Exits	8.20	3.90



Maunalua Bay Ferry Terminal

SHORELINE CHANGES, 1975–1988 Fig. 11

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Wilson Okamoto
& Associates, Inc.

Paiko Peninsula continued to grow to the north and east. The predominant sand transport along the peninsula is to the east, and then north at the tip. Much of the reef off of the peninsula has a veneer of sand and this apparently acts as a source of material for building the peninsula. The north tip of the peninsula now ends at the dredged channel off Kuliouou Stream. It can continue to grow eastward, but sand transported northward will be lost to the deeper water of the channel.

The Kuliouou Beach Park shoreline is stable, with little change registered for the study period.

Along the Maunalua Bay Beach Park shoreline, the portion west of the small cove near the comfort station has been subject to erosion and is presently protected by a 600 foot long revetment. The beach immediately west of the revetment is eroded and sediment transport is to the west. The eroded material is being deposited near the boat ramp, where the shoreline has accreted 25 feet since 1974. The shoreline from the comfort station to the marina entrance channel is stable.

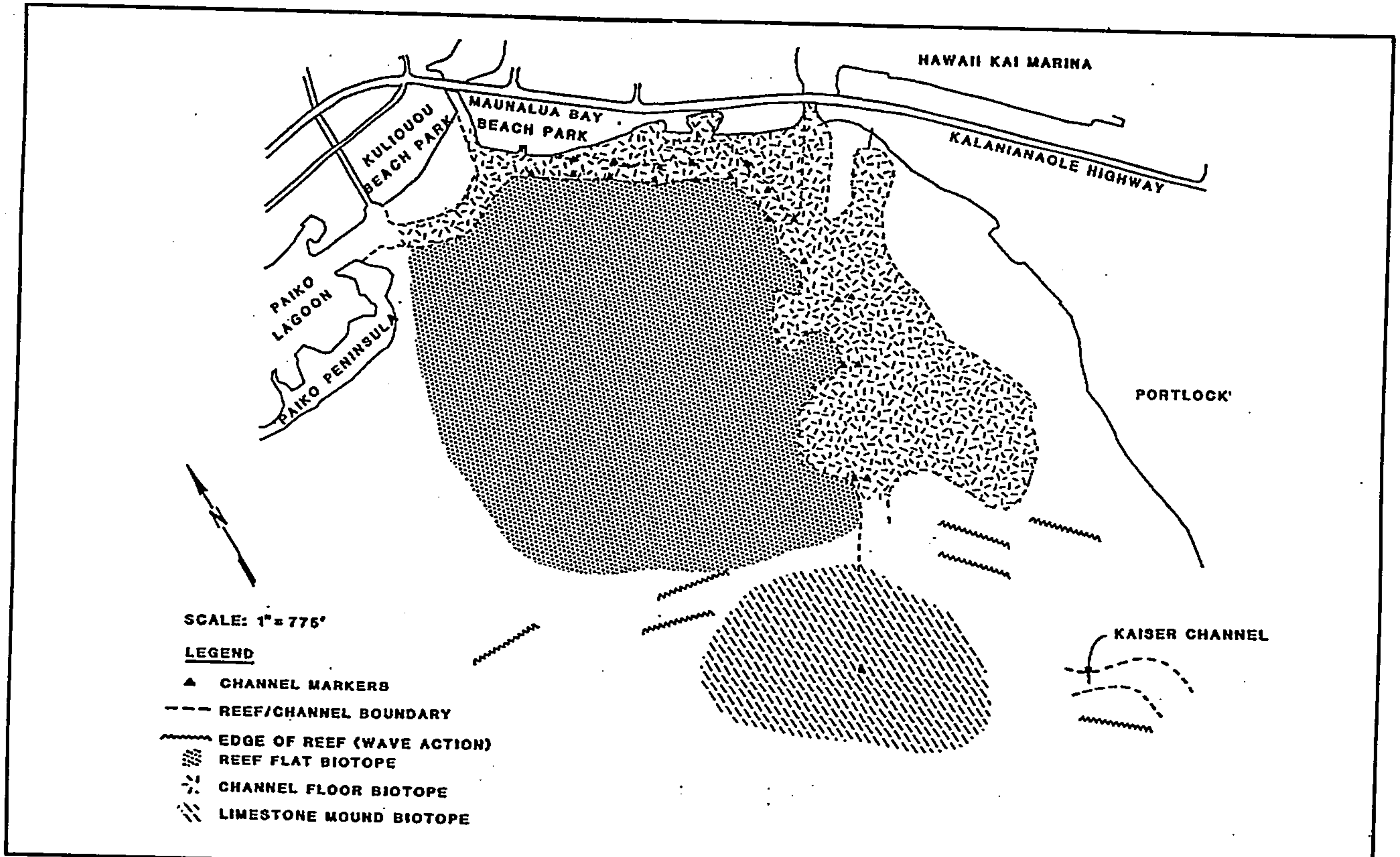
The sandy shoreline along Portlock is eroding, with the exception of a 250 foot section adjacent to the bridge, which is accreting. A 20 foot recession in the vegetation line from 1974 to 1988 is typical for the eroding area. Transport of sand is in a one-way westerly direction due to the effect of predominant tradewind waves, causing eroded sand to accumulate at the west end of the beach and in the entrance channel. There is now an extensive sand bar in the marina just inshore of the bridge. The channel, once dredged to a width of 250 feet is now only 40 feet wide, which was its approximate original width.

The cause of erosion at Portlock may be due to several factors acting singly or in combination. First, dredging of the entrance channel may have created a "sink" that is removing sand from a littoral system which would otherwise maintain the beach. Second, the dredging may have interrupted the eastward migration of sand required to balance the westward migration which now dominates and results in one-way transport. A third factor may be the degradation of the reef due to siltation and the resultant loss of new sand input produced by the reef.

The outer part of the Hawaii Kai entrance channel is shoaling, with a sandbar being formed across the channel, just shoreward of where waves break on the reef adjacent to the channel. The sandbar is shallower on the east side of the channel, indicating that the sand is moving from the reef east of the channel westward into the channel.

Biological Conditions

Three biotopes were identified during a recent biological survey of the offshore areas in the vicinity of the project site: the reef flat biotope, the channel floor biotope, and seaward of the fringing reef, the limestone mounds biotope. See Figure 12.



Maunalua Bay Ferry Terminal

BIOTOPE DEFINED BY THE BIOLOGICAL SURVEY

Fig. 12

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Sea Engineering

Reef Flat Biotope The reef flat biotope fronts Maunalua Bay Beach Park and extends from the shoreline to the crest of the fringing reef about 3,000 feet offshore. The biotope occupies an old limestone bench covered by a veneer of fine mud and rubble which is most apparent within 800 feet of the shoreline. Further seaward, the limestone substratum is visible between pockets of muddy sand and rubble. Much of the biotope is in water less than three feet deep and is exposed at low tide.

In general, benthic communities in this biotope may be characterized as highly disturbed along the inner portions and dominated by sessile filter and suspension feeding forms. Further offshore, algae and a variety of invertebrate and fish species common to Hawaiian reefs may be found.

Limestone Mounds Biotope The limestone mounds biotope lies seaward of the reef flat biotope, beyond the reef crest, about 3,000 feet from shore. Beginning at an average depth of 12 feet, the biotope extends seaward for approximately 1,000 feet to a depth of 20 feet or more. It is characterized by mounds or patches of limestone emerging from a sandy bottom. The mounds range in size from 30 by 50 feet to more than 100 by 300 feet. They are spaced from 100 feet to 300 feet apart.

Benthic communities in this biotope are not well developed as there is little shelter for motile forms and occasional scouring action of wave driven sand inhibits establishment of sessile forms on the mounds. A number of coral species were identified, including Poritis lobata, Pocillopora meandrina, Montipora verrusoca, M. patula, and Cypastrea ocellina, although overall coverage does not exceed four percent. Macroalgae coverage is less than 8 percent. Where shelter is available, fishes may also be seen. Notable was the abundance of moray eel species found in the open. This may be due to the scarcity of shelter which would normally be sought by the eels.

Channel Floor Biotope The channel floor biotope is restricted to the areas where channels bisect the reef flat biotope. Some of these channels are those of natural origin which have since been enlarged by dredging. The sparse life supported in this biotope reside on or in a substratum of very fine mud that may be more than three feet thick in areas. Burrows seen in this biotope include those of the shrimp Alpheus mackayi and those of larger crab species. A commensal goby, Psilogobius mainlandii, may also be present since they are known to share the burrows of Alpheus mackayi. Few other fishes were encountered in this biotope although tilapia, kaku and pua may be seen along the channel edges and fishermen reportedly catch small papio. The presence of nehu has also been reported.

Biological Changes

In general, the biological survey of the waters off of the project site suggest that the marine communities are, for the most part, poorly developed and have low diversity. These attributes are typical of marine communities exposed to or impacted by negative environmental influences which result in a reduction in species numbers and simplification of community structure and function. Overall, only two macrothalloid species, four macroinvertebrate species and two fish species were encountered while mean coral coverage was five percent. These values are extremely low relative to most Hawaiian marine habitats and suggest that marine communities in the area are severely impacted by low environmental quality.

Main sources of environmental disturbance suggested by the study are the input of freshwater and fine mud from landward sources, as well as fine carbonate material from the reef platform. High sedimentation, and periodic freshwater inundation has occurred since construction of the marina commenced in 1959. Perhaps the greatest rainfall related impact to the reef communities in this area occurred during the January 1, 1988 storm which produced the highest sustained rainfall ever recorded in East Oahu. In a 24 hour period approximately 25 inches of rain fell on the Koolau mountains in the Hawaii Kai drainage basin. The effect of the storm appears to have been aggravated by heavier than usual rainfall during the preceding two weeks which saturated the soil and resulted in massive erosion when the subsequent storm occurred. The magnitude and duration of the storm's effect were indicated by the presence of a cell of turbid water approximately three miles long and two miles wide which remained in the Maunalua Bay area for more than 45 days following the storm. It appears that the mud and large volume of freshwater which emanated from Kuliouou Stream and the Hawaii Kai marina as a result of the storm probably severely impact marine communities over much of the study area.

In relation to a study conducted by the U.S. Army Corps of Engineers in 1975 and another study conducted in that same year by ECI, significant degradation of marine communities in the study area is indicated. The ECI study reported that the shallow reef flat near the Hawaii Kai marina was inhabited by small colonies of the corals Cyphastrea ocellina and Pocillopora damicornis, six species of fish (dominated by the 'omaka) and the alga Acanthophora spicifera. Today this area is mostly covered by fine mud and only a few very small colonies of the coral Pocillopora damicornis were seen. The alga Acanthophora spicifera is still present but the 'omaka was not seen.

In 1975, ECI noted an abundance of the corals Porites compressa and Porites lobata and the alga Dictyosphaeria cavernosa growing on boulders on the western edge of the entrance channel, and particularly on a reef spur near channel marker #3. Today there are no live corals on those boulders and no Dictyosphearia cavernosa was seen. The previously reported abundance of coral on the western channel edge has declined. Some Porites compressa and P. lobata remain on the reef spur.

Declines in benthic algae are significant. The ECI study indicated algae growth approaching 100 percent in some areas and dominated by Codium edule, Halimeda sp. and Enteromorpha sp. The 1988 study found nine algal species having a mean coverage of only 0.8 percent.

With respect to fish, the ECI study recorded at least 53 species, most associated with high coral cover, particularly along the western edge of the entrance channel. The 1988 study found only two species in this area, neither of which were recorded in the previous study.

Changes in the limestone mounds biotope appear to be less pronounced over the years, probably due to its distance from sources of potential adverse impact near the shoreline. Most previously recorded species were found in the 1988 study.

The comparisons of the 1988 study with the 1975 studies suggest that considerable change has occurred in the marine communities shoreward of the Maunalua Bay fringing reef. These changes are manifested as significant decreases in species numbers and coverage, probably in response to continuing sediment stress. The changes may have occurred gradually since the time of the 1975 study or they may have been abrupt, as a result of the January 1, 1988 storm. The significant decrease in corals along the western edge of the entrance channel and the lack of any evidence of recently killed corals suggests that these changes have been chronic in nature and ongoing for some time. Irrespective of how they have occurred, the result is that the marine communities offshore of Maunalua Bay Beach park are poorly developed and the community structure suggests a highly disturbed environment.

SOCIOECONOMIC CHARACTERISTICS

For purpose of this report, the Hawaii Kai community is characterized based on four census tracts established by the U.S. Bureau of the Census - CT 1.02, 1.03, 1.04 and 1.05. See Figure 13.

Population

The 1987 State of Hawaii Data Book gives Hawaii Kai's 1984 population as 27,074 people. Between 1970 and 1980, Hawaii Kai experienced tremendous population growth. In comparison with a 21% increase for the City and County of Honolulu, Hawaii Kai's population increased 104% during the same 10 year period.

Within the study area, population growth occurred primarily in Census Tracts 1.03 and 1.04, while the more established areas in tracts 1.02 and 1.05 remained stable.

Households

In 1980, Hawaii Kai had 7,518 households with an average of persons per household ranging from 3.1 to 3.7. This is slightly higher than for the City and County of Honolulu. Census Tract 1.02 has the fewest households with only eight percent of the total.

Age

Hawaii Kai is predominantly made up of families with members below the age of 55. The majority of adults fall in the 35 to 54 age bracket, with their children of school age between 5 and 19 years. This is especially true in census tracts 1.03 and 1.04, the more recently developed areas which also have a higher density.

Place of Birth

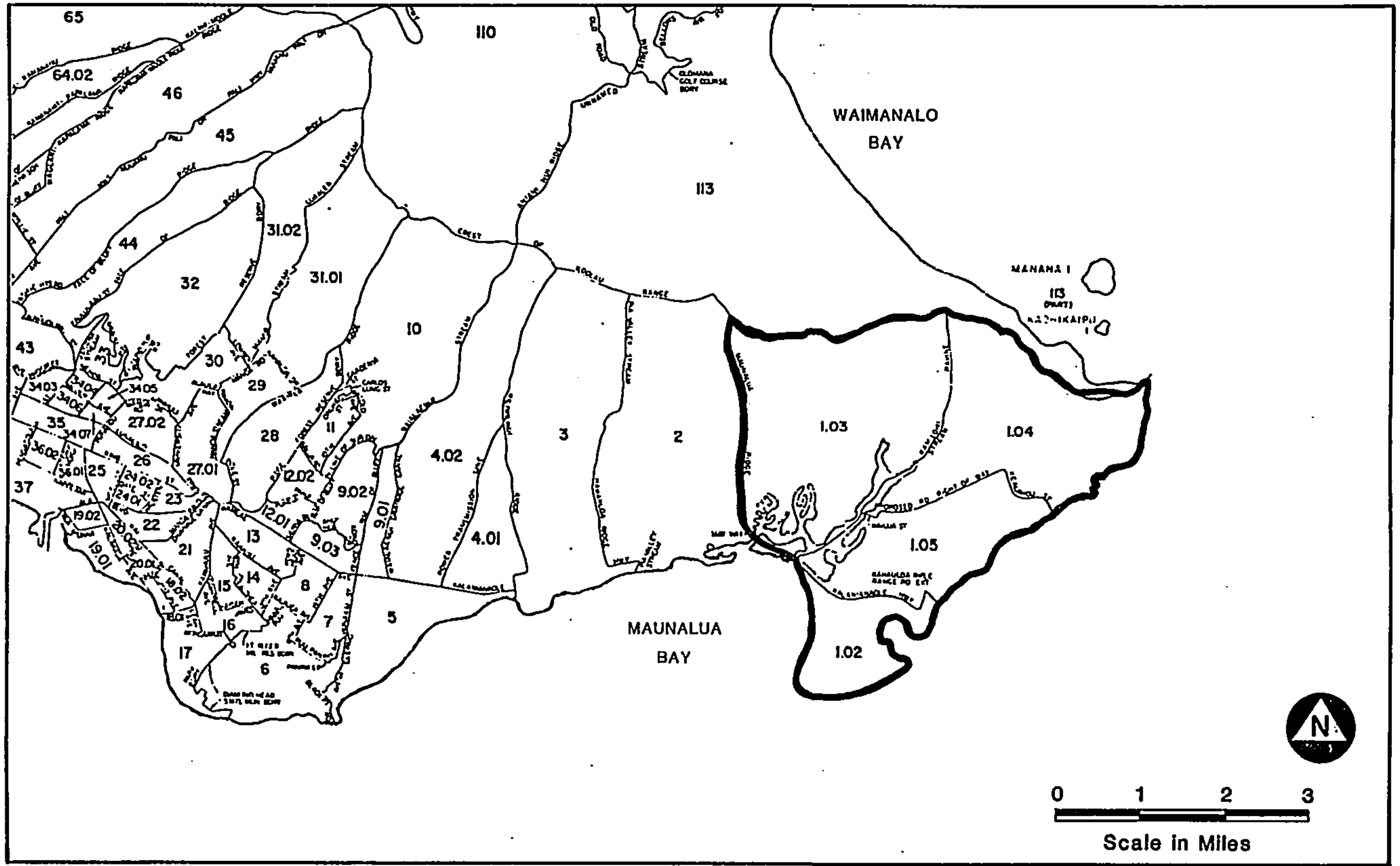
Approximately 52% of Hawaii Kai residents were born in Hawaii, as compared to the City and County of Honolulu's 55%. Hawaii Kai has the highest percentage of people born in other states and the lowest percentage of foreigners as compared to other census tract on Oahu.

Education

Hawaii Kai has a significantly higher percentage of persons with at least some college education. Approximately 61% of the residents attended college versus 40 % for the City and County of Honolulu.

Labor force and Occupation

The Hawaii Kai population, compared to the City and County of Honolulu, has a greater number of employable age persons. Of this number, 97.6% are employed and 2.4% unemployed. Next to Waialae-Kahala, Hawaii Kai has the second lowest unemployment rate on Oahu.



Maunalua Bay Ferry Terminal

1980 CENSUS TRACTS

Fig. 13

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Wilson Okamoto
& Associates, Inc.

A substantial portion (41%) of Hawaii Kai's employed residents are in managerial, professional specialty and professional and related services occupations. This compares to the City and County of Honolulu's 28%. Conversely, Hawaii Kai has the lowest comparative percentage of the labor force in categories of service and blue collar occupations.

With regard to income, Hawaii Kai can generally be categorized as a higher than average, affluent community. Over 50% of households had incomes over $35,000 per year in 1979, including 21% with incomes over $50,000. The median income for households of Hawaii Kai was $36,232 versus $21,077 for the City and County of Honolulu.

Housing Characteristics

There are 8,000 existing housing units in Hawaii Kai, of which 1,100 are low and medium density. Owner-occupied residences account for 82% of total households versus 18% for renters.

Public Facilities and Services

Police and Fire Protection. The Hawaii Kai Fire Station, which consists of an engine company and a hook-and-ladder unit, is located on Lunalilo Home Road approximately 2 miles from the project site. The Wailupe Fire Station, located on Kalanianaole Highway is approximately 3 miles away. The proposed project will likely be served by existing facilities.

Police services will be provided by the Honolulu Police Department. Nine police officers (three officers in three shifts) are assigned daily to patrol the Hawaii Kai area which is designated as Beats 90, 91 and 92. The nearest police station, Honolulu Police Station, is located at Pawaa Annex in Honolulu approximately 7 miles west of Hawaii Kai.

Health Services. Three health care facilities are located within the immediate project area. Kaiser Clinic is located in the Hawaii Kai Towne Center, Straub Clinic at the Koko Marina shopping center and the Hawaii Kai Emergency and Family Medicine Clinic in the Kuapa Kai Shopping Center.

Emergency services are offered by the Hawaii Kai Fire Station and an ambulance is stationed at the Wailupe Fire Station. The nearest hospitals are the Queens Hospital and Straub Clinic located in Honolulu.

Educational Facilities. The three public elementary schools in the project area are Hahaione, Kamiloiki and Koko Head. The closest intermediate school is Niu Valley and the nearest high school is Kaiser High located on Lunalilo Home Road.

Recreational Facilities. Hawaii Kai and the vicinity has an abundance of public and private recreational facilities. There are three public parks in the Hawaii Kai area: Koko Head District Park (CT 1.02), Hahaione Playground (CT 1.03) and Kamiloiki Community Park (CT 1.04). Table 2 summarizes both public and private recreation facilities in the project area.

TABLE 2

PUBLIC PARKS AND FACILITIES

HAWAII KAI AREA

EXISTING PARKS		Acreage
Hahaione Community Park		4.09
Hahaione Neighborhood Park		6.20
Kamiloiki Community Park		9.98
Kamiloiki Neighborhood Park		7.00
Koko Head District Park		50.00
Maunalua Bay Beach Park		4.00
Hanauma Bay Beach Park		8.70
Kalama Valley Community Park		6.00
	Total	95.97

UNDEVELOPED PARKS		
Koko Kai Beach Parks		1.15
Koko Head Park		1,057.15
	Total	1,058.30

Transportation. Vehicular traffic in the East Honolulu area is served by a single major artery, Kalanianaole Highway. Kalanianaole Highway connects Interstate Route H-1 to Windward Oahu and is East Honolulu's primary link to major Honolulu employment centers.

Kalanianaole Highway is a divided highway in a 120-foot wide right-of-way from Interstate H-1 to Kirkwood Street. The divided section has three lanes in each direction west of West Hind Drive, and three westbound and two eastbound lanes between West Hind Drive and Kirkwood Street. Between Kirkwood Street and Hawaii Kai Drive, the roadway is a four-lane undivided highway, with left-turn lanes provided only at East Halemaumau, Hawaii Kai Drive, Keahole Street and Lunalilo Home Road.

Current roadway facilities and public transit services along Kalanianaole Highway are intensely used throughout the morning and evening peak travel periods.

Utilities. Water, electrical and telephone service lines are available along the Kalanianaole Highway right-of way. Drainage from the site and adjacent Kalanianaole Highway is discharged through a swale traversing the proposed parking area into Maunalua Bay. No sewerage connection is available in the immediate area: the comfort station at Maunalua Bay Beach Park is served by a cesspool.

RELATIONSHIPS TO PLANS, POLICIES AND PERMITS

Plans

Hawaii State Plan. The development of an East Honolulu to Downtown ferry link is supported by the State Plan. According to Section 226-17 of the Hawaii State Plan, one of the first stated objectives regarding transportation is "to develop an integrated multi-modal transportation system that services statewide needs and promotes the efficient, economical, safe, and convenient movement of people and goods". Section 226-17 b (11) indicates that this will be achieved through "the use of low-cost, energy efficient, non-polluting means of transportation". The State shall "encourage systems that serve development need of communities".

The State Functional Plan. Development of an intra-island ferry system is also in harmony with the State Transportation Functional Plan Objective which promotes the "development of a balanced, multi-modal statewide transportation system that serves clearly identified social, economic and environmental objectives of the Hawaii State Plan".

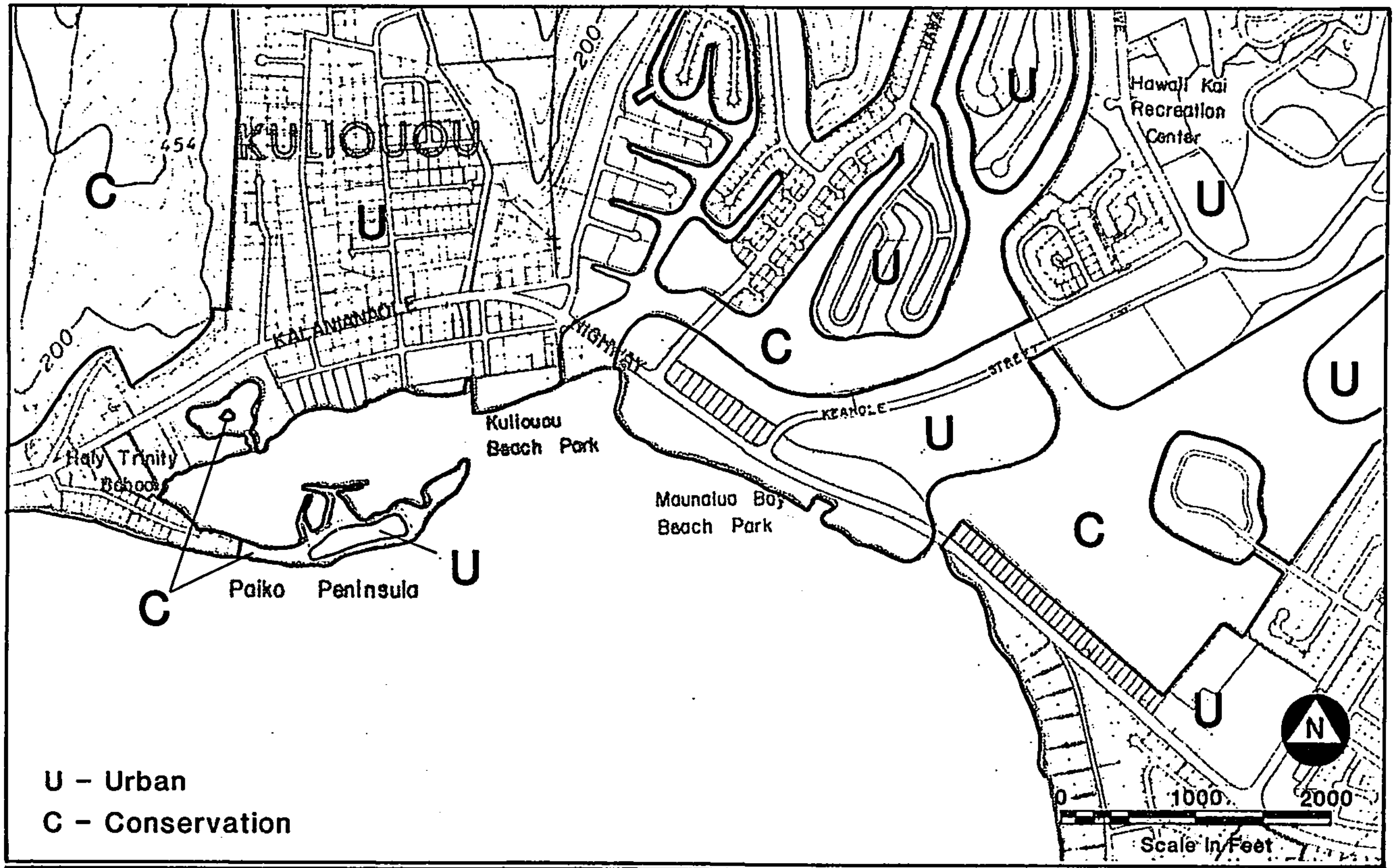
The General Plan of the City and County of Honolulu. The General Plan of the City and County of Honolulu establishes long-range objectives and policies for guiding both the quantity and quality of future growth in Oahu.

The proposed Hawaii Kai to Downtown Honolulu ferry link will facilitate implementation of the General Plan. It specifically addresses the objective to "create a transportation system which will enable people and goods to move safely, efficiently, and at a reasonable cost; serve all people, including the poor, elderly, and the physically handicapped; and offer a variety of attractive and convenient modes of travel".

Land Use Policies and Zoning

State Land Use District. Pursuant to Hawaii Land Use Law (Chapter 205, HRS), the State Land Use Commission classifies all lands into four land use districts: urban, agricultural, conservation, and rural. Maunalua Bay Beach Park is situated within the Urban District, except for lands and submerged lands seaward of the shoreline. See Figure 14. Therefore, implementation of the Maunalua Bay Ferry Terminal will not require an amendment to the State Land Use boundaries. Development of land within the Conservation district lying seaward of the shoreline, will be discussed under the Conservation District Use Application process in the Shoreline and Environmental Permits section.

City and County of Honolulu Development Plans. Eight development plans were established to provide detailed schemes for "implementing and accomplishing the objectives and policies of the General Plan." The development plans guide the desired sequence, patterns and characteristics for future development.



Maunalua Bay Ferry Terminal

STATE LAND USE DISTRICT

Fig. 14

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Wilson Okamoto
& Associates, Inc.

The proposed project is situated within the East Honolulu district which extends from the Waialae-Kahala area to Makapuu and whose policy is to provide for increased urbanization in this area. The development plan land use map for this region designates a portion of the site as "parks and recreation", while the boat ramp and parking area is designated as "preservation". See Figure 15. A development plan amendment to designate the site as "public facility" will be required.

The public facility designation covers public and quasi-public uses and would allow the development of a publicly or privately operated ferry terminal.

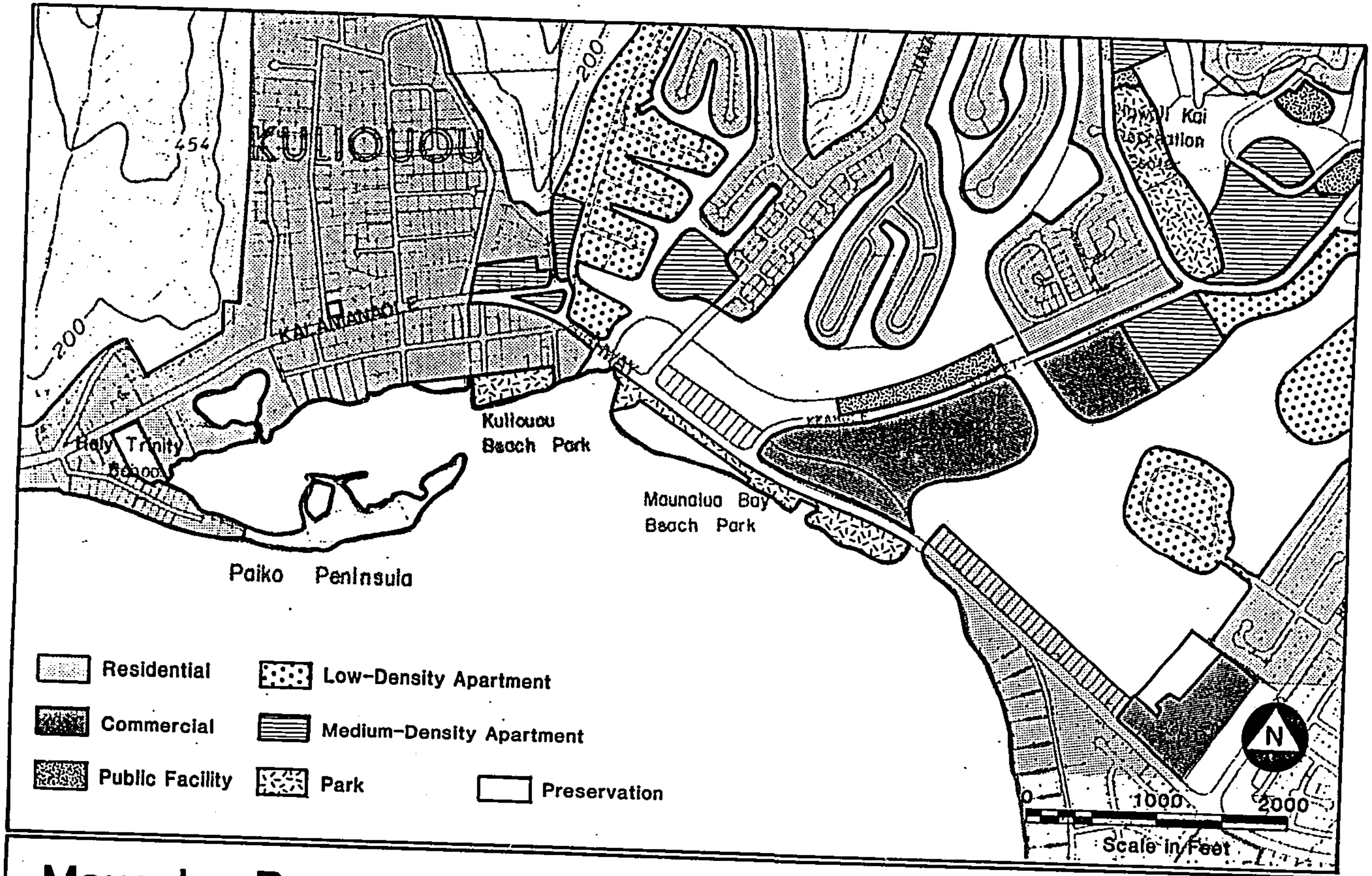
Land Use Ordinance. The City and County of Honolulu Land Use Ordinance (LUO) regulates land use in accordance with adopted land use policies, including the Oahu General Plan and Development Plan.

Under the current LUO zoning, the proposed project site is designated P-2 (General Preservation District) which preserves and manages major open spaces and recreation lands and lands of scenic and other natural resource value. See Figure 16. The maximum height allowed in the General Preservation District is up to 25 feet if setbacks are provided. The proposed ferry terminal is considered a public use and is a permitted use in the General Preservation District.

Shoreline and Environmental Permits

Department of the Army Permit. The Department of the Army permit is administered by the U.S. Army Corps of Engineers, Honolulu District under Section 10 of the Rivers and Harbors Act (33 USC 403), Section 404 of the Clean Water Act (33 USC 1344) and Section 103 of the Marine Protection, Research and Sanitation Act of 1972 (33 USC 1413). The permit is required for all work within water of the United States, including ocean and coastal waters, inland and tidal waters, tidal ponds, fishponds, rivers, streams, and adjacent wetlands, perched wetlands, and intermittent streams.

Issuance of the permit is based on an evaluation of the probable impact of the proposed activity on the public interest, reflecting national concern for both protection and utilization of important resources. Factors considered include those relating to: conservation, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, land use, navigation, recreation, water supply, water quality, energy needs, safety, food production and, in general, the needs and welfare of the people.



Maunalua Bay Ferry Terminal

DEVELOPMENT PLAN LAND USE

Fig. 15

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Harbors Division

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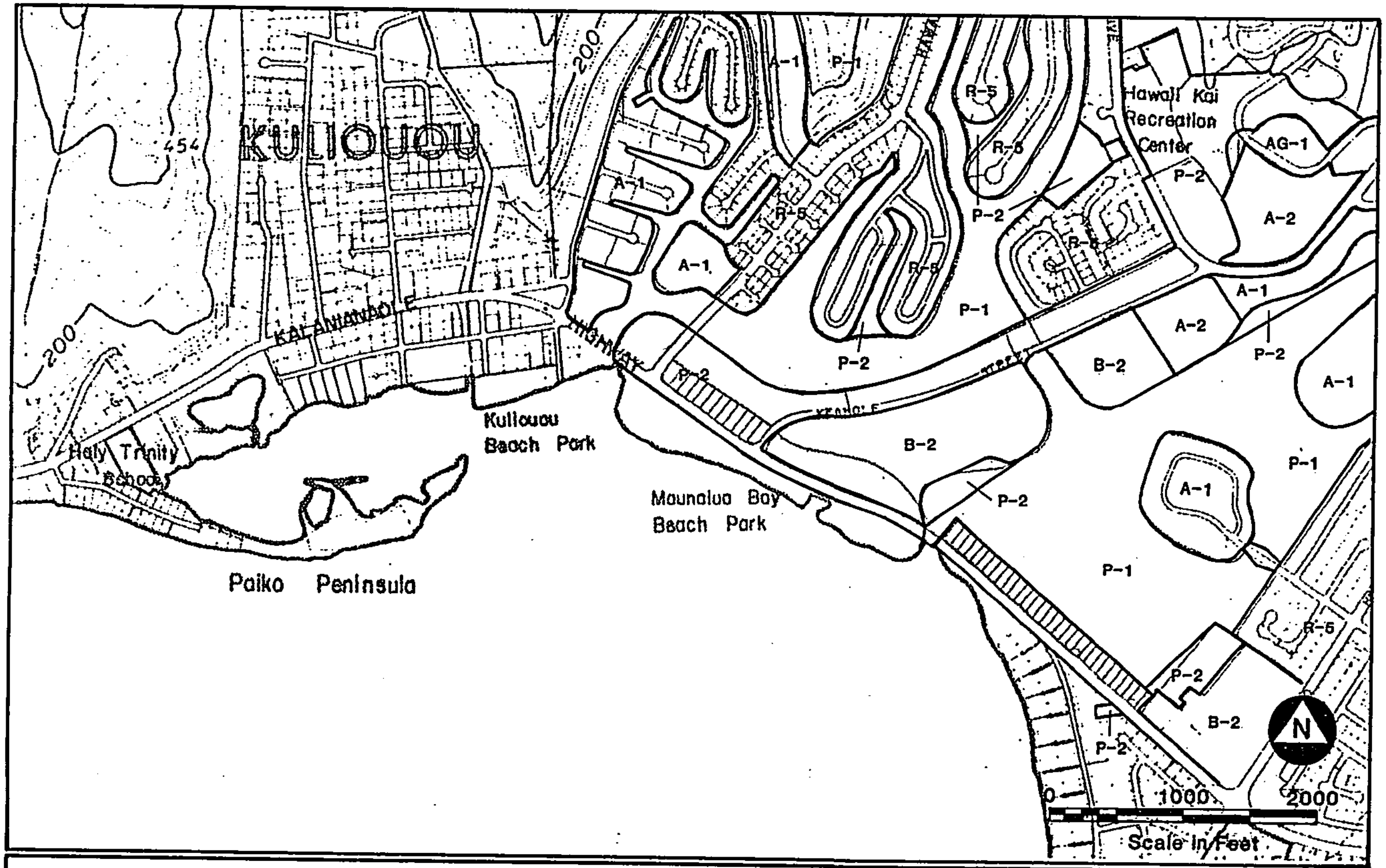


Maunalua Bay Ferry Terminal

LUO ZONING

Prepared for:
Department of Transportation
Harbors Division

Fig. 16

Prepared by:
Wilson Okamoto & Associates, Inc.

Portions of the Ferry Terminal subject to review under the Department of the Army permit are those which involve ocean and coastal waters, including:

1. Dredging to widen and deepen the existing channel;
2. Dredging a turning basin;
3. Constructing a pier for the ferry vessel.
4. Constructing a revetment along the eroded shoreline aligned with the existing revetment.

<u>Conservation District Use Application</u>. Any use of lands, including submerged lands within the State's Conservation District, as established by the State Land Use Commission, is subject to review pursuant to Chapter 183, HRS and Title 13, Chapter 2 of the Department of Land and Natural Resources Regulations. At the terminal site, the area beyond the shoreline, defined as "the upper reaches of the wash of waves, other than storm and tidal waves, usually evidenced by the edge of vegetation growth, or the upper line of debris left by the wash of waves," is subject to review as a use in the "Resource (R) subzone of the State Conservation District (Section 13-2-13, Administrative Rules of the Department of Land and Natural Resources). Approval by the State Board of Land and Natural Resources will be required through a Conservation District Use Application for all dredging and construction beyond the shoreline.

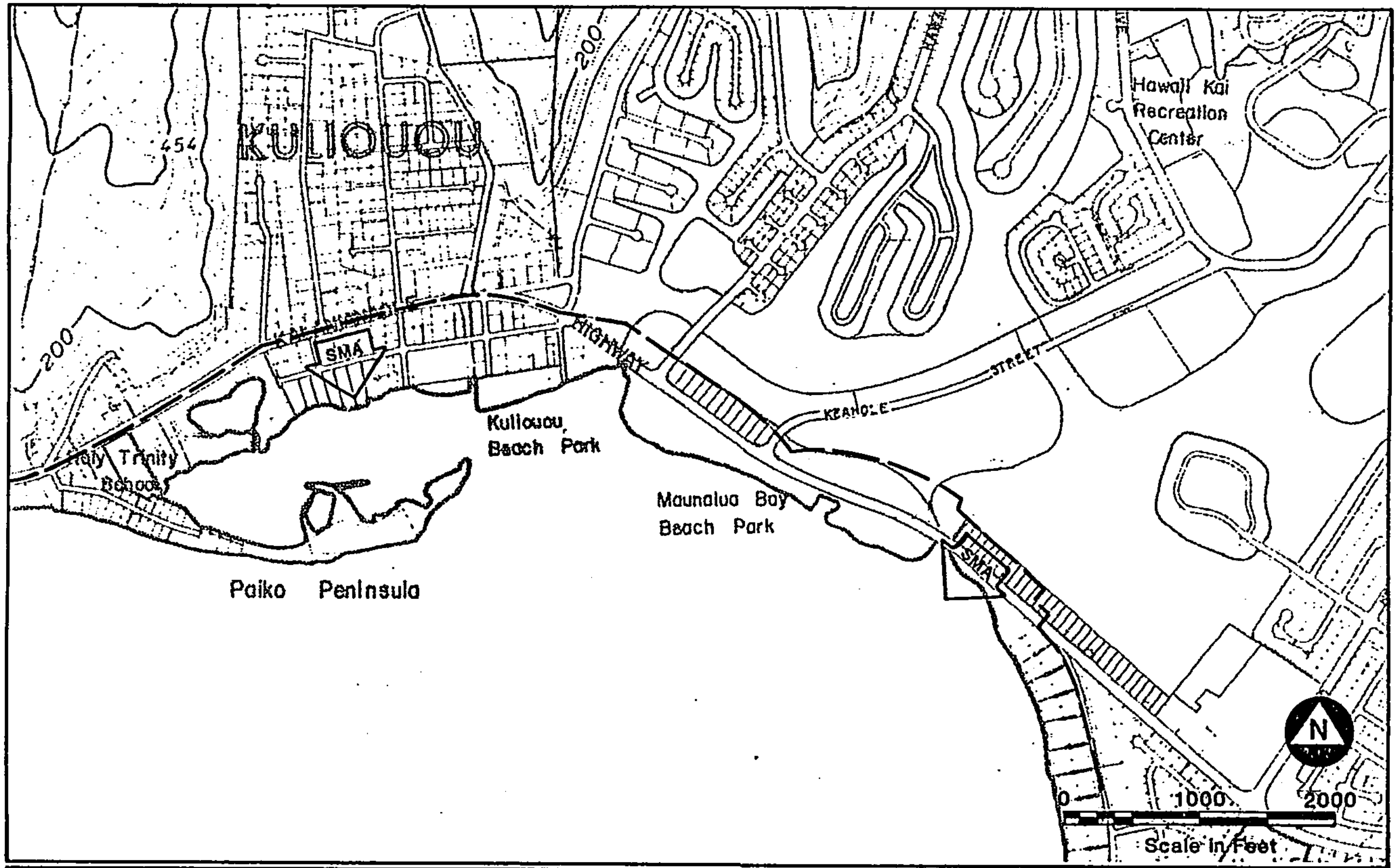
<u>Special Management Area (SMA) Permit</u>. The Hawaii Coastal Zone Management Law (Chapter 205A, HRS) charged the Counties with designating and administering Special Management Areas (SMA) along the State's coasts. Any "development", as defined by Law, within the SMA requires an SMA permit, which is administered by the City ad County of Honolulu, Department of Land Utilization pursuant to Ordinance No. 84-4.

The entire project site is located within the SMA boundary and is subject to review under the SMA permit procedures. See Figure 17.

<u>Shoreline Setback Variance</u>. The State's Shoreline Setback Law, (Chapter 205, HRS) prohibits virtually any development or development-related activity including the removal of sand, rocks, soil, etc. from the shoreline setback area, a 40-foot (20 feet in some areas) strip of land along the shoreline. The Counties, however, are authorized to grant variances for construction that would encroach in the setback area. The City and County of Honolulu, Department of Land Utilization administers this variance under its shoreline setback regulations.

Variances may be granted in consideration of a structure, or activity being in the public interest, hardship to the applicant if the proposed structure or activity is not allowed and the effect a structure or activity would have on natural shoreline processes, particularly with regard to shoreline erosion.

The shoreline variance request will be processed concurrently with the Special Management Area Permit with simultaneous decision-making by the City Council.



Maunalua Bay Ferry Terminal

SMA BOUNDARY

Fig. 17

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Wilson Okamoto
& Associates, Inc.

Hawaii Coastal Zone Management Program Federal Consistency Review. Section 307 of the National Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et. seq.) provides for State review of federal actions affecting the coastal zones of States with approved Coastal Zone Management Programs. Hawaii's Coastal Zone Management (CZM) Program, established pursuant to Chapter 205A, HRS was federally approved in 1977. It is administered by the Office of State Planning (OSP).

Among Federal actions subject to review is the issuance of permits, including the Department of the Army Permit, which will be required for offshore channel improvements, turning basin, pier and shoreline revetment construction. Before the permit can be issued, the OSP must determine its consistency with the enforceable policies of the Hawaii CZM Program. These policies encompass broad concerns such as impact on recreational resources, historic and archaeological resources, scenic and open space resources, coastal ecosystems, economic uses, coastal hazards and the management of development.

Permit for Work in Shores and Shorewaters. The Shorewaters Permit is administered by the State Department of Transportation pursuant to Section 266-16, HRS and Section 19-42-161, Hawaii Administration Rules, Department of Transportation, Harbors Division.

This permit is required for any construction, dredging, or filling within the shorewaters of the State, as defined by Chapter 266, HRS. Jurisdiction extends to shores, shorewaters, navigable streams and harbors, belonging to or controlled by the State.

Portions of the ferry terminal project subject to review include the widening and deepening of the channels, dredging the turning basin and construction of the pier and shoreline revetment. This will be reviewed via interagency coordination with the Department of Land and Natural Resources on the Conservation District Use Application. The DOT, however, could request an independent review under the Shorewaters Permit.

Section 401 Water Quality Certification. The State Department of Health is charged with the responsibility of establishing and administering a State certification system pursuant to Section 401 of the National Clean Water Act (33 USC 1344) and Section 342-32(13), HRS. Water quality certification is required of any applicant for a Federal license or permit to conduct any activity that may result in any discharge into navigable water.

LONG AND SHORT TERM IMPACTS

Anticipated impacts of the proposed project have been assessed for the long and short terms. Short term impacts, beneficial and adverse, generally result from construction related activities. Short-term impacts should persist no longer than the duration of the construction. Long-term impacts, beneficial and adverse, result from the implementation and operation of the proposed project.

Short Term Impacts

Construction related impacts are unavoidable but through proper application of mitigative measures, can be minimized in severity and duration.

Construction activities will typically be scheduled from 7:00 A.M. to 3:30 P.M., Monday through Friday (excluding holidays). The duration of construction and associated impacts will be contingent upon project phasing and construction methods used.

Noise. Noise levels in the vicinity of the project site will increase as a result of operating heavy vehicles and other power equipment during construction. It shall be the contractor's responsibility to minimize noise by complying with Title 11, State Department of Health Administrative Rules, Chapter 42 - Vehicular Noise Control for Oahu and Chapter 43 - Community Noise Control for Oahu. Accordingly, the contractor shall be responsible for properly maintaining mufflers and other noise attenuating equipment. A noise permit will be required if it is anticipated that noise levels will exceed allowable limits as specified in the regulations.

While mitigative measures will be implemented, unavoidable construction-related noises could affect leisure activities at the Maunalua Bay Beach Park. These actives include picnicking, fishing, canoe paddling and kayaking. Person engaged in activities such as jet skiing and commercial fishing will probably be less aware of the noise.

Air Quality. Ambient air quality is expected to temporarily decrease as a result of construction related activities. Airborne dust shall be controlled with appropriate dust control measures, such as water spraying and sprinkling. Roads at the construction site shall be paved or frequently watered to minimize dust.

Recreational users onshore and offshore may be temporarily affected by dust generated during construction.

Water Quality. Site preparation and grading activities shall be conducted in compliance with applicable State and City and County regulations to minimize runoff and adverse impacts to offshore waters.

An increase in turbidity is anticipated in the vicinity of the project site during construction. It is expected that dredging during tradewind conditions will result in a seaward moving plume of water. Once beyond the reef the turbid water will be diluted and transported toward Portlock Point. During periods of ebbing tide, the turbid water will be transported offshore and to the east. In calm conditions, transport of the plume will be due to tide generated currents. During flood tide, the plume will be transported shoreward or into the marina. During occurrence of "Kona" winds, transport will also be shoreward.

Once settled out of the water column, sediments will be deposited on the reef flat, the channel areas, and the deeper offshore bottom. Most of the sediment should settle in the immediate vicinity of the dredging; finer particles will be deposited over a wider area and will be subject to resuspension and subsequent transport.

The short term increase in turbidity is not expected to have an adverse effect on the marine environment due to the existing condition of the reef flat community. Turbidity generated from construction related activity would be less than the effect of any one of several storms per year and should be well within the variation in water quality presently occurring.

Benthic Impacts. Dredging will disturb the soft sediment deposited on the reef flat and on the channel floors, thus high turbidity levels may be expected during the construction phase. Marine communities within the fringing reef are presently subjected to considerable turbidity. This is indicated by the high proportion of suspension or filter feeding forms of invertebrate species encountered in the inner reef area. These heterotrophic forms are know to be common in areas receiving high particulate loading. Moreover, lack of algae below the five foot depth within the fringing reef margin may also be attributed to turbid conditions impeding penetration of light.

Potential impacts due to turbidity could be greatest on benthic communities seaward of the reef margin in the limestone mounds biotope. However, benthic community development in the limestone mounds biotope fronting the project area does not appear to be diverse or particularly high in species numbers. Benthic community structure and coral coverage increases somewhat with greater depth offshore, but as the turbidity plume is carried seaward, dilution due to mixing and advection occurs, lessening potential impact.

Recreation/Boating. Temporary effects on recreation will be primarily related to dredging the channel and turning basin and constructing the pier and revetment. During dredging operations, boaters, canoers, surfers, jet skiers and other water users will be required to stay clear of the dredge. Access to the shoreline and use of the channel will be permitted during construction.

The quality of fishing in the area fronting Maunalua Bay Beach Park may be affected due to the increase in noise and turbidity. The area presently receives daily high noise input from boat traffic and jet-ski operations.

Following the completion of the construction phase, turbidity levels should return to present conditions.

Traffic and Parking. During construction, truck, heavy equipment and other vehicles will use existing roads to import materials and to access construction areas. The increased traffic from construction-related vehicles is not anticipated to be significant, but may cause some minor inconveniences in the immediate vicinity for the duration of construction. If required, flagmen shall be employed to ensure traffic safety.

Existing parking areas located within the project site will be limited but adequate parking will be available in the adjacent parking lot near the boat ramp.

Public Safety. Necessary measures to ensure public safety will be provided throughout all phases of construction. Signs, barricades, and if necessary, police officers will be employed to adequately separate the public from construction activities. Pedestrians may be required to bypass certain construction areas, however, this may be considered a minor inconvenience of short duration.

Between working hours (nights, weekends, holidays), open excavated areas shall be secured by adequate safety signs, signals and or other safety devices.

Incidence of ciguatera poisoning have been associated with eating of fish taken in newly dredged areas. The relationship between the creation of new surfaces in benthic communities, algal growth and ciguatera in resident reef fishes, however, is highly variable. New surfaces for algal colonization in coral reefs may be brought about by dredging, construction or by storms denuding reef surfaces. The mechanisms involved with the development of ciguatera are not well known and in some cases, dredging has not resulted in a ciguatera problem. The organism identified as being responsible for the disease is Gambierdiscus toxicus. Environmental monitoring for G. toxicus can be conducted and it may provide a margin of safety for individuals consuming fishes from areas following extensive man-induced disturbance. Other ways that are being developed to alleviate the problem include use of the "poke stick" test if the flesh of individual fish has ciguatoxin and if a person is afflicted with the disease, to administer mannitol which shows promise in alleviating the symptoms.

Economy. The short-term economic impacts resulting from construction include the provision of jobs to local construction workers. Local material suppliers and retail businesses may also benefit from the increased construction activities.

Fauna and Marine Life. Potential construction impacts on whales and green sea turtles include the generation of noise, particularly due to blasting. Complete mitigation of blasting impacts on whales will be achieved by curtailing blasting during the months of November through March. There does not appear to be any information of potentially adverse noise impacts on sea turtles which inhabit areas west of the entrance channel. Blasting will not be done within these areas. Moreover, it is anticipated that shock waves from blasting will be partly confined by existing channel sides and dissipated as they pan along limestone formations before reaching areas where turtles occur.

Increased turbidity from construction related activities could affect the Paiko Lagoon Wildlife Sanctuary by impacting their food supply. However, the lagoon has a net seaward flow of water because of a freshwater spring feeding into it, suggesting that transport of particulate material would be out of the lagoon. Moreover, the lagoon is presently a mud basin supporting foraging species capable of surviving in this substratum type. Thus any additional turbidity, if it were to occur, would not affect the present forage base.

Wind transport of floating substances or trash which apparently occurs may counteract to some degree the transport of material out of the Lagoon. While some incidental leakage of oil from construction vehicles may occur, this amount will be insignificant in relation to such leakages currently associated with boats, thrill craft, automobiles, buses and other vehicles using the area.

Long Term Impacts

Noise. Noise will be generated when the ferry vessels approach and depart from the terminal. The loudest perceived noise will be produced for approximately two to three minutes when the vessel is maneuvering away from pierside.

Intensive noise from the ferry vessel should not be significant; however, operations may affect residences located east of the main entrance channel. Noise levels generated by the vessel will not exceed 80 dbA from 50 feet astern while maneuvering and not greater than 73 dbA from 600 feet abeam while operating at full power. Noise in the passenger compartment will not exceed 76 dbA. The vessel will pass no closer than 850 feet from the closest residences, and the perceived vessel noise should be less than traffic noise along Kalanianaole Highway.

Air Quality. Air quality may be slightly affected by the operation of the ferry system, but the impacts are not anticipated to be significant. Predominant trade winds from the northeast will tend to blow emissions out to sea and away from populated areas.

Buses and automobiles bringing commuters into the terminal area at Maunalua Bay will be an additional source of air pollution because of their volume and the daily duration of operation. The additional source of air pollution is not expected to result in air quality impacts greater than those occurring from traffic peak periods on the adjacent Kalanianaole Highway. Moreover, persons commuting on the ferry could be regarded as reducing air pollution by reducing vehicular traffic on the highway.

Water Quality/Erosion. The long term effect of the channel alterations and ferry operations on factors suspected of causing shoreline erosion will likely be insignificant. Channel widening will very slightly decrease tidal flow rate in the larger channels. This will be countered by a very slight increase in wind induced currents. The water quality effect of increased boat traffic may include a negligible increase in incidental oil discharges, litter and leaching of hull bottom paint. These effects are believed to be too small to be significant or even measurable.

Benthic Impacts. The development of the ferry system will require dredging of the present entrance channel and a turning basin. This will result in the direct loss of benthic communities residing in the area slated for removal. The benthic communities in the affected areas are poorly developed and thus little impact is foreseen.

The widening of the entrance channel could impact the existing live coral if the western channel edge were to be dredged. Based on the presence of this coral and the need to remove less material from the eastern side, it is recommended that the entrance channel widening be restricted to the eastern side of the channel. Once the material is removed, it is to be disposed of at the EPA approved dump site approximately 7 miles offshore of Honolulu.

Visual Quality. Maunalua Bay is a predominant scenic feature within the East Honolulu area. Westbound travelers on Kalanianaole Highway have both a makai (ocean) and mauka (mountain) view, including a relatively unobstructed view of the entire bay and the Koko Marina area. Residences on the upper slopes of Hawaii Kai, Hawaii Loa Ridge, Portlock and Kuliouou also have panoramic views of Maunalua Bay. Inasmuch as the proposed ferry terminal improvements are not visually obtrusive, the overall open space character of the area will be preserved; including existing views to the bay from Kalanianaole Highway and upper slopes of hills. There will be no significant alteration of the land forms or visual environment except for the parking lot and passenger shelter, both of which have a low profile and will be landscaped. The current use of the site for parking will be essentially maintained.

A sectional view through the proposed terminal area based on planned highway and parking lot elevations, reveals that the visual impression of the site as a parking area will be retained along Kalanianaole Highway. See Figure 18. Automobiles and buses in the terminal area will be visible from the highway. The passenger shelter will be the most significant stationary vertical feature on the site. The existing comfort station has a comparable building "footprint" as the passenger shelter, although the shelter is anticipated to have a lower vertical profile. Landscaping and design of the proposed shelter will enhance its visual appeal.

Between the vehicles and passenger shelter, the ocean will be visible from the top of the revetment or pier to the horizon. In the foreground, the new asphalt paving for the parking lot and vehicle queuing area can be obscured by a three foot tall shrubbery screen.

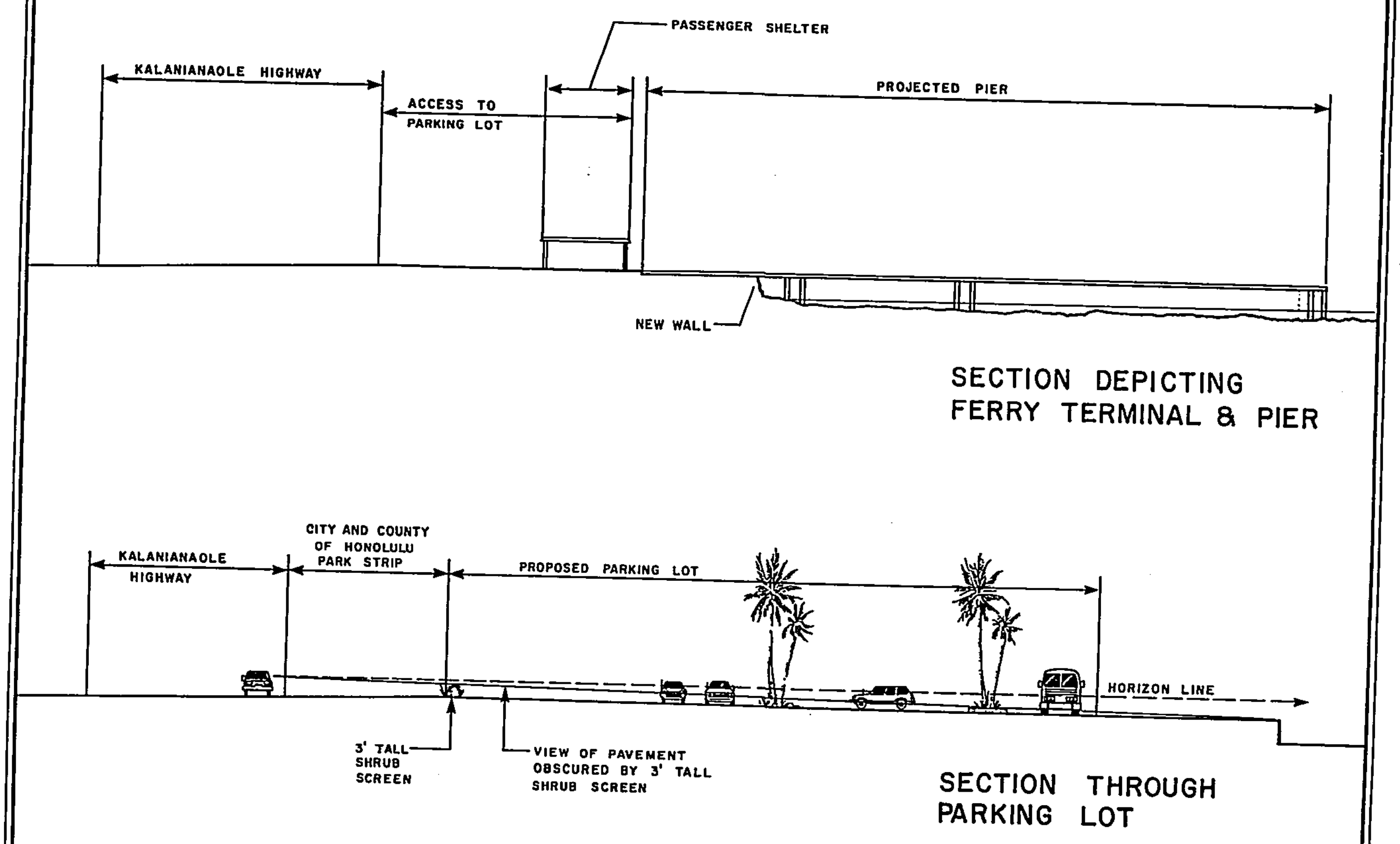


Fig. 18

Maunalua Bay Ferry Terminal

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.

Archaeological/Historic Sites. Inasmuch as Maunalua Bay project area was constructed within the past 20 years, archaeological remnants are not anticipated to be uncovered during construction. The area seaward of Kalanianaole Highway was formed from material dredged from Kuapa Kai pond. However, should archaeological remnants be unearthed, work would be halted and the State Historic Preservation Office notified to assess impacts and implement mitigative measures as deemed necessary.

There are no historic sites registered in the State or National Register of Historical Sites in or within proximity to the site.

Flora and Fauna. Construction of the ferry terminal is not anticipated to result in adverse impacts to terrestrial flora and fauna. Since the project area is comprised of filled material, there are no rare or endangered flora species.

Offshore and about 500 meters west of the blinker buoy marking the Hawaii Kai boat entrance channel is a well-known green sea turtle (*Chelonia mydas*) resting area. This site is know as "Turtle Canyon" and is located in water between 9 to 11 meters in depth. The area is popular among dive tour operators who escort their clients to this location. To avoid areas where turtles are present, the ferry operators will be directed to travel seaward until well offshore prior to steering to the west. Such a course will also keep the rapidly moving ferry away from divers in Maunalua Bay.

Further offshore, humpback whales (*Megaptera novaeangliae*) are frequently seen. This endangered species migrates to the Hawaiian Islands each November and remains in island waters for calving and breeding through April when it migrates north. During the whale "season" humpbacks transit through Maunalua Bay usually inside of the 100 fathom depth contour during the month of January through April.

Research in Maui attribute declines in nearshore whale abundance to boat traffic but the correlation has not been positively established. Considerable boat traffic transits through Maunalua Bay at the present time and the ferry runs will not be a significant addition to this traffic.

Collision with a whale could injure a whale as well as disable the ferry vessel. The possibility for collision is remote, however. The ferry operator will adhere to standard operating procedures designed to preclude possible collisions with the whales. During the period when Seaflite was operating, the ferry transited on a regular basis, without incidence, the State's most significant Humpback whale calving and breeding area off of Maalaea, Maui. Inasmuch as the southern coastline of Oahu is not known for dense concentrations of whales, ferry traffic is not anticipated to increase the already remote possibility of collision.

Traffic. Kalanianaole Highway is a principal arterial, a State highway linking Kailua to Honolulu via Makapuu Point. Keahole Street is a four-lane primary accessway to Hawaii Kai from Kalanianaole Highway. A channelized left-turn storage lane and separate left turn signalization is available for westbound traffic on Kalanianaole Highway to turn into the park and boat launching area where the ferry terminal will be sited. This left turn movement is currently restricted from 5:00 to 8:30 AM, except on Saturdays, Sundays and holidays.

To determine the nature of traffic-related impacts of the proposed project, the signalized intersection of Kalanianaole Highway and Keahole Street was qualitatively assessed for potential traffic congestion and hazards. See Appendix F. This assessment is based on a prior study prepared for Kaiser Development Company entitled Hawaii Kai Transportation Management Study which identified future travel needs within the Hawaii Kai community and along the Kalanianaole Highway corridor between Hawaii Kai and Interstate Route H-1.

The traffic assessment indicates that the primary impact of the Maunalua Bay Ferry Terminal would be a redistribution of existing and projected traffic, as opposed to generation of "new" traffic. This finding is consistent with the assumption that the majority of commuters using the intersection to get to or depart from the ferry terminal would otherwise be entering the intersection to travel along Kalanianaole Highway. The assessment also indicates that the redistribution of traffic will not likely cause volumes to exceed the capacity of the Kalanianaole Highway/Keahole Street intersection during peak traffic hours.

To assure that traffic flow is facilitated and to minimize potential hazard, the following measures should be considered:

- Remove restriction on left turn movement from Kalanianaole Highway into the site.
- Provide left turn signalization for traffic proceeding from the site onto Kalanianaole Highway.
- Modify signing and striping along Kalanianaole Highway and Keahole Street.
- Adjust traffic signal indication timing.

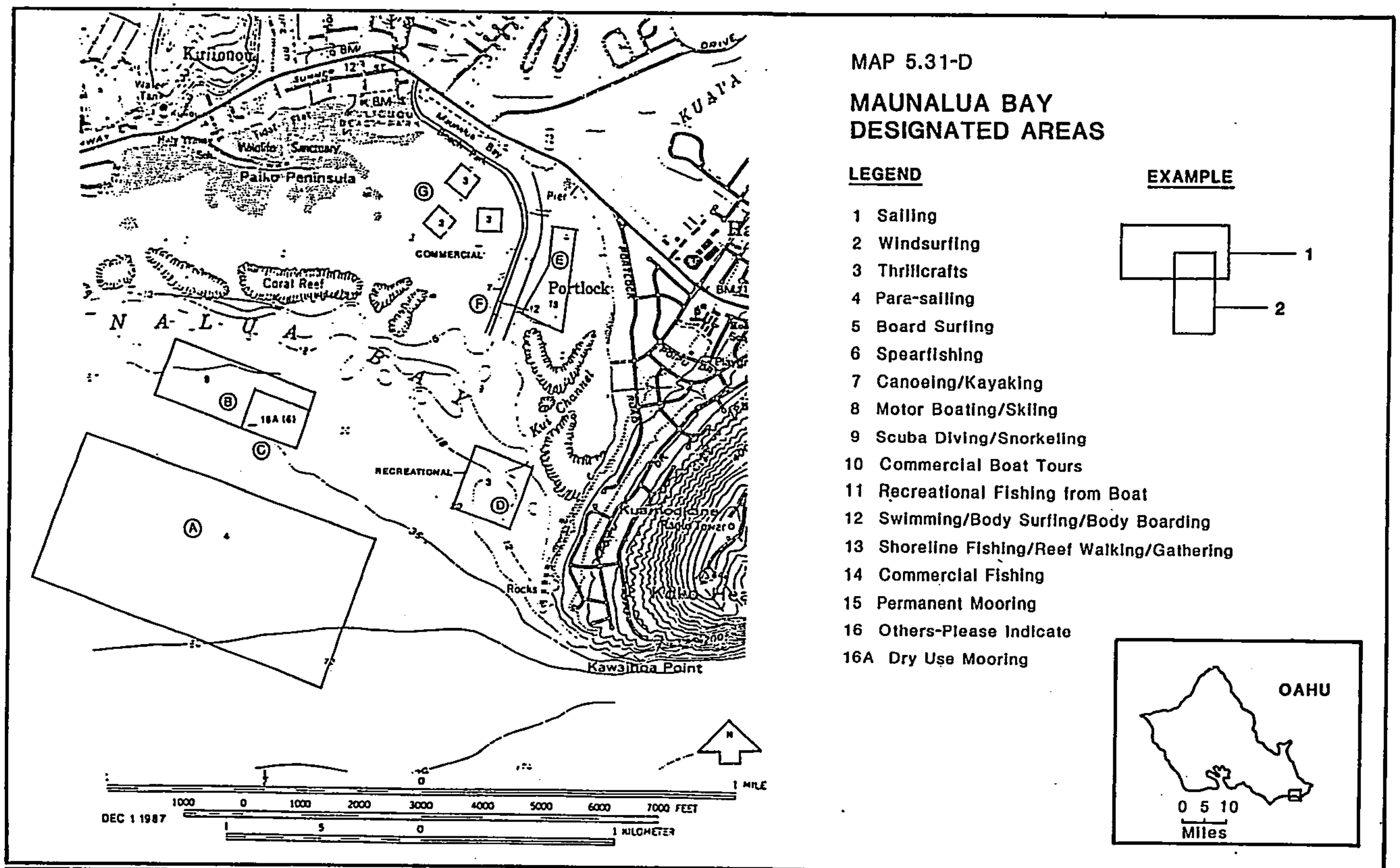
Recreation. In recognition of the increasing competition for recreational space in Maunalua Bay by potentially incompatible users, the Thirteenth State Legislature requested the Department of Transportation in House Resolution 170, H.D. 1, to formulate an Ocean Recreation Motorcraft Management Plan aimed at reducing conflict among motorized water craft and other ocean recreation users. The conflict of divers, canoers, surfers, jet skiers, kayakers and other ocean recreation users is exacerbated by the fact that there are no designated areas except for the jet skiers who operate 700 feet offshore. The adoption of DOT Administrative Rules and Regulations will clearly establish designated areas for both commercial and recreational users of Maunalua Bay. Public hearing are currently being held throughout the State.

The ferry system will not impact or affect implementation of the proposed Ocean Recreation Motorcraft Management Plan. See Figure 19. Although the ferry terminal will be located in the planned area, the designated spaces for specific users are not located within the channel or turning basin. The channel will be wide enough to accommodate simultaneous passage of the ferry and boats with 13 foot beams. This space will be more than adequate for passage of canoes, kayaks and surfboards. Moreover, the wake created by the ferry vessel will be less than that of boats which currently use channels in the area. Thus, implementation of the ferry system is not likely to result in a significant decrease of the supply of recreational resources.

While the operation of the ferry system may decrease availability of parking between commuter hours, more parking will be available outside of commuting hours, including weekends when the majority of recreational activities take place.

With regard to impacts on long-term recreational fishing, development of the Hawaii Kai ferry system could impact the quality of fishing that may occur in the area affronting the Maunalua Bay Beach Park and the Hawaii Kai Marina. During construction, fishing quality could impacted by increased noise and turbidity. With regard to noise, however, the area presently receives high noise input from boat traffic and jet-ski operations, suggesting that the impact of ferry noise on fishing may be negligible.

Following the completion of the construction phase, turbidity levels should return to conditions approximating the present. As noted above, the inshore area is presently quite turbid and any fish or invertebrate of commercial or recreational fishing interest, will be species tolerant of existing conditions. Thus following completion of the project, any species that is presently targeted by fishermen in the area should be present. It should be noted that during the field work no evidence of fishing in the inner reef area was noted; this may be related to the high level of use that this area receives from jet-ski operators and to the high degree of habitat degradation that has occurred in these inshore areas.



MAP 5.31-D

MAUNALUA BAY DESIGNATED AREAS

LEGEND

1 Sailing
2 Windsurfing
3 Thrillcrafts
4 Para-sailing
5 Board Surfing
6 Spearfishing
7 Canoeing/Kayaking
8 Motor Boating/Skiing
9 Scuba Diving/Snorkeling
10 Commercial Boat Tours
11 Recreational Fishing from Boat
12 Swimming/Body Surfing/Body Boarding
13 Shoreline Fishing/Reef Walking/Gathering
14 Commercial Fishing
15 Permanent Mooring
16 Others-Please Indicate
16A Dry Use Mooring

Maunalua Bay Ferry Terminal

PROPOSED STATEWIDE OCEAN RECREATION MANAGEMENT PLAN

Fig. 19

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Aotani
and Associates

ALTERNATIVES

NO ACTION

The Maunalua Bay to Downtown link of the Intra-Island Ferry Terminal is proposed as the first phase of developing the Statewide Intra-Island Ferry System. This first phase is intended both to demonstrate the feasibility for an intra-island ferry system and provide an alternative mode of transportation between Hawaii Kai and Downtown during the eight year long road widening improvements on Kalanianaole Highway. Neither of these objectives could be accomplished without construction of the proposed project.

ALTERNATIVE SITES

Alternative sites for the Maunalua Bay Ferry Terminal were sought but not found. The proposed site offers several key advantages:

1. Convenient access by a large commuting population in the Hawaii Kai area;

2. Ownership by the State which would avoid costly land acquisition;

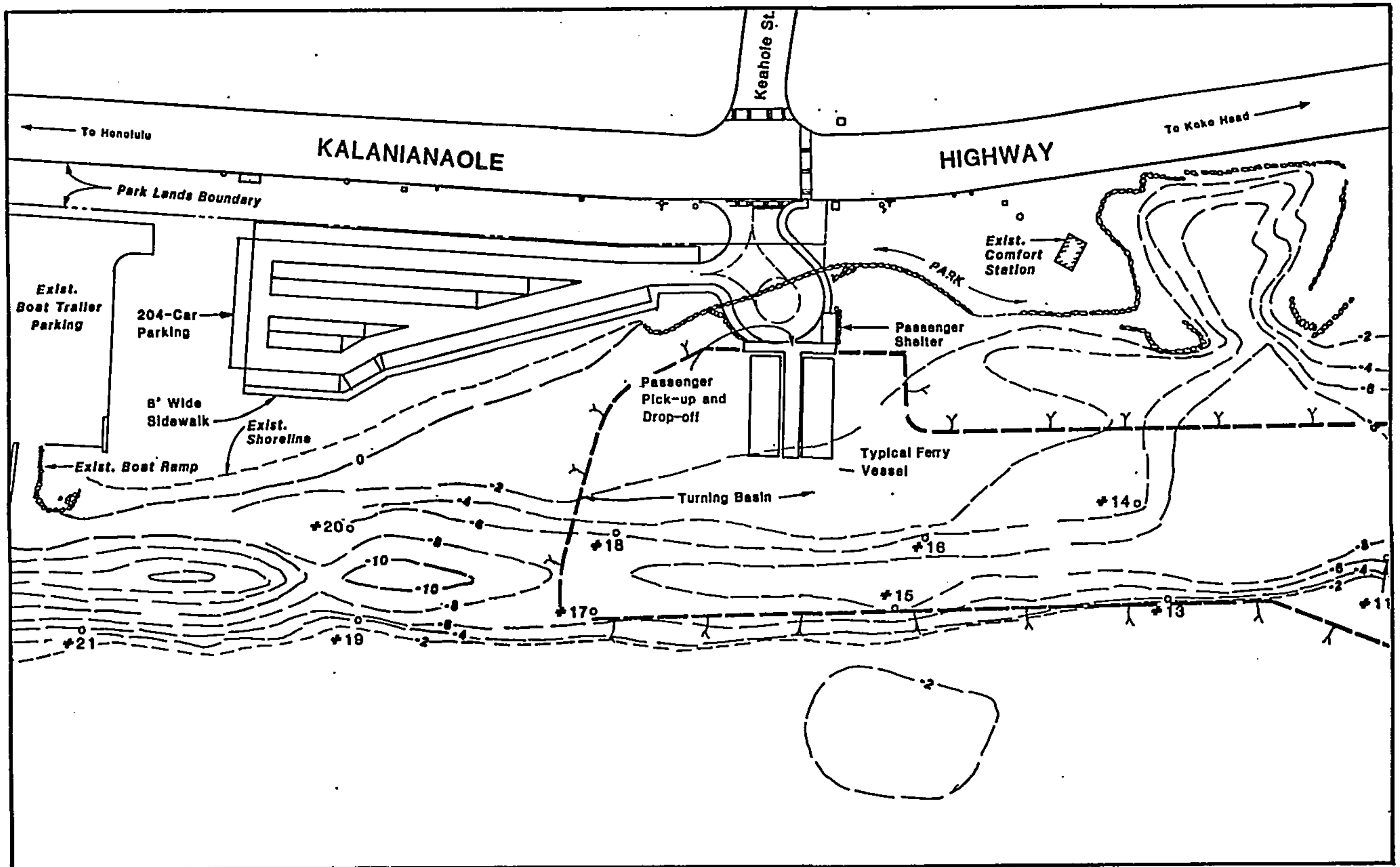
3. Adequate land area to accommodate a 200 parked cars and a vehicular queuing area for passenger drop-off and pick-up;

4. Proximity to other mass transit facilities, including bus terminals and a park-and-ride station, the majority of passengers are expected to arrive by bus.

5. Availability of the comfort station and rest area in the nearby Maunalua Bay Beach Park.

ALTERNATIVE DEVELOPMENT CONCEPTS

Two alternative development concepts were considered, one of which would provide slightly greater car parking capacities but would require filling within the Bay to construct a the vehicle turn-around area. See Figure 20. Filling within the Bay is considered a potential environmental drawback which would require more stringent permit review. the other alternative would omit the vehicular parking area, limiting vehicular improvements to the access driveway and turn-around area. See Figure 21. This alternative would place parking demands on existing and planned parking areas in the vicinity, including those for the existing boat launching ramp and Maunalua Bay Beach Park and the planned City and County Park and Ride Facility.



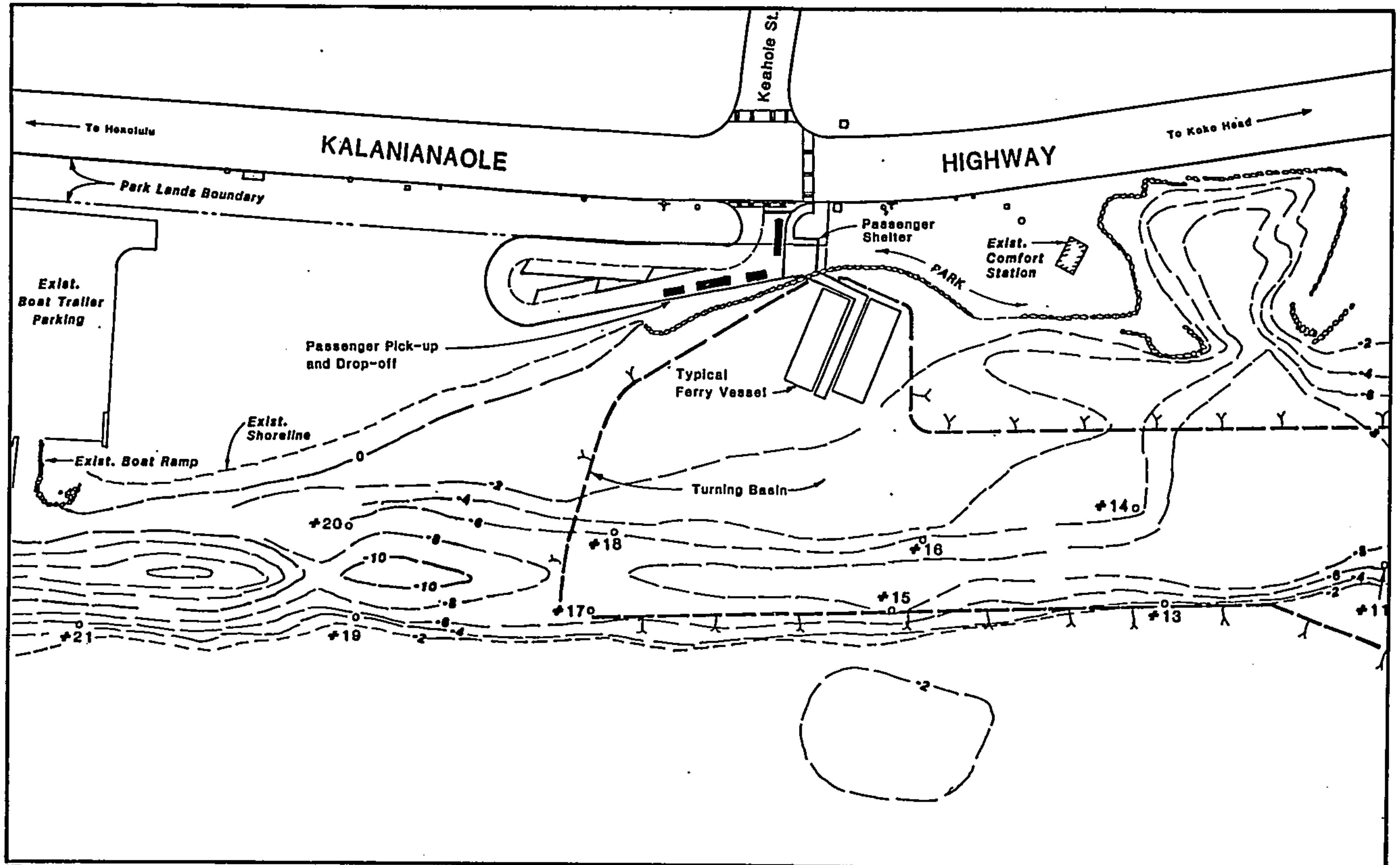
Maunalua Bay Ferry Terminal

ALTERNATIVE DEVELOPMENT CONCEPT 1

Fig. 20

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Wilson Okamoto
& Associates, Inc.



Maunalua Bay Ferry Terminal

ALTERNATIVE DEVELOPMENT CONCEPT 2

Fig. 21

Prepared for:
Department of Transportation
Harbors Division

Prepared by:
Wilson Okamoto
& Associates, Inc.

DETERMINATION

Based on the significance criteria of Section 11-200-12 (Administrative Rules, DOH), as discussed below; consultation with the Intra-island Ferry Task Force; and, input received at public information meetings, the proposed development of the Maunalua Bay Ferry Terminal is determined as not having a significant effect on the environment. Therefore, an environmental impact statement shall not be required.

Significance Criteria

Involves an irrevocable commitment to loss or destruction of any natural or cultural resource.

Based on the assessment of long term impacts relating to air and water quality, erosion, benthic biotopes, visual quality, archaeology and historic sites, flora and fauna, and recreation, the proposed project shall not involve an irrevocable loss or destruction of any natural or cultural resource. Widening of channels will be an irrevocable commitment, however, the assessment reveals that the existing biota in the nearshore area is presently degraded and that offshore areas are unlikely to be affected by the dredging operations.

Curtails the range of beneficial uses of the environment.

The assessment of long and short term impacts on recreation and boating, including commercial fishing, which are the primary uses occurring at the site, indicate that the proposed project shall not significantly curtail such uses and may, in fact, enhance such activities on weekends as more parking would be available.

Conflicts with the state's long-term environmental policies or goals and guidelines as expressed in chapter 34, Hawaii Revised Statutes, and any revisions thereof and amendments hereto, court decisions or executive orders.

A review of the long and short term impacts of the proposed project in relation to these long-term environmental polices, goals and guidelines does not reveal any potential conflicts.

Substantially affects the economic or social welfare of the community or the State.

As discussed in the environmental assessment, the expenditure of State funds for construction of the proposed project will have a positive short-term impact on the local economy. In the long-term, the project will provide an alternative mode of transportation within the State's economically and socially vital highway, air and water transportation systems.

Substantially affects public health.

The short and long term impacts on ambient noise and on air and water quality suggest that there will be no substantial effect on public health.

Involves substantial secondary impacts, such as population changes or effects on public facilities.

Construction of the ferry terminal is not anticipated to induce any significant population changes. With regard to public facilities, the project will insignificantly tax existing infrastructure and utilities. Its intent, in fact, is to offer an alternative to reliance on Kalanianaole Highway, the major arterial connecting Hawaii Kai to downtown Honolulu.

Involves a substantial degradation of environmental quality.

Based on the assessment of short and long term impacts relating to air and water quality, erosion, benthic biotopes, and flora and fauna and marine life, the proposed project shall not involve substantial degradation of environmental quality.

Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions.

The Maunalua Bay Ferry Terminal is the first link within the proposed Intra-island Ferry System. The potential environmental impacts of the other terminals have been assessed in cursory fashion in Appendix A. As discussed in the preface, environmental assessments, or if deemed necessary, environmental impact statements will be prepared for individual ferry terminals when they are sited and designed, unless otherwise exempt from review through Section 11-2--08 (Administrative Rules, DOH).

Substantially affects a rare, endangered species, or its habitat.

As indicated in the discussion of short-term impacts on "Fauna and Marine Life," construction activities will not likely affect the Paiko Lagoon Waterbird Sanctuary while seasonal restrictions on blasting would mitigate potential impact on migrating humpback whales. Blasting will not be conducted within the primary habitat of turtles in Maunalua Bay.

The assessment of long-term project impacts on flora and fauna indicates that ferry operations can be conducted to avoid the primary habitat of turtles while the probability of collision with humpback whales is extremely low.

Detrimentally affects air or water quality or ambient noise levels.

As discussed in the assessment of short and long term impacts on noise, air and water quality, the project will have insignificant, minimal or controllable impacts in these areas of concern.

Affects an environmentally sensitive area such as flood plain, tsunami zone, erosion-prone are, geologically hazardous land, estuary, fresh water, or coastal waters.

Environmentally sensitive areas at or near the project site, including tsunami zones, areas prone to shoreline erosion, the Paiko Lagoon Wildlife Sanctuary and coastal waters have been assessed with respect to long and short term impacts. Identified impacts are judged to be insignificant, minimal or controllable through appropriate construction methods and proper conduct of ferry operations.

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APPENDIX A
INTRA-ISLAND FERRY SYSTEM

ENVIRONMENTAL ASSESSMENT FOR
INTRA-ISLAND FERRY SYSTEM

Proposing Agency:

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION

JUNE 1988

Prepared by:

WILSON OKAMOTO & ASSOCIATES, INC.

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FIGURES

PREFACE

The Department of Transportation (DOT), State of Hawaii is proposing to establish an intra-island ferry system serving the southern coastline of Oahu. Seven terminals are planned from Hawaii Kai to Barbers Point. Development of the ferry terminals will proceed as specific sites are selected and facilities are designed. The first link of the system will establish terminals at Maunalua Bay and Downtown. Future terminal sites include Waikiki, the Airport, Middle Loch of Pearl Harbor, Ewa and Barber's Point.

This environmental assessment is prepared pursuant to Section 343-5, Hawaii Revised Statutes, defining actions subject to environmental impact statement requirements. Specifically, the various terminal sites will involve the use of State funds and some will utilize State-owned land. All terminal improvements extending into the ocean will involve the use of the State Conservation District. All terminal sites will also be located in the shoreline area.

To comply with Section 11-200-7 (Administrative Rules, Department of Health (DOH)), the proposed intra-island ferry system is herein assessed as a phased agency action treated as a single action. Inasmuch as the specific sites for each terminal have yet to be determined and individual facilities designed, this document provides a cursory environmental assessment of envisioned terminal locations. Subsequent environmental assessments for terminal sites not otherwise exempt from review under Section 11-200-8 (Administrative Rules, DOH) shall be prepared when they are sited and designed. Further, if deemed necessary, environmental impact statements shall be prepared for individual terminals.

PROPOSED ACTION

Project Need

Transit systems for the Island of Oahu are envisioned to be comprised of three modes: bus, water and rail. Mass transit by water is the only alternative which can relieve traffic congestion on the existing highway system without large investment in infrastructure.

From Hawaii Kai in East Honolulu to downtown Honolulu, only Kalanianaole Highway provides direct access as it passes through and alongside residential areas. Already heavily congested during commuting hours, the highway will be reconstructed over a period of about eight years during which congestion will be exacerbated. Paralleling the highway is the ocean, which offers the opportunity for development of an alternative water route.

From fast-growing West Honolulu, Interstate Route H-1 and other highways must loop around Pearl Harbor, because neither a bridge nor a tunnel across the entrance channel is feasible. Eight eastbound freeway lanes converge into three at Middle Street, well short of downtown Honolulu. An ocean ferry route would by-pass Pearl Harbor and the highway bottleneck from Middle Street into Downtown.

From Honolulu International Airport to Waikiki, the most direct route is along Nimitz Highway, which is less than scenic and has resisted aesthetic upgrading. An ocean route, with Diamond Head off the bow, will be far more in keeping with the desired first impression of Hawaii for visitors.

Ferry System Operation

Establishment of the Intra-island Ferry System is being pursued through a bid procedure open to qualified private operators. The contract to be awarded will be for a twenty year term. Under the contract, the operator is required to provide commuter transit service during the morning and evening traffic peak periods between the Maunalua Bay terminal in Hawaii Kai and the Downtown terminal at Pier 8 in Honolulu Harbor, at a fare not greater than $2.50 one-way for residents with a valid Hawaii drivers license. Due to anticipated budgetary deficits resulting from this service, the DOT sought bids to determine the level of funding the operator would require. The funding would be for eight years, with the rate fixed for the initial four years and declining thereafter to zero for another four years. The DOT would also design, secure necessary government approvals, and construct the ferry terminals. Furthermore, the operator would be permitted to engage in other commercial revenue generating operations during hours the commuter transit service is not in operation. He would be permitted to use the DOT's ferry terminals for such operations, except that he would not be allowed to use the Maunalua Bay terminal and the Ala Wai Boat Harbor, should a terminal be sited there.

Bids were opened on March 7, 1988; the apparent low-bidder is San Diego Ship Building and Repair, Inc. Instead of seeking funding for providing the service, the State was pleasantly surprised that the low bidder offered to pay the State $1,200 per year for the first four years and declining to zero in a straight line for the next four years for a total payment of $7,200 over the 8 year period. The contract will be awarded after trials are conducted on the ferry vessel and it is determined that all the operational and technical specifications outlined in the bid document have been met.

Construction of the Maunalua Bay ferry terminal and any improvements to the Downtown terminal are anticipated to be completed by December, 1989. Two ferry vessels are required initially to serve the Maunalua Bay to Downtown commuter transit link. The vessels will make four runs to the Downtown Terminal (Pier 8) during the 3-hour morning rush hour and will make four runs to the Maunalua Bay Terminal during the evening rush hour. Pier 13 at Honolulu Harbor will be used for vessel berthing and maintenance.

Additional ferry terminals in the intra-island system will be developed depending on the availability of funding and approval of necessary permits. Permits generally required for construction activities at the shoreline include those listed in Appendix A.

Ferry Vessel

The vessel proposed for use by the apparent low-bid ferry operator is a "surface effect ship" which rides on a cushion of air. The vessel is 118 feet long and has a beam width of 38 feet. It has a capacity of approximately 300 passengers and an estimated speed of 42 knots (48 mph).

Two engines power fans maintaining the air cushion which is contained under the craft by two solid walls on either side and by curtains fore and aft. The air cushion can be adjusted by an on-board computer to allow the ship to ride higher within wave troughs and lower over wave crests. This provides a smoother ride in rough seas. While riding on the air cushion, the ship has a draft of 1.5 feet. Off cushion, the ship draws 6 feet. A third engine powers a water jet propulsion system which draws water from beneath the ship and discharges it in two jet streams to propel and steer the ship. There are no propellers in the water. The water jet propulsion and steering system allows the ship to turn 360° within a space 1-1/2 times its length at dead stop.

FERRY TERMINAL SITES

Maunalua Bay Terminal

SITE BACKGROUND

Location and Land Ownership

The proposed Maunalua Bay Ferry Terminal is located adjacent to Maunalua Bay Beach Park on the leeward (south) side of Oahu. The project site is makai of Kalanianaole Highway, across the intersection of Kalanianaole Highway and Keahole Street. See Figure 1. Kuliouou is located to the west and Hawaii Kai is located to the north and east of the site.

Development of the ferry terminal will primarily encompass a two acre portion of TMK: 3-9-07:34 which is owned by the State. See Figure 2. Access to the parcel from Kalanianaole Highway will be developed over an existing unpaved access opposite Keahole Street, traversing two thin strips of land under control of the City and County of Honolulu, Department of Parks and Recreation. TMK: 3-9-07:8 is owned by the City and County of Honolulu and comprises the strip of park along the makai edge of Kalanianaole Highway. Access is permitted through the parcel where the existing unpaved access traverses it. TMK: 3-9-07:11 is owned by the State and controlled by the City and County under Executive Order No. 2626. The eastern portion of the parcel contains the majority of the developed Maunalua Bay Beach Park.

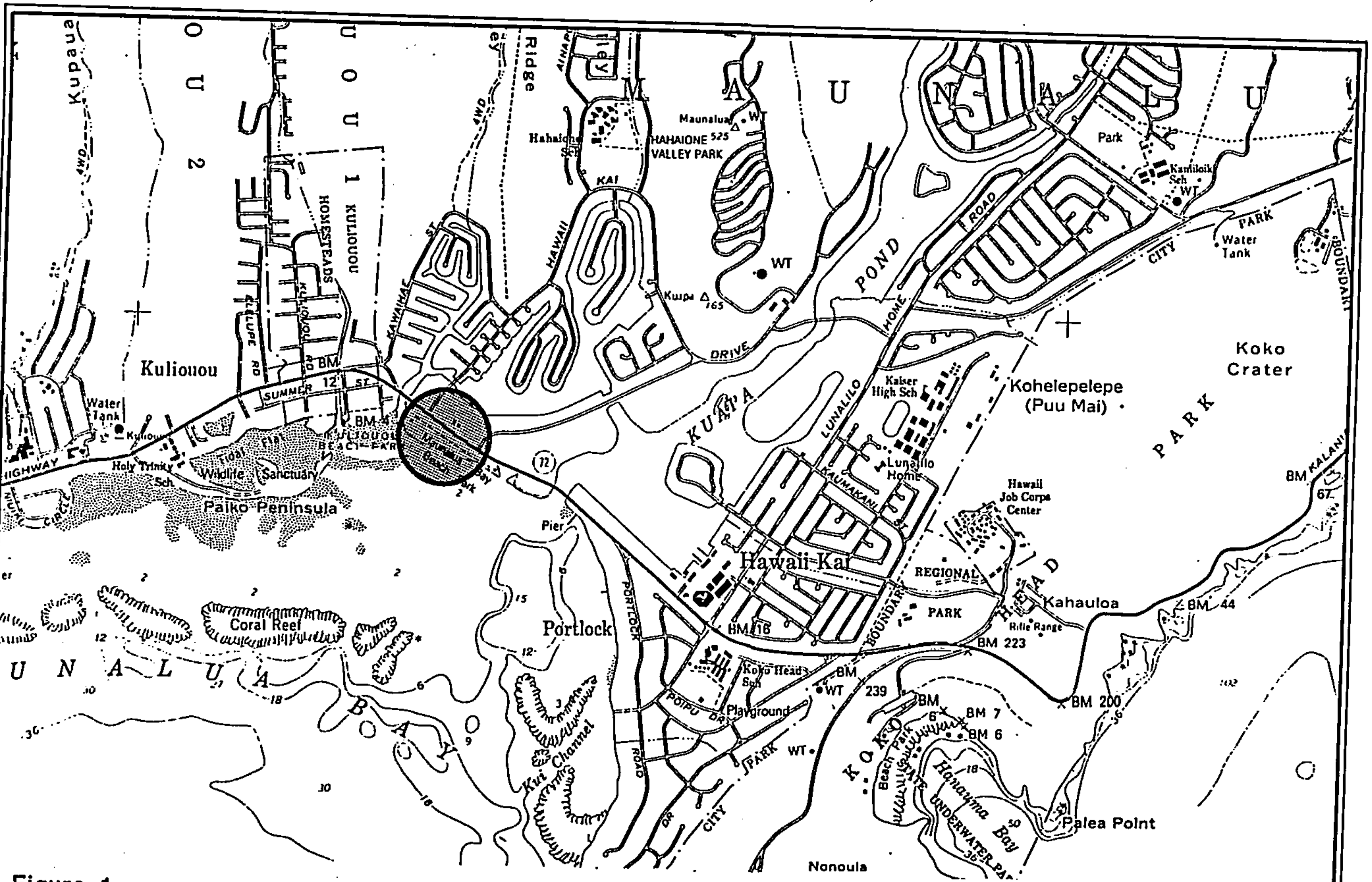


Figure 1
MAUNALUA BAY TERMINAL
Intra-Island Ferry System

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.

History

Development of the Hawaii Kai community precipitated major changes in the area. Work commenced in 1959 with the dredging and filling of portions of Kuapa Pond. The marina is currently used for recreational and commercial boating, water sports and fishing, and the filled portions comprise part of the residential development of Hawaii Kai.

Modification of Kuapa Pond also included widening the entrance channel to the marina from 40 feet to 250 feet and constructing the existing bridge over it. An access channel, paralleling the shore, was dredged from the main channel to the mouth of Kuliouou Stream. A secondary channel was also dredged into the west end of the marina. The dredged material was used to construct the present beach park and boat launching area at Maunalua Bay.

DESCRIPTION OF THE EXISTING ENVIRONMENT

Existing Land Uses

Existing development includes a beach park and boat launching ramp with a paved parking lot. Recreation at Maunalua Bay include public and commercially promoted activities, including boating, fishing, swimming, kayaking, canoeing, diving, parasailing and jet skiing. Commercial fishing operations are also staged from the boat launching ramp.

Surrounding Land Uses

Land uses surrounding the proposed project site has predominantly been open space to the north and single family residences to the east and west. During the past year, KACOR has developed the parcel to the north across Kalanianaole Highway into a business complex. A Park and Ride Facility on the west side of Keahole Street is currently under construction by the City and County of Honolulu, Department of Transportation Services. The Paiko Lagoon wildlife sanctuary is located to the east of the proposed Maunalua Bay Ferry Terminal.

Access

Access to the site is available via Kalanianaole Highway. Between Ainakoa Avenue and West Hind Drive, the highway consists of a six lane roadway including full shoulders which are utilized as bikeways, sidewalks and turnouts for buses. Between West Hind Drive and Kirkwood Street, the highway narrows down to five lanes with no decrease in the 120 foot right-of-way.

Existing Conditions

Maunalua Bay Beach Park extends from the west to east entrance of Hawaii Kai Marina, a distance of approximately 2,500 feet. The shoreline is a mixture of coral rubble, mud and sand punctuated by the boat launching ramp and small cove toward its eastern extent. A 600-foot long section west of the cove is protected by a rock revetment.

DEVELOPMENT CONTROLS

Land Use Plans and Zoning

Maunalua Bay Beach Park is designated "Urban" on the State Land Use District map. The proposed ferry terminal is permitted under the "Urban" designation.

The City and County of Honolulu Land Use Development Plan Map designates the site as "parks and recreation", while the boat ramp and parking area are designated as "preservation". A development plan amendment to designate the site as "public facility" will be required.

Under the current Land Use Ordinance zoning, the proposed project site is designated P2 General Preservation District. The proposed ferry terminal is considered a public use and is a permitted use in the General Preservation District.

PROBABLE IMPACTS

Probable environmental impacts will be related to any required dredging and resulting siltation and loss of habitat. Potential conflicts in use include those with existing recreational and boating activities during construction and operation of the ferry. Other impacts may be related to noise in residential areas, vehicular traffic and community aesthetics.

Waikiki Terminal

SITE BACKGROUND

Location and Land Ownership

Two possible locations for the Waikiki terminal under consideration are the Ala Wai Boat Harbor and the Hilton pier. The Ala Wai Boat Harbor is located between Waikiki Beach and Ala Moana Beach Park. Hilton pier is located off the Hilton Hawaiian Hotel between the Ala Wai Boat Harbor and Fort DeRussy Park. See Figure 2 and accompanying photographs.

History

Ala Wai Boat Harbor is administered by Department of Transportation, Harbors Division. The harbor was originally constructed from a barge channel built by the U.S. Armed Forces in the early 1920's. Through the years, dredging for harbor improvements provided fill for Ala Moana Shopping Center and Magic Island beach park.

Hilton pier was constructed in the early 1950's and is owned by the Hilton Corporation.

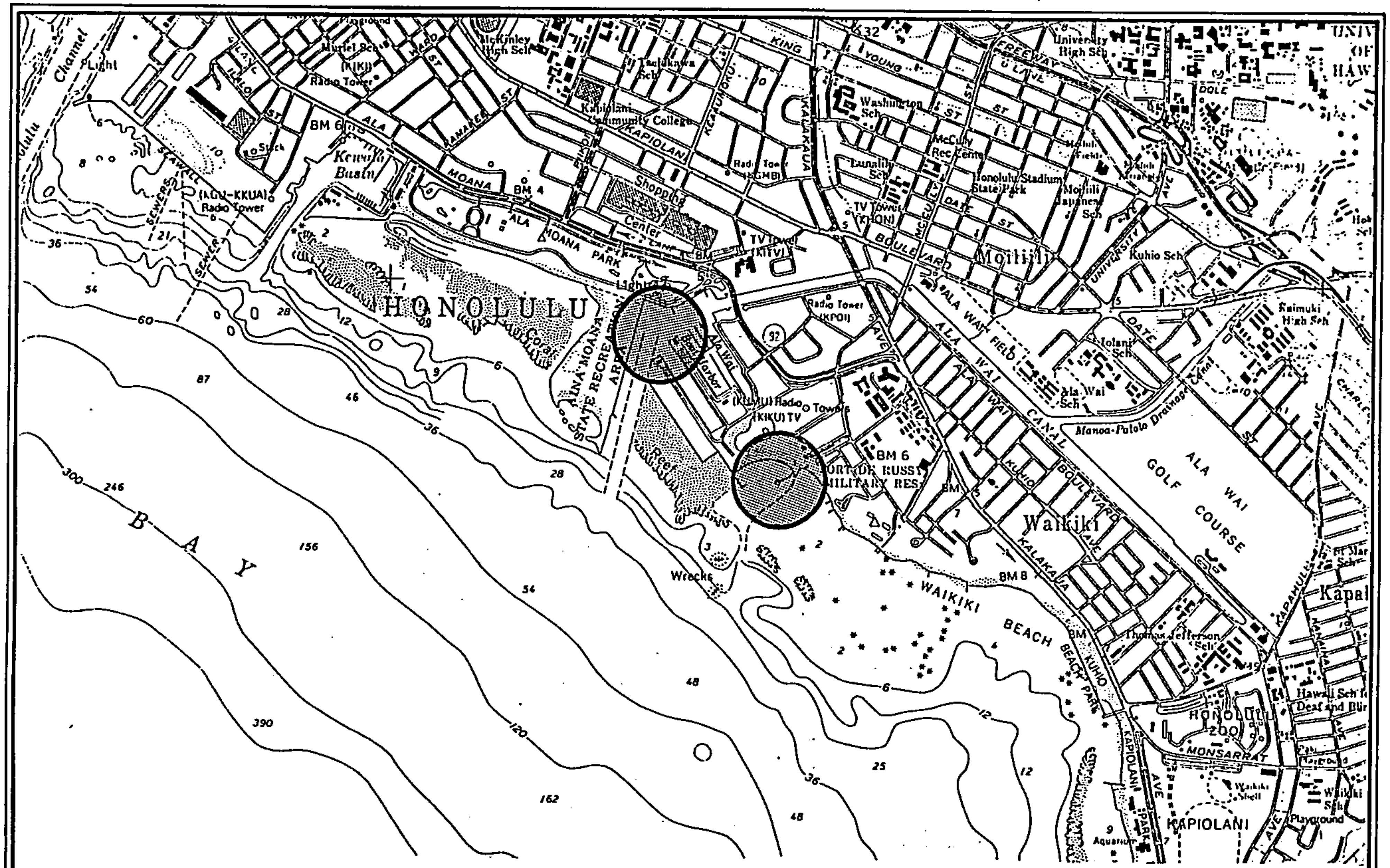
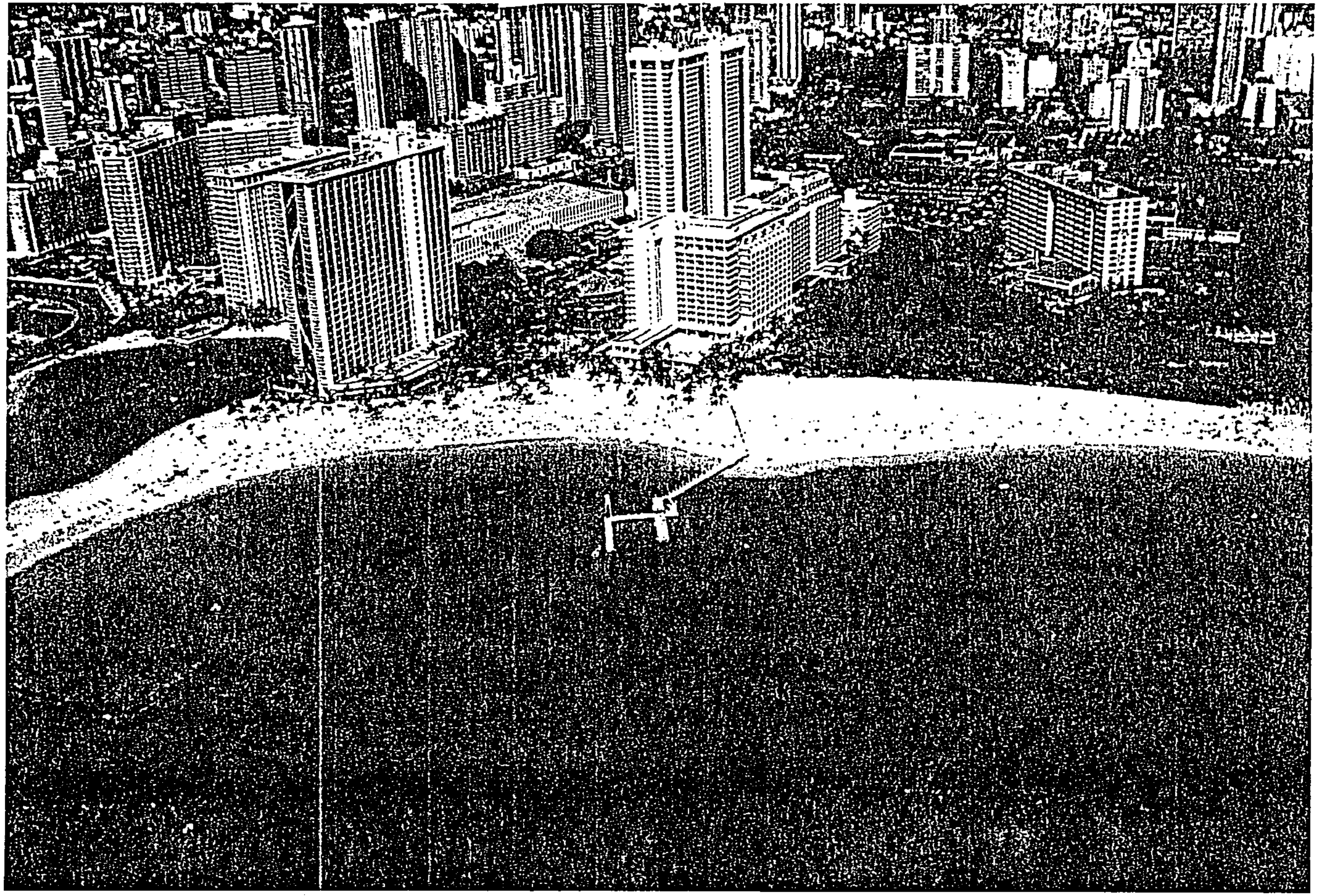


Figure 2
WAIKIKI TERMINAL
Intra-Island Ferry System

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.



DESCRIPTION OF THE EXISTING ENVIRONMENT

Existing Land Uses

The Ala Wai Boat Harbor encompasses 31 acres and includes such facilities as a marina, boat ramp, bathhouse, restrooms, showers and parking. One of the most popular places for small boat activities on Oahu, several yacht clubs are headquartered in the vicinity. Marine supplies and complete repair facilities are available in the harbor including a sailmaker, and radio repair service.

The Hilton pier is used exclusively by Hilton Rainbow I Catamaran tours for loading and unloading catamaran passengers.

Surrounding Land Uses

Land uses surrounding both sites are predominantly hotels and tourist oriented facilities. The Hilton Hawaiian Village, Ilikai Hotel, and Ilikai Marina Hotel border the north edge of the harbor and Hilton pier. The Yacht Harbor Plaza, hotel-condominium is currently under construction adjacent to the Ilikai Hotel on the north side of the Ala Wai Boat Harbor. Fort DeRussy Park is located to the northeast and the Department of Transportation heliport is to the south of both terminal sites. Magic Island beach park is across the harbor on the west.

Recreational and commercial activities in the area surrounding Hilton pier include, sunbathing, swimming, fishing, and water cycling on rental craft. Canoes, catamarans, surfers and boogie boarders use this area to access the open ocean.

Access

The major arterial nearest both sites is Ala Moana Boulevard. Ala Moana Boulevard is a six-lane divided roadway running from Ala Wai Boulevard to Bishop Street where it becomes Nimitz Highway. The Ala Wai Boat Harbor is accessible from Hobron Lane while Hilton pier is accessible through Kalia Road. The Ala Wai Boat Harbor parking lot offers the only public parking in the vicinity of the proposed terminal vicinity. For Hilton pier, approximately 20 parking stalls near the Hale Koa Hotel are provided for park users.

Existing Conditions

Ala Wai Boat Harbor is fully developed with slips for 663 vessels. No natural shoreline remains and the area is generally devoid of vegetation except for landscaping.

The sandy beach adjacent to Hilton pier is predominantly used for sunbathing and storing commercial recreational equipment while the shoreline near the heliport is rocky and generally unused. A surfing area is located to the west of the heliport.

DEVELOPMENT CONTROLS

Land Use Plans and Zoning

Ala Wai Boat Harbor and Hilton pier are within an "Urban" designation on the State Land Use District map. The proposed ferry terminal is permitted under the "Urban" designation.

The City and County of Honolulu Land Use Development Plan map designates the Ala Wai Boat Harbor and Hilton pier as "Public Facility", under which ferry terminal development is permitted.

With regard to the City and County of Honolulu, Land Use Ordinance, both Ala Wai Boat Harbor and Hilton pier lie within the Waikiki Special Design District. In general, the purpose of the Waikiki Special Design District is to guide the development of Waikiki with due consideration to optimum community benefits. The alternative project sites are designated "Public Precinct", in which the proposed ferry terminal is a permitted use requiring design review under a Special Design permit.

PROBABLE IMPACTS

Environmental impacts related to development of either site will be *minimized if dredging is unnecessary* and terminal facilities are limited in scale. At the Ala Wai Boat Harbor, ferry operation should have insignificant impacts in the context of existing boating activity. At the Hilton pier, however, conflict may occur due to the abundance of swimmers, surfers and novelty craft rented by tourists. Parking would generally be unavailable at either site due to existing demand in the area. Other impacts may be related to noise and vehicular traffic.

Downtown Terminal

SITE BACKGROUND

The proposed Downtown terminal will be located at Pier 8 in the Honolulu Harbor. Pier 13 is proposed as a vessel berthing and maintenance area. Honolulu Harbor, among the ten largest container handling ports in the United States, is the principal deep-water port of the State of Hawaii. It is the primary shipping link between Hawaii, the Mainland U.S., the Far East and the entire Pacific Rim. It also serves as the hub for marine passenger and cargo service to the Neighbor Islands.

Location and Land Ownership

Honolulu Harbor is situated on a narrow coastal plain on the southern coast of Oahu. Honolulu Harbor is located makai of Nimitz Highway between Fort Armstrong and Keehi Boat Harbor. See Figure 3 and accompanying photograph.

The Main Channel, known as the Fort Armstrong Channel, is the primary

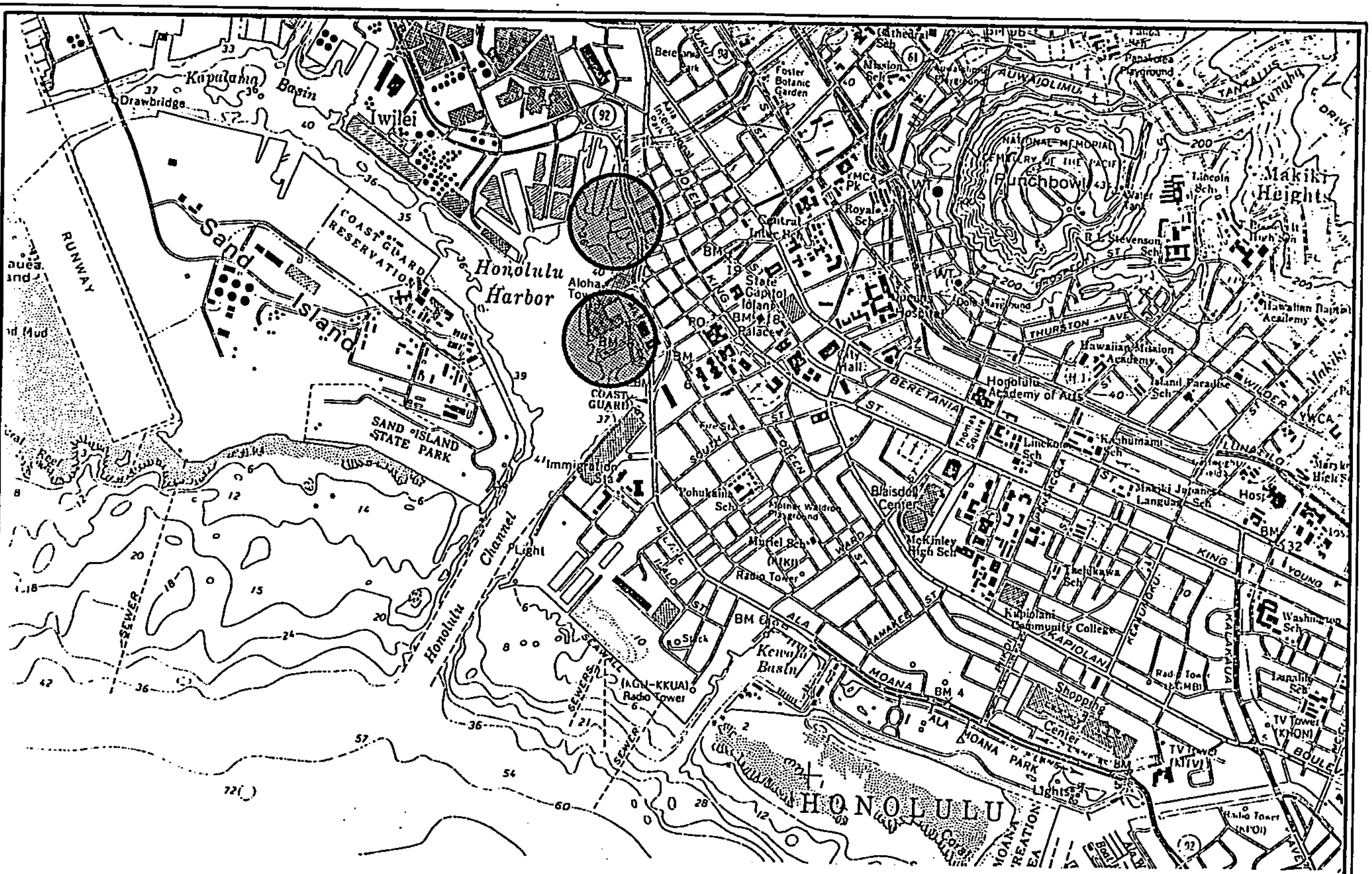
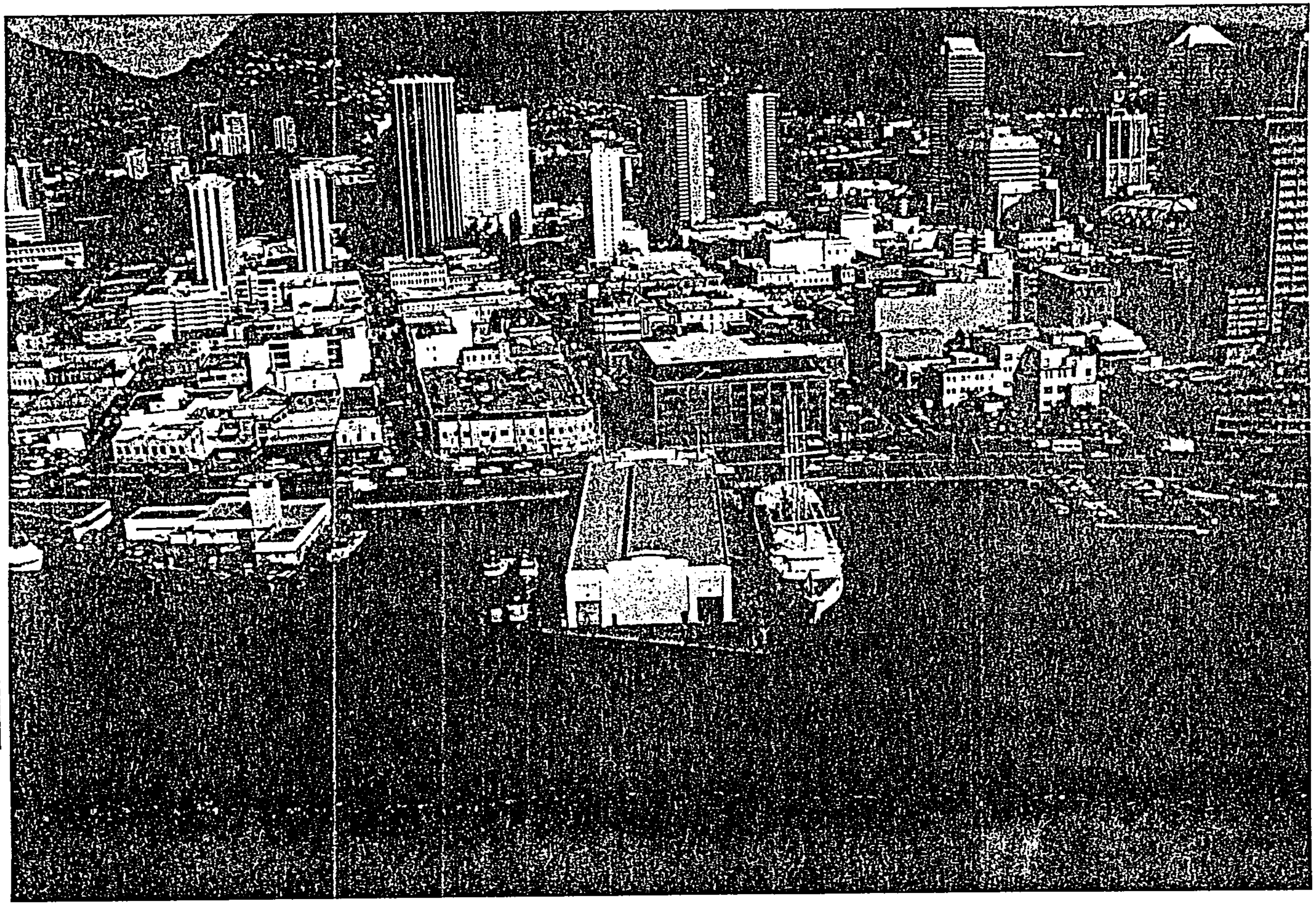


Figure 3
DOWNTOWN TERMINAL
Intra-Island Ferry System

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.



entry and exit point to Honolulu Harbor. Spoils from the dredging were deposited off-shore, forming the existing Sand Island in the center of the harbor which, along with a fringing reef, serves to protect the harbor from ocean swells. The main channel connects with the main Harbor basin, Kapalama Channel, Kapalama Basin and the Kalihi Channel. See Figure 4. The Sand Island Access Road drawbridge over the Kalihi Channel was permanently fixed in place to allow for the uninterrupted flow of containers to and from Sand Island. Thirty berthing facilities with over 22,500 linear feet of cargo handling pier are found along the two basins, Kapalama Channel, and the eastern side of Fort Armstrong Channel.

Access

Access to the site is available via Nimitz Highway. Nimitz Highway is a ten to six-lane arterial running from Bishop Street to Plantation Drive at Pearl Harbor.

Existing Conditions

Honolulu Harbor is administered by the Department of Transportation Harbors Division and comprises 234.2 acres. Controlling depths range from 35.0 feet to 36.2 feet. Fully developed with wharfs, no natural shoreline remains and the area is devoid of vegetation except for landscaping.

DEVELOPMENT CONTROLS

Land Use and Zoning

Lands within Honolulu Harbor are designated "Urban" on the State Land Use District Map. The proposed ferry terminal is a permitted use under the "Urban" designation.

The City and County of Honolulu Land Use Development Plan Map designates Pier 8 as "Commercial" while Pier 13 is designated as "Public Facility". A development plan amendment to designate the ferry terminal at Pier 8 as "public facility" will be required. The proposed maintenance area at Pier 13 is permitted under the "Public Facility" designation.

Under the current Land Use Ordinance, Pier 8 is zoned "Central Business Mixed Use District BMX-4," in which the proposed ferry terminal is a permitted public facility.

PROBABLE IMPACTS

No adverse impacts are anticipated due to the compatible uses and facilities at Honolulu Harbor.

Airport Terminal

SITE BACKGROUND

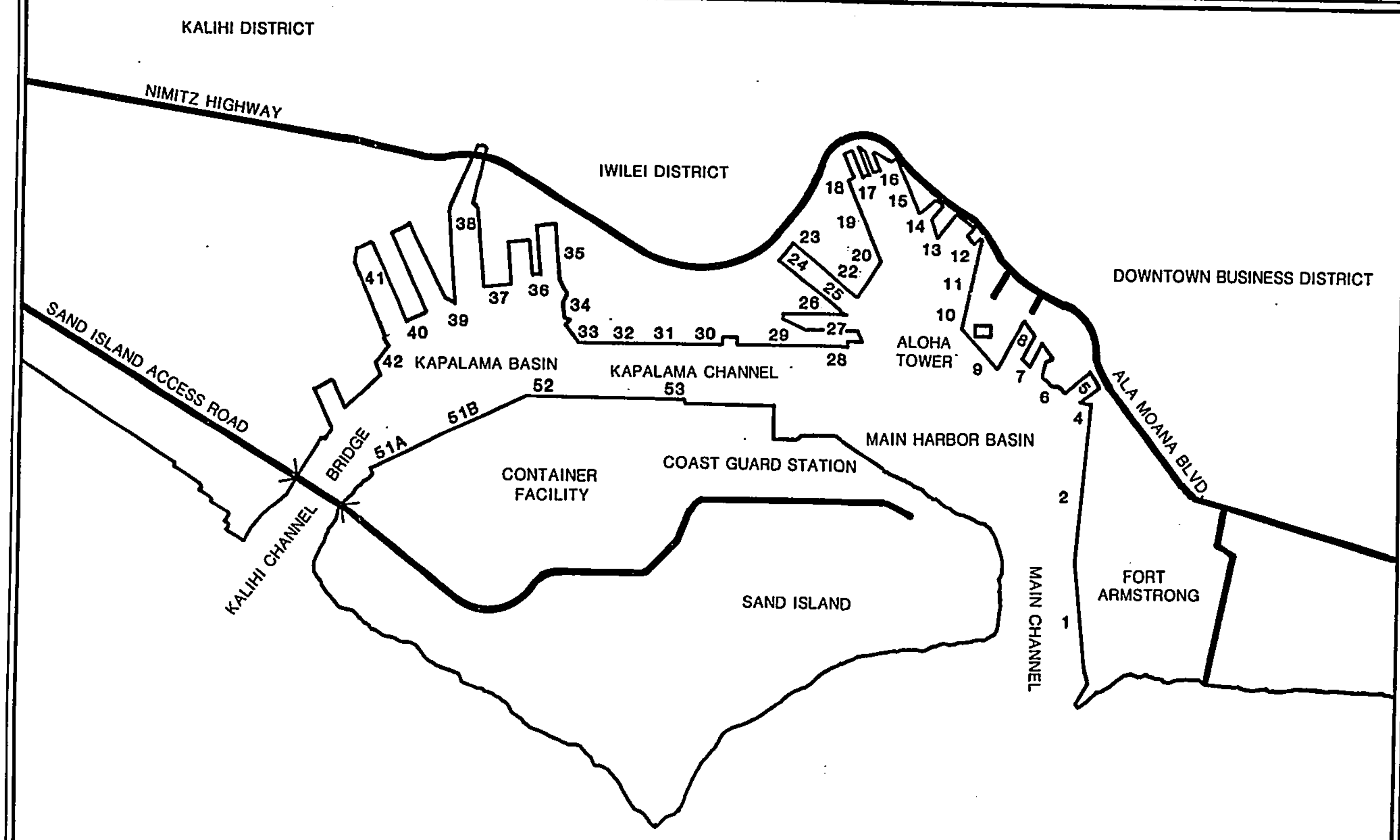


Figure 4
HONOLULU HARBOR
Intra-Island Ferry System

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.

Location and Land Ownership

Keehi Lagoon is a sheltered embayment located approximately midway between Pearl Harbor and Honolulu Harbor. It is a triangle-shaped body of water bordered by a shallow fringing reef flat to the south, Honolulu International Airport, including the Reef Runway, to the west and Sand Island to the east. The proposed ferry terminal site is on the makai side of Lagoon Drive. See Figure 5 and accompanying photograph.

The entire site and most of the perimeter shoreline is owned by the State of Hawaii. Governor's Executive Order (G.E.O) No. 3202 sets aside the majority of the lagoon water area under the management and control of the DOT, Airports and Harbors Division; G.E.O. No. 3201 sets aside airport lands under the management of the DOT Airports Division; G.E.O. No. 2704 sets aside Sand Island park shoreline under the management and control of the Department of Land and Natural Resources; and G.E.O. Nos. 2526 and 2636 set aside the eastern shoreline along Sand Island Access Road under the management and control DOT, Harbors Division.

History

In 1925, the Territory of Hawaii acquired Keehi Lagoon and adjacent land for construction of John Rodgers Airport. By 1940, air transportation had grown and the U. S. Congress authorized dredging of Keehi Lagoon to construct seaplane runways. By 1944, the U. S. Navy had completed construction of major airport terminals and the seaplane facilities. Three seaplane runways were constructed. The runways are 1,000 feet wide, 10 feet deep and 2.9, 3.0, and 2.25 miles long. Approximately one third of Keehi Lagoon prior to 1940 became filled land. From that time until now, Keehi Lagoon has remained much as it is with the exception of the construction of the Reef Runway in 1977.

The Reef Runway was constructed to alleviate aircraft noise and safety concerns over metropolitan Honolulu, provide more flexibility for aircraft takeoff and landings, and increase airfield capacity.

DESCRIPTION OF THE EXISTING ENVIRONMENT

Existing Land Uses

Keehi Lagoon is presently used for a number of water recreational activities, including canoe racing, water skiing, boating, fishing, jet skiing and parasailing. Jet skiing and parasailing are primarily commercially promoted.

Surrounding Land Uses

The land area mauka of the existing Lagoon Drive is presently used by aviation support businesses and organizations. The land area makai of Lagoon Drive was once utilized as a taxiway and docking facility for seaplanes.

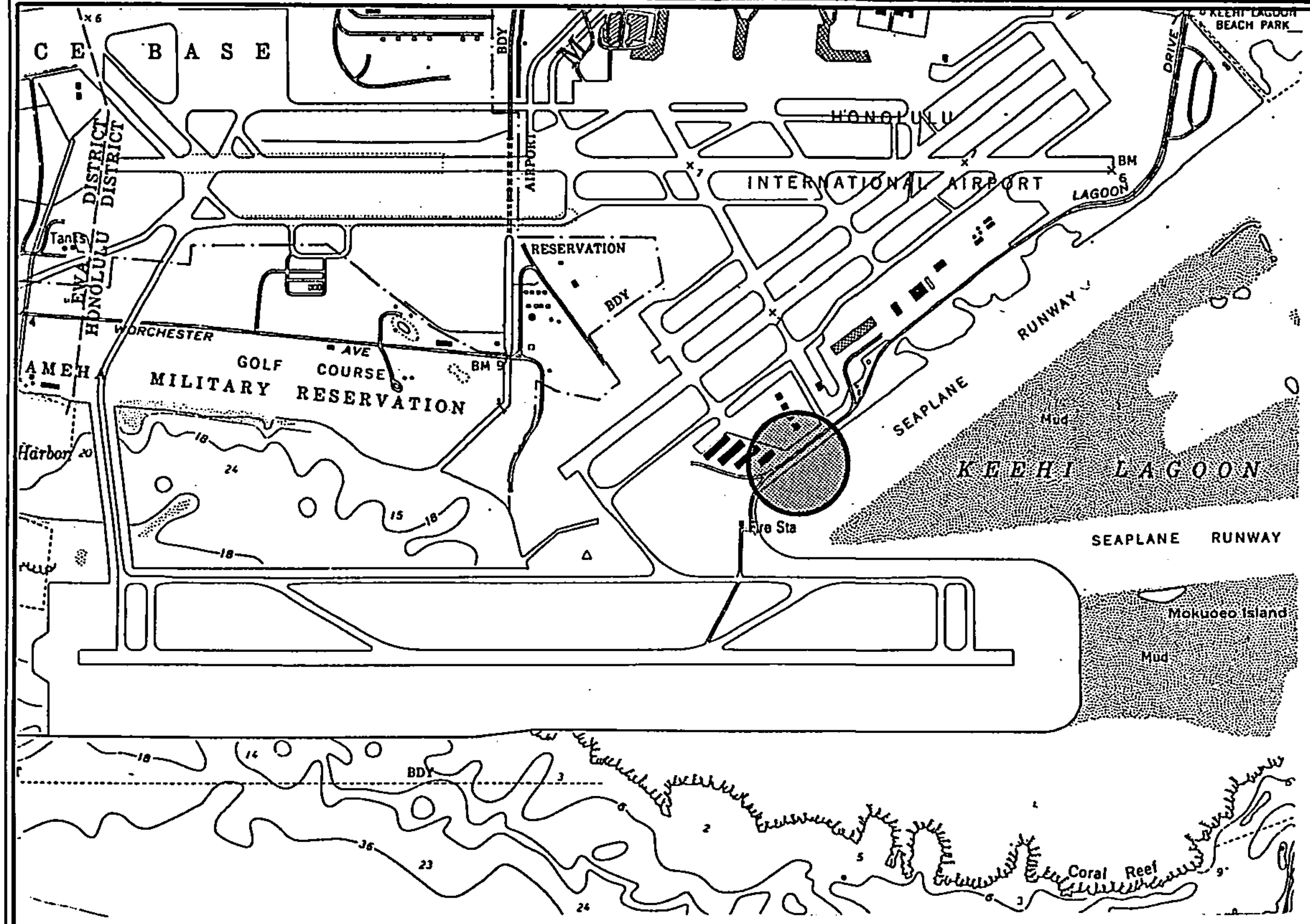
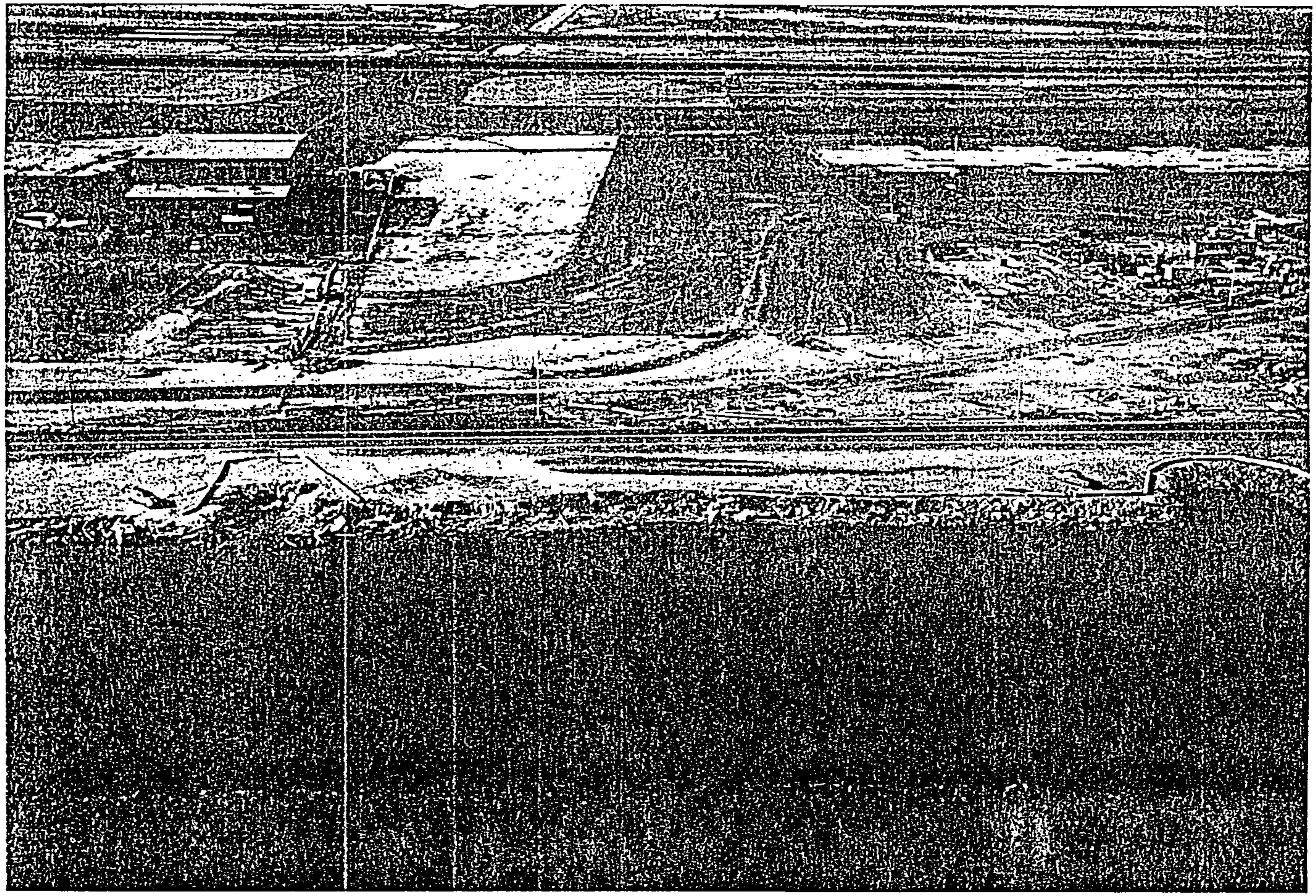


Figure 5
AIRPORT TERMINAL
Intra-Island Ferry System

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.



Access

Keehi Lagoon can be accessed from Interstate Route H-1 and Nimitz Highway via Lagoon Drive. Lagoon Drive narrows from a four lane, divided roadway to a two lane, undivided roadway. The two lane section, which fronts the proposed terminal site, continues west, and terminates approximately 800 feet east of the Reef Runway Fire Station Access Road.

Existing Conditions

The shoreline areas are filled lands which have been created by major dredging and construction activities. The surface of the fill area is comprised of piles of soil, rock and miscellaneous debris. Surface elevations vary from 0.0 to approximately 20 feet above sea level.

Surface vegetation consists of generally sparse low-lying grasses and weeds.

DEVELOPMENT CONTROLS

Land Use Plans and Zoning

The area along Lagoon Drive is designated "Urban" on the State Land Use District Map. The proposed ferry terminal is permitted under the "Urban" designation.

The City and County of Honolulu Land Use Development Plan Map designates the site as "Public Facility" under which the ferry terminal is a permitted use.

Under the current Land Use Ordinance, the site is zoned "Industrial I2." in which the proposed ferry terminal is permitted as a public use.

Ke'ehi Lagoon Recreational Plan

The Ke'ehi Lagoon Recreation Plan (State of Hawaii Department of Transportation, 1987) updates the 1977 plan to meet newly recognized community needs related to the growth of ocean recreation and commercial development. The updated plan recommends specific site plans for various locations within Keehi Lagoon. The plans include the development of a marina along the east shore of the lagoon where the project site is located. The proposed ferry terminal may be incorporated into the design of the marina facility or it may be auctioned publicly for private development. The Fourteenth State Legislature recently passed a bill which allows the State to contract a private firm to develop commercial, recreational and light industrial activities at the 300 acre site.

PROBABLE IMPACTS

Impacts to recreational activities are not anticipated due to compatibility of the ferry terminal with the proposed marina development at Ke'ehi Lagoon.

Ewa Terminal

SITE BACKGROUND

Location and Land Ownership

The proposed terminal site is located near the Pearl Harbor entrance channel on the Waipio Peninsula. Lima Landing is located within the West Loch Branch of Lualualei Naval Magazine which is a restricted area. See Figure 6 and accompanying photograph.

The entire site is owned by the Federal Government and is part of the Pearl Harbor Naval Complex.

DESCRIPTION OF EXISTING ENVIRONMENT

Existing Land Uses

West Loch Branch contains ammunition wharfs for receiving and shipping most of the military ordnance and explosives for the Island of Oahu.

The 1,000-foot Lima landing pier is seldom used except for periodic landing of small commuter boats.

Surrounding Land Uses

Iroquois Point Puuloa Naval Housing is located to the south of the proposed ferry terminal. Located approximately 1,800 feet north of Lima Landing, the Okiokilepe Fish Pond is currently listed in the National Register of Historic Places. The coral-stacked pond wall is 200 meters long and encloses an area of approximately 4.5 acres.

Access

Access to the proposed ferry terminal is available via Fort Weaver Road to the main gate at Iroquois Road. The site was once accessible from a gate on North Road when Sea Transit (Subsidiary of Sea Flite) operated 10 years ago. Permission from the U.S. Navy would be required for public passengers to access this terminal site.

Existing Conditions

The site is currently in a state of disrepair and overgrown with weeds.

DEVELOPMENT CONTROLS

Land Use Plans and Zoning

Lands within the project site are designated "Urban" on the State Land Use

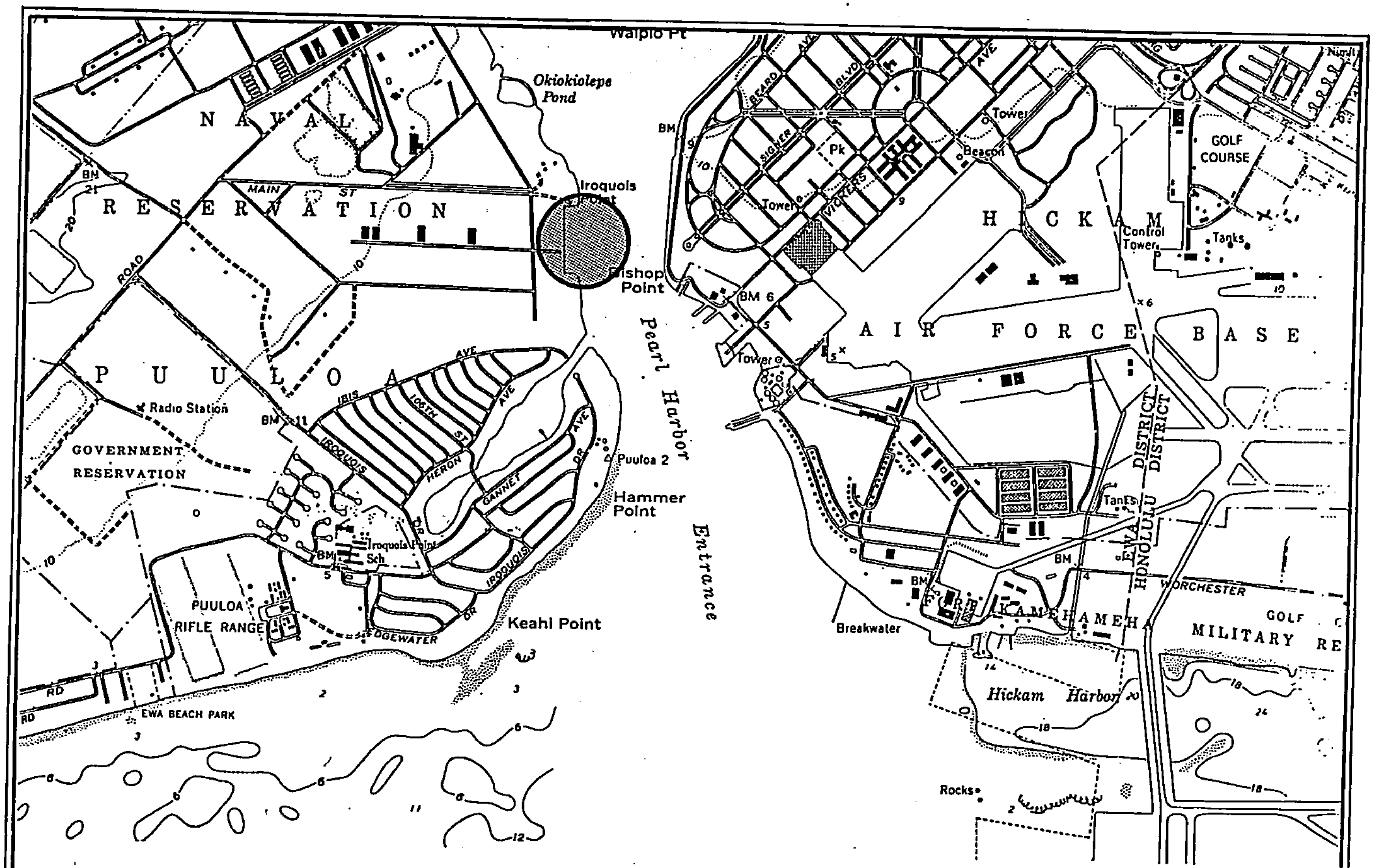
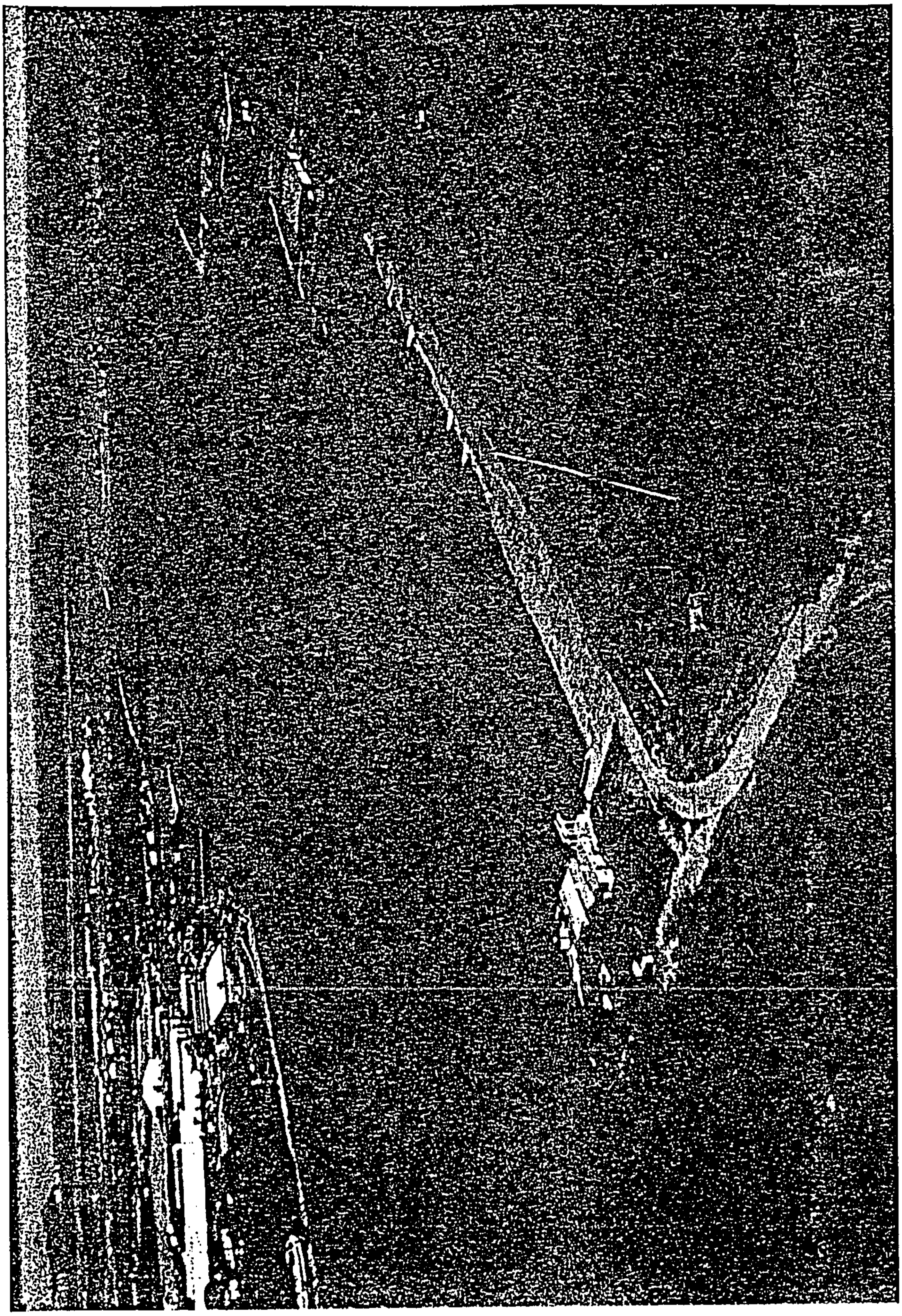


Figure 6

EWA TERMINAL

Intra-Island Ferry System

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.



Development Map. The proposed ferry terminal is permitted under the "Urban" designation.The City and County of Honolulu Land Use Development Plan designates the site as "Park". A development plan amendment to designate the site as "Public Facility" will be required.

Under the current Land Use Ordinance, the site is zoned "Federal F-1", land under the control of the Federal government. U.S. Navy permission will be required to develop the ferry terminal.

The West Loch Master Plan proposes a diver training building, boat shop, small craft ramp and pier at Lima Landing for the Explosive Ordnance Disposal Unit.

Waipahu Terminal

SITE BACKGROUND

Location and Land Ownership

The proposed Waipahu terminal site is generally located between the Waipio Peninsula and the Pearl City Peninsula, along the shoreline of Pearl Harbor's Middle Loch. See Figure 7 and accompanying photograph.

The mauka portion of the site is owned by a private developer who has plans to construct 863 condominium units in five ten-story buildings on the sites. The makai portion is owned by Hawaiian Electric Company.

DESCRIPTION OF EXISTING ENVIRONMENT

Existing Land Uses

The site is currently undeveloped. Recreational fishing is done from the shoreline.

Surrounding Land Uses

Land uses surrounding the immediate proposed project site include watercress and ung choi cultivation. Leeward Community College is located to the northeast, while Waipahu High School is located to the northwest of the proposed site.

The Pearl Harbor National Wildlife Refuge consists of 61 acres of man-made wetland habitat in two separated units on the south shore of Oahu. These units were created in an effort to compensate for loss of stilt feeding habitat when the Reef Runway was constructed. The Waiawa or Pearl City unit (24.5 acres) is located near the east shore of Middle Loch, southwest of the proposed Waipahu Terminal. Nesting islands have been provided. The refuge is managed by the U.S. Fish and Wildlife Service under a use agreement with the U.S. Navy.

The State of Hawaii has established an energy corridor from Campbell

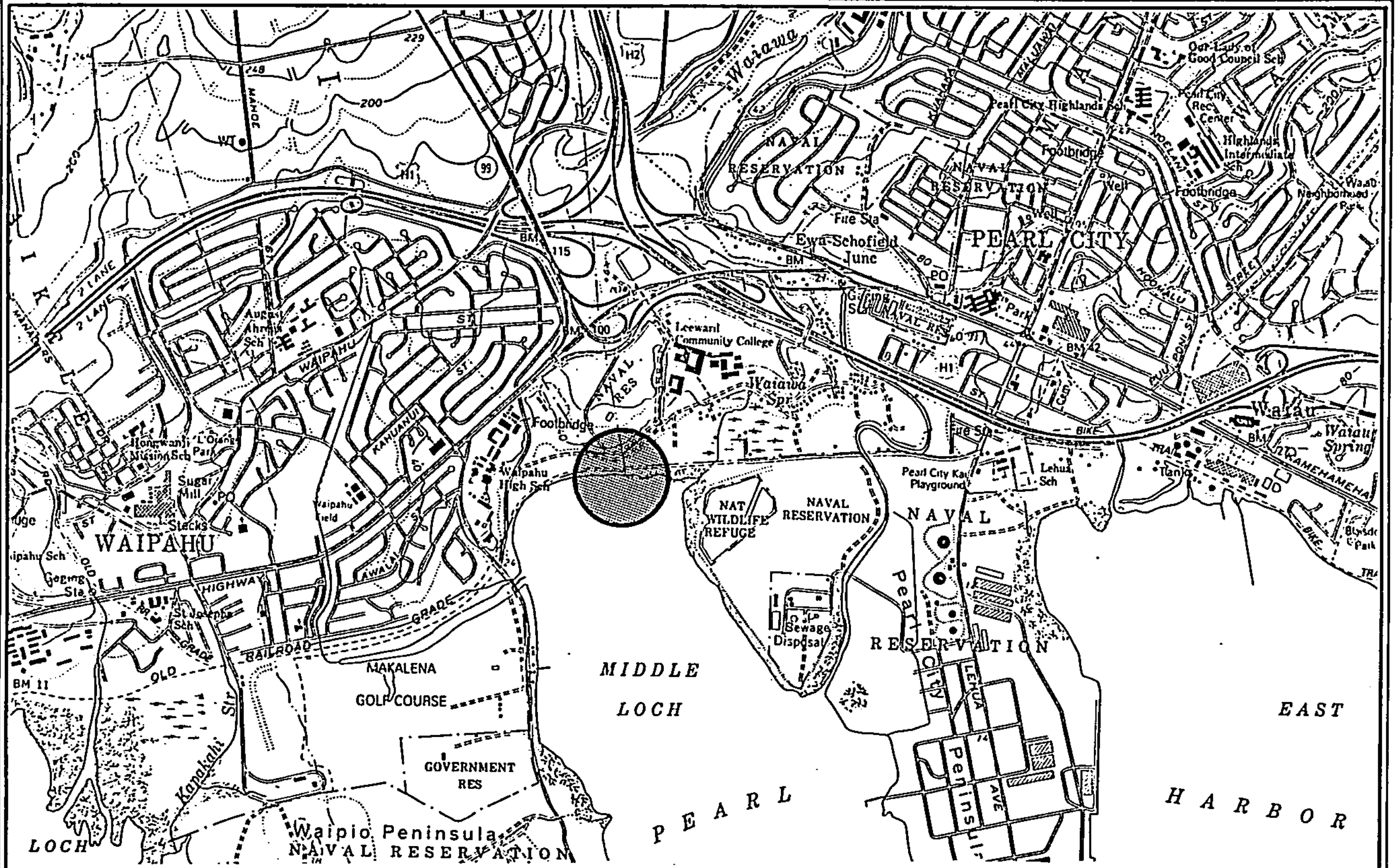
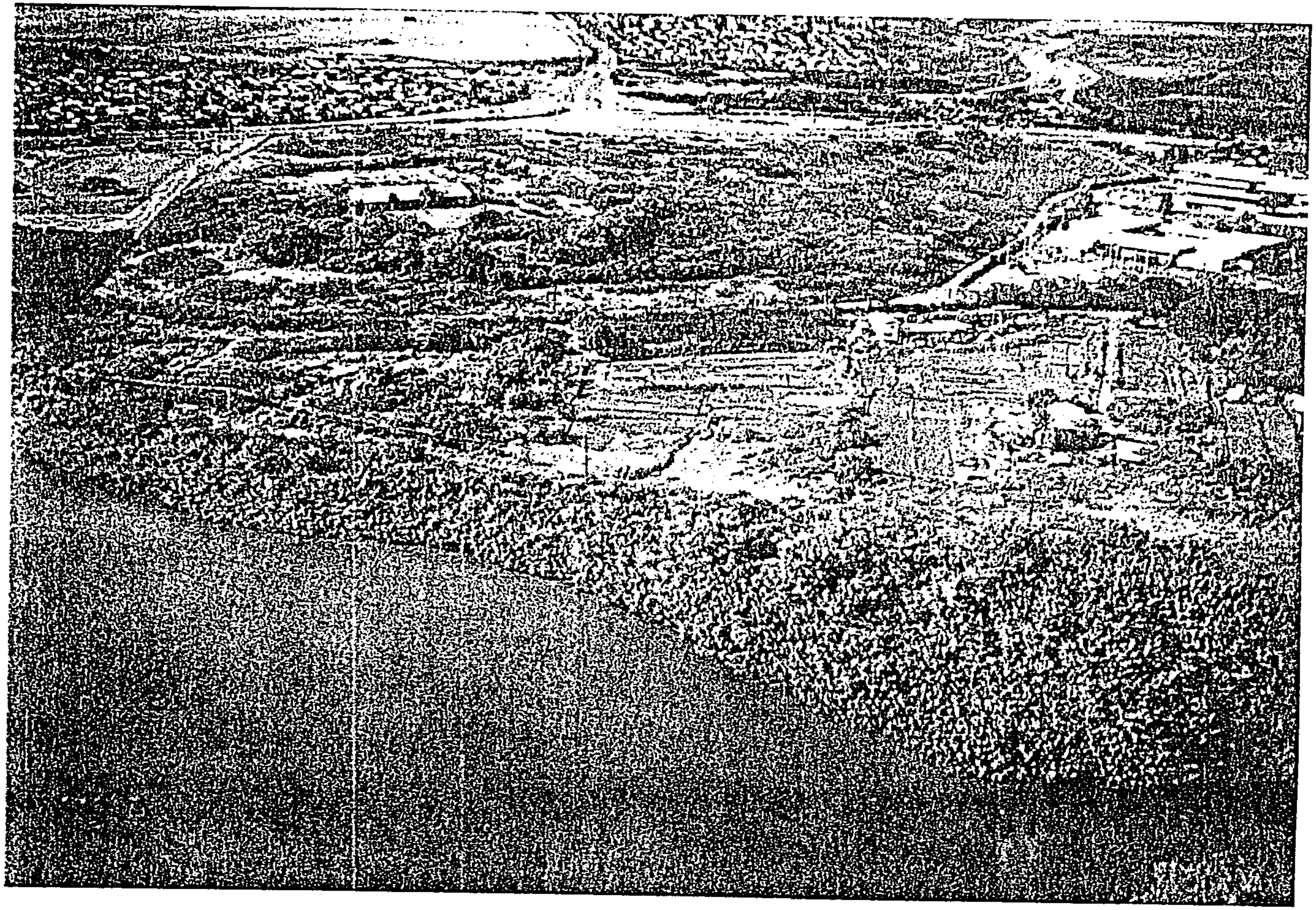


Figure 7
WAIPAHU TERMINAL
Intra-Island Ferry System

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.



Industrial Park to Sand Island for the purpose of providing a right-of-way for transmission of energy-related products. This corridor includes a 100-feet offshore easement from Campbell Industrial Park to Sand Island. The "landside" segment of the corridor runs adjacent to the proposed site and is utilized by GASCO, Chevron and HIRI Refinery.

Access

The major highway system serving the ferry terminal is Farrington Highway. Waipio Access Road leads to a small dirt road along Middle Loch which currently serves as the primary access road to the site.

Existing Conditions

The area is overgrown with trees and shrubs such as kiawe, koa haole, and mangrove.

DEVELOPMENT CONTROLS

Land Use Plans and Zoning

Lands along Middle Loch are designated "Urban" on the State Land Use District Map. The proposed ferry terminal is permitted under the "Urban" designation.

The City and County of Honolulu Land Use Development Plan Map designates the site as "Agriculture". A development plan amendment to designate the site as "Public Facility" will be required. The adjacent parcel to the west is designated as "Medium Density Apartment" while the northern parcel is designated "Industrial".

Under the current Land Use Ordinance, the site is zoned "Apartment A2" in which the proposed ferry terminal would be permitted as a public facility.

West Beach Terminal

SITE BACKGROUND

Location and Land Ownership

Located near the southwest tip of the Island of Oahu, Barbers Point Harbor is Oahu's second deepdraft commercial harbor. See Figure 8 and accompanying photo. Campbell Industrial Park abuts the south and east boundary of the harbor, while the West Beach Development is located on the northwest boundary. The Hawaiian Electric Company's Kahe Power Plant is located approximately 0.5 miles to the north, across Interstate Route H-1.

The entire area was owned by Campbell Estate which has granted the land to the State of Hawaii in exchange for approximately 90 percent of the sales proceeds from the coralline material dredged from the channel and harbor.

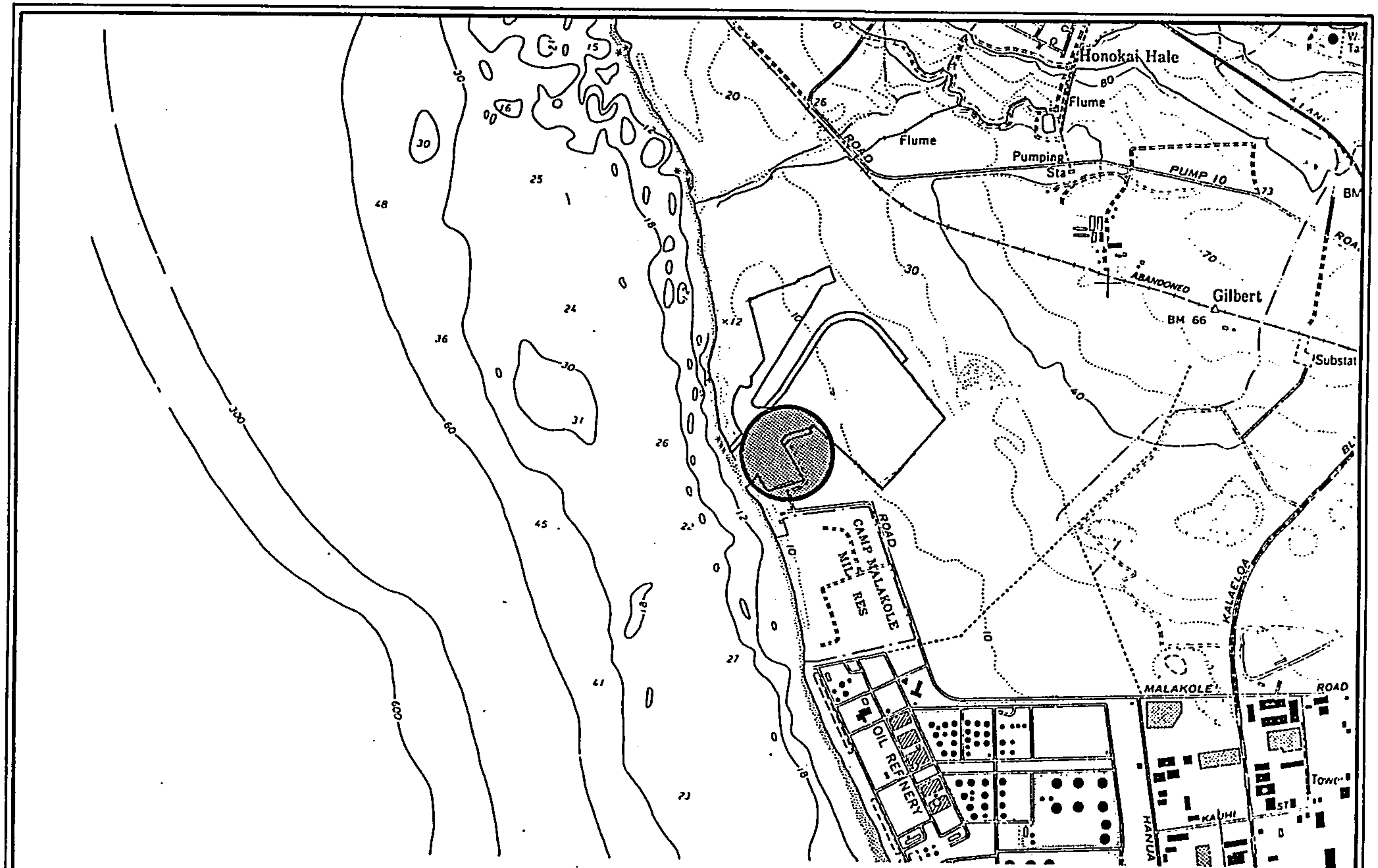
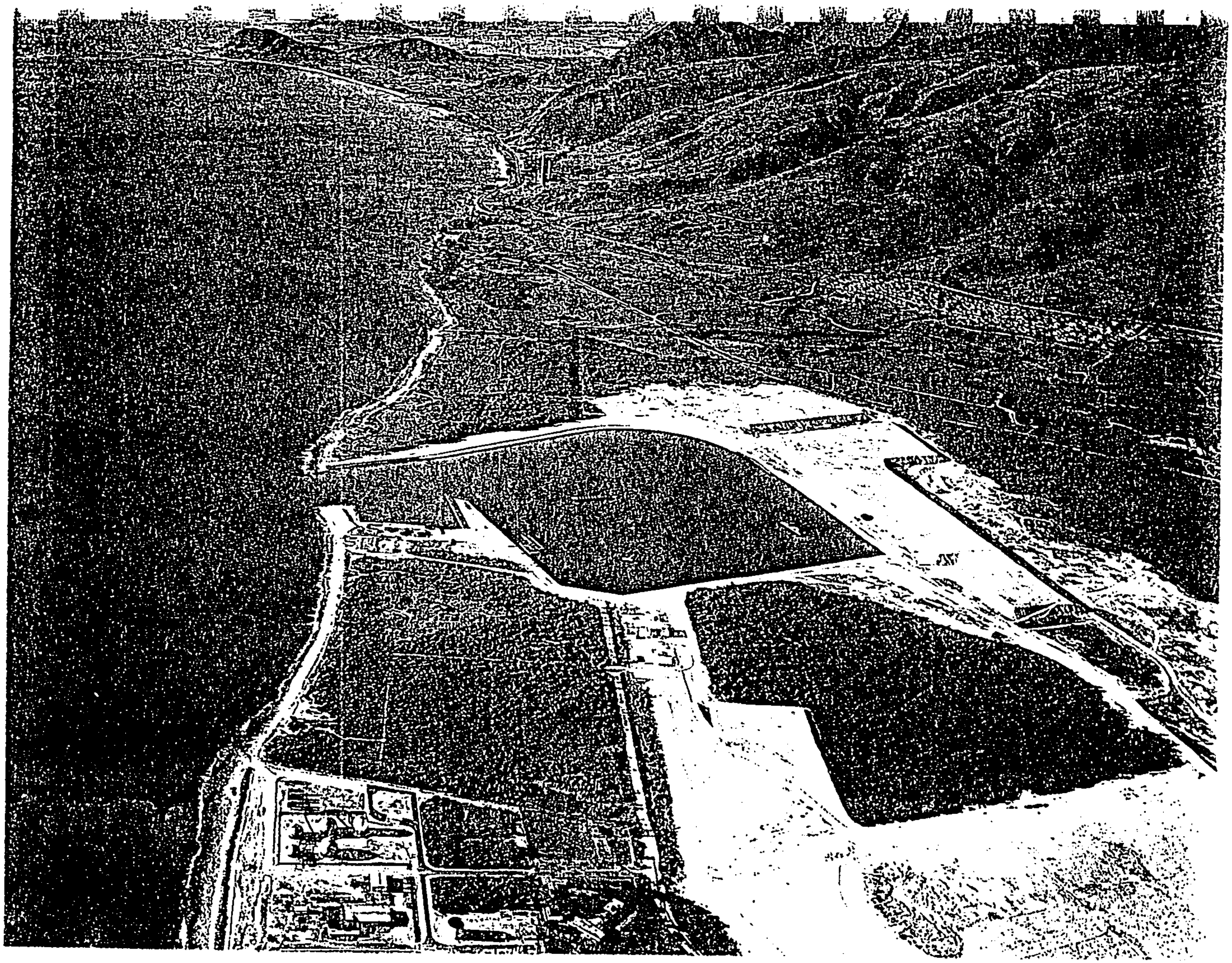


Figure 8
BARBERS POINT TERMINAL
Intra-Island Ferry System

Prepared for:
DEPARTMENT OF TRANSPORTATION, HARBORS DIVISION
Prepared by:
WILSON OKAMOTO & ASSOCIATES, INC.



Existing Conditions

The Barbers Point Harbor basin was dredged at the site of a former barge harbor, a portion of which has been incorporated in the harbor configuration. The area encompassed by Barbers Point Harbor is 92 acres and 38 feet deep. The first increment was completed in 1985 at a cost of $50 million. Approximately 10 million cubic feet of coral was removed to form the harbor basin and entrance channel. The harbor is equipped with 4,700 feet of wave absorbers, berthing areas and navigation aids.

DESCRIPTION OF THE EXISTING ENVIRONMENT

Existing Land Uses

A ship repair company, Marisco, Ltd., currently operates a 8,000-ton floating dry dock capable of handling vessels up to 78 feet wide and over 500 feet long. Future development at Barbers Point Harbor will include a 1,600-foot pier, a container yard and bulk cargo facilities, storage areas, a back-up yard and myriad ship support activities.

Surrounding Land Uses

Oil refineries and petroleum storage tanks lie to the south on Campbell Industrial Park lands. West Beach Development is a self-contained resort complex on 640 acres of land. Currently under construction, the project includes 1,680 residential units, 7,520 hotel/condominium units, a marina, a lagoon system, tourist recreational-commercial center, park, shopping centers, a golf course, a school and other necessary support facilities.

Access

Barbers Point Harbor can be accessed from Interstate Route H-1 on Kalaeloa Boulevard then Malakoe Street.

Existing Conditions

The site is characterized by relatively gentle slopes, with scattered mounds and depressions.

Vegetation in the Barbers Point Harbor area is characteristic of that found in dry areas of Oahu. Major vegetation along the beach strand include species growing in areas strongly influenced by the sea. Inasmuch as the site has been developed into a harbor, there are no rare or endangered plants remaining in the vicinity of the proposed terminal. Wildlife in the project area be is affected by the low rainfall, scarcity of vegetation and the high level of disturbance to the natural setting. Potential inhabitants may include feral cats and dogs, mongoose, mice and various common bird species.

DEVELOPMENT CONTROLS

Land Use Plans and Zoning

The site along the eastern edge of the harbor is designated "Urban" on the State Land Use District Map. The proposed ferry terminal is considered a permitted use.

The City and County of Honolulu Land Use Development Plan Map designates the site as "Public Facility" under which the ferry is a permitted use.

Under the current Land Use Ordinance, the site is zoned " Industrial I-3." The proposed ferry terminal would be permitted as a public facility.

DETERMINATION

Of the various ferry terminals to be developed, those at Pier 8 in Honolulu Harbor, Ala Wai Boat Harbor, Keehi Lagoon, Barbers Point Deep Draft Harbor and Lima Landing at Pearl Harbor are determined to be exempt from review under the Environmental Impact Statement Rules since they fall within the class of actions defined as "Construction or placement of minor structures accessory to existing facilities," which in these cases are existing harbor and marina developments (Section 11-200-8, Administrative Rules, DOH).

The determination of significance regarding the environmental effects of developing the other ferry terminals is deferred until they are sited, designed and more thorough individual environmental assessments can be prepared. If a significant effect is determined, an environmental impact statement(s) shall be prepared.

REFERENCES

Edward K. Noda and Associates and Eugene P. Dashiell, AICP, Ke'ehi Lagoon Recreation Plan Update, January 1988.

Environmental Communications, Final Environmental Impact Statement for the Proposed Waterfront Manor Condominium Project, December 1983.

Environmental Communications, Final Environmental Impact Statement for the Proposed West Beach Resort, September 1980.

M & E Pacific, Inc., Environmental Impact Statement for the Barbers Point Deep Draft Harbor on Oahu, June 1978.

State of Hawaii Department of Transportation, Draft Environmental Impact Statement Improvements at Ala Wai Boat Harbor, August 1971.

State of Hawaii Department of Transportation, Port Hawaii Handbook 1988-1989, 1988.

VTN Pacific, Revised Environmental Impact Statement for the Ala Moana Canal, January 1981.

APPENDIX A

LIST OF APPROVALS

PERMITS

Department of the Army Permit

The Department of the Army permit is administered by the U.S. Army Corps of Engineers, Honolulu District under Section 10 of the Rivers and Harbors Act (33 USC 403), Section 404 of the Clean Water Act (33 USC 1344) and Section 103 of the Marine Protection, Research and Sanitation Act of 1972 (33 USC 1413). The permit is required for all work within water of the United States, including ocean and coastal waters, inland and tidal waters, tidal ponds, fishponds, rivers, streams, and adjacent wetlands, perched wetlands, and intermittent streams.

Issuance of the permit is based on an evaluation of the probable impact of the proposed activity on the public interest, reflecting national concern for both protection and utilization of important resources. Factors considered include those relating to: conservation, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, land use, navigation, recreation, water supply, water quality, energy needs, safety, food production and, in general, the needs and welfare of the people.

Conservation District Use Application

Any use of lands, including submerged lands within the State's Conservation District, as established by the State Land Use Commission, is subject to review pursuant to Chapter 183, HRS and Title 13, Chapter 2 of the Department of Land and Natural Resources Regulations. At the terminal site, the area beyond the shoreline, defined as "the upper reaches of the wash of waves, other than storm and tidal waves, usually evidenced by the edge of vegetation growth, or the upper line of debris left by the wash of waves," is subject to review as a use in the "Resource (R) subzone of the State Conservation District (Section 13-2-13, Administrative Rules of the Department of Land and Natural Resources). Approval by the State Board of Land and Natural Resources will be required through a Conservation District Use Application for all dredging and construction beyond the shoreline.

Special Management Area (SMA) Permit

The Hawaii Coastal Zone Management Law (Chapter 205A, HRS) charged the Counties with designating and administering Special Management Areas (SMA) along the State's coasts. Any "development", as defined by Law, within the SMA requires an SMA permit, which is administered by the City and County of Honolulu, Department of Land Utilization pursuant to Ordinance No. 84-4.

All project sites are located within the SMA boundary and subject to review under the SMA permit procedures.

Shoreline Setback Variance

The State's Shoreline Setback Law, (Chapter 205, HRS) prohibits virtually any development or development-related activity including the removal of sand, rocks, soil, etc. from the shoreline setback area, a 40-foot (20 feet in some areas) strip of land along the shoreline. The Counties, however, are authorized to grant variances for construction that would encroach in the setback area. The City and County of Honolulu, Department of Land Utilization administers this variance under its shoreline setback regulations.

Variances may be granted in consideration of a structure, or activity being in the public interest, hardship to the applicant if the proposed structure or activity is not allowed and the effect a structure or activity would have on natural shoreline processes, particularly with regard to shoreline erosion.

The shoreline variance request can be processed concurrently with the Special Management Area Permit with simultaneous decision-making by the City Council.

Hawaii Coastal Zone Management Program Federal Consistency Review.

Section 307 of the National Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et. seq.) provides for State review of federal actions affecting the coastal zones of States with approved Coastal Zone Management Programs. Hawaii's Coastal Zone Management (CZM) Program, established pursuant to Chapter 205A, HRS was federally approved in 1977. It is administered by the Office of State Planning (OSP).

Among Federal actions subject to review is the issuance of permits, including the Department of the Army Permit. Before the permit can be issued, the OSP must determine its consistency with the enforceable policies of the Hawaii CZM Program. These policies encompass broad concerns such as impact on recreational resources, historic and archaeological resources, scenic and open space resources, coastal ecosystems, economic uses, coastal hazards and the management of development.

Permit for Work in Shores and Shorewaters

The Shorewaters Permit is administered by the State Department of Transportation pursuant to Section 266-16, HRS and Section 19-42-161, Hawaii Administration Rules, Department of Transportation, Harbors Division.

This permit is required for any construction, dredging, or filling within the shorewaters of the State, as defined by Chapter 266, HRS. Jurisdiction extends to shores, shorewaters, navigable streams and harbors, belonging to or controlled by the State.

DOT review of this permit is normally conducted via interagency coordination with the Department of Land and Natural Resources on the Conservation District Use Application. The DOT, however, could request an independent review.

Section 401 Water Quality Certification

The State Department of Health is charged with the responsibility of establishing and administering a State certification system pursuant to Section 401 of the National Clean Water Act (33 USC 1344) and Section 342-32(13), HRS. Water quality certification is required of any applicant for a Federal license or permit to conduct any activity that may result in any discharge into navigable water.

APPENDIX B
CONSULTATION

INTRA-ISLAND FERRY TASK FORCE MEETING DATES

May 29, 1987
June 6, 1987
June 26, 1987
August 4, 1987
September 4, 1987
November 6, 1987
March 16, 1988

INTRA-ISLAND FERRY TASK FORCE MEMBERS
As of July, 1987

	NAME	ORGANIZATION
1.	Edward Uchida	Planner, Department of Transportation-Statewide Transportation Planning Office
2.	Dan Tanaka (Alt.)	Planner, Department of Transportation-Statewide Transportation Planning Office
3.	Admiral E. Alvey Wright	Project Coordinator, Department of Transportation-Statewide Transportation Planning Office
4.	Dennis O'Conner	Councilman, City and County of Honolulu
5.	Robert Dods (Alt.)	Senior Assistant for Councilman O'Conner
6.	Michelle Tucker (Alt.)	Researcher, City Council, City and County of Honolulu
7.	John Emmerson	Chief, Operations Branch, U.S. Army Corps of Engineers
8.	Dave Swenson (Alt.)	Regional Economist, U.S. Army Corps of Engineers
9.	Donna Ikeda	Senator, Hawaii State Legislature
10.	Harry Murakami	Assistant Chief for Engineering, Department of Transportation-Harbors Division
11.	David Yokoyama	Planning Engineer, Department of Transportation-Harbors Division
12.	Ron Tsuzuki	Planning Engineer, Department of Transportation-Highways Division

13.	Kenneth Au (Alt.)	Advance Planning Engineer, Department of Transportation-Highways Division
14.	Libert Landgraf	Deputy Director, Department of Land and Natural Resources
15.	Michael Yoshinaga (Alt.)	Project Coordinator, Department of Land and Natural Resources
16.	Robin Foster	Planner, Department of Land Utilization, City and County of Honolulu
17.	Verne Winquist	Planner, Department of General Planning, City and County of Honolulu
18.	Bill Medeiros (Alt.)	Planner, Department of General Planning, City and County of Honolulu
19.	Don Griffin	Planner, Department of Parks and Recreation, City and County of Honolulu
20.	Jim Ball	Project Manager, Department of Transportation Services, City and County of Honolulu
21.	Marilyn Kali	Public Information Officer, Department of Transportation-Director of Public Relations
22.	Chris Kam (Alt.)	Information Specialist, Department of Transportation-Director of Public Relations

PUBLIC PRESENTATIONS AND INFORMATIONAL MEETINGS

Public Information Meetings

July 1, 1987	Hawaii Kai Rotary
July 27, 1987	Hawaii Kai Neighborhood Board
August 25, 1987	Hawaii Kai Elementary School
January 7, 1988	Makakilo Elementary School
January 14, 1988	Ewa Elementary School
January 31, 1988	Waipahu Elementary School
March 22, 1988	Hawaii Kai Elementary School

Public Exhibitions and Presentations

October 15, 1987	Board of Realtors - City Affairs Comm.
December 1, 1987	Farr. High Sch. Public Exhibit
Feb. 14-21, 1988	Kahala Mall Shopping Center
February 18, 1988	Hawaiian Canoe Program Advisory Council
February 23, 1988	Hawaii Yacht Club
March 1988	International Order of the Blue Gavel
March thru April 1988	Windward Shopping Mall
April 13, 1988	Waikiki Yacht Club
April 24, 1988	Waikiki Yacht Club
May 14-20, 1988	Pearl Ridge Shopping Center
May 18, 1988	Waterborne Transportation Conference
May 19, 1988	Pacific Congress on Marine Science & Technology

GOVERNMENTAL AGENCIES CONSULTED

September 18, 1987	U.S. Army Real Estate Office
October 2, 1987	U.S. Army Corps of Engineer
October 20, 1987	U.S. Army Corps of Engineer, National Marine Fishery Service & U.S. Fish and Wildlife Service
November 18, 1987	Oahu Metropolitan Planning Organization
November 20, 1987	DOH - Water Quality Certification
November 20, 1987	U.S. Army Corps of Engineers, Planning Office
February 11, 1988	City and County of Honolulu - Department of Parks and Recreation
March 31, 1988	City and County of Honolulu - Department of Transportation Services
April 5, 1988	U.S. Army Corps of Engineers, National Marine Fishery Service, U.S. Fish and Wildlife Service & Environmental Protection Agency
May 12, 1988	Office of State Planning
May 12, 1988	Department of Land and Natural Resources - Conservation & Environmental Affairs
May 19, 1988	Office of Environmental Quality Control
May 20, 1988	City and County of Honolulu - Department of Land Utilization
May 25, 1988	Department of Land and Natural Resources - Conservation & Environmental Affairs
May 26, 1988	U.S. Army Corps of Engineers
June 2, 1988	Office of Environmental Quality Control
June 3, 1988	Department of Land and Natural Resources - Aquatic Resources

APPENDIX C

MAUNALUA BAY MEASUREMENTS

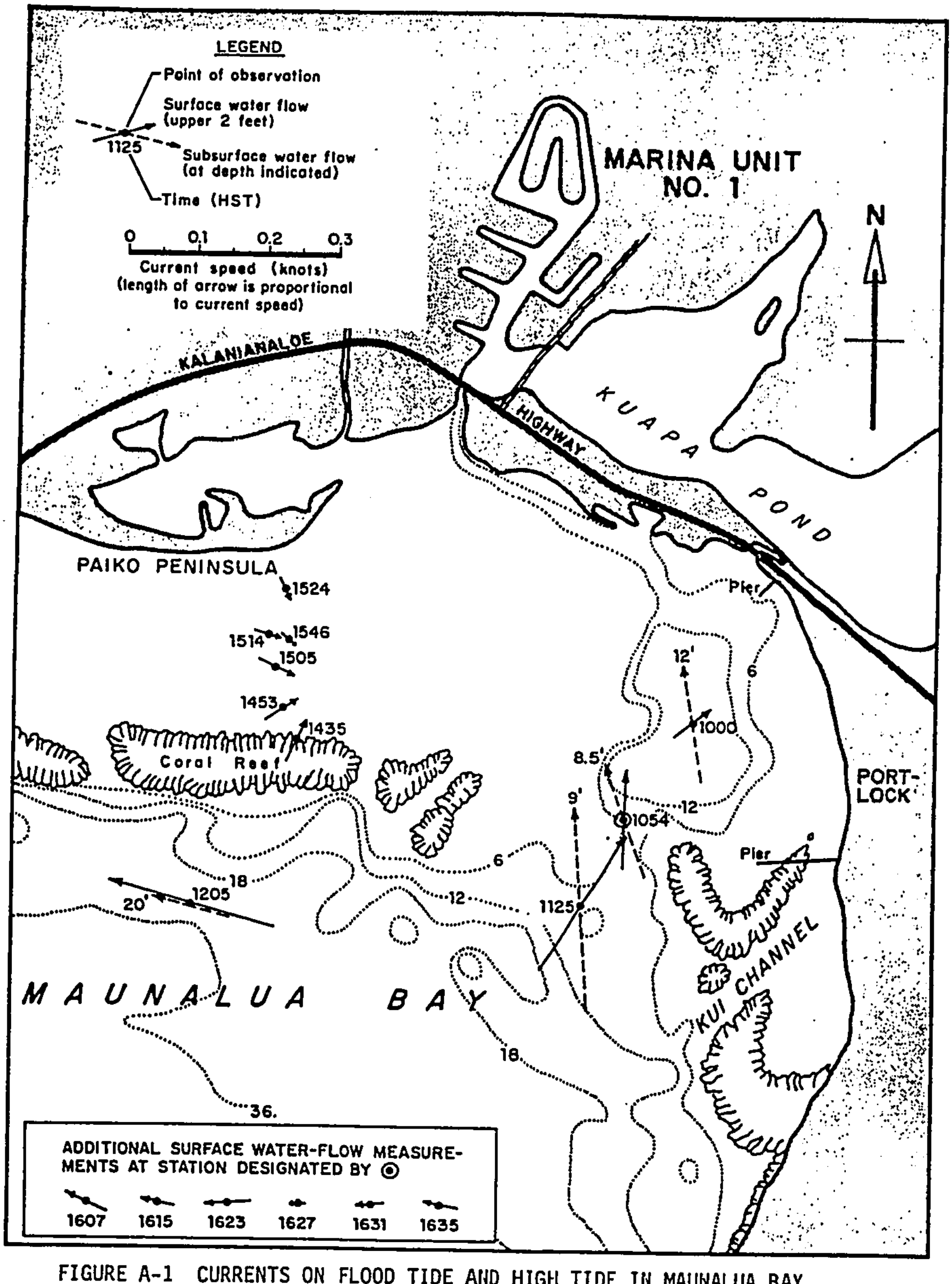


FIGURE A-1 CURRENTS ON FLOOD TIDE AND HIGH TIDE IN MAUNALUA BAY, 29 APRIL 1961
(Predicted tide: -0.2 ft. at 0905; 1.3 at 1551; 0.1 at 2220 HST)
(from Marine Advisers, 1961)

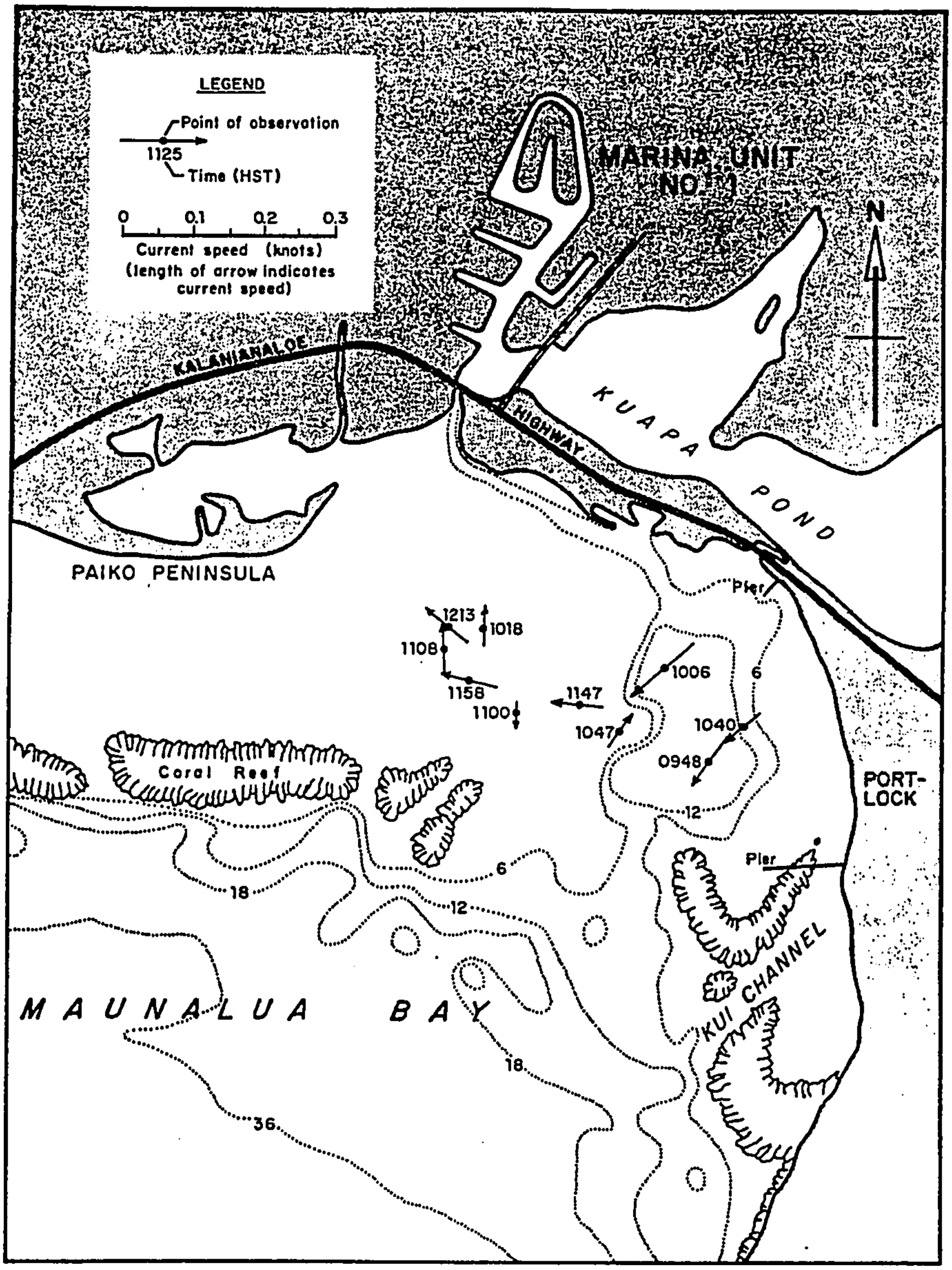


FIGURE A-2 "SURFACE" CURRENTS DURING TRANSITION FROM EBB TIDE TO FLOOD TIDE 2 MAY 1961 (Based on drogue tracking) (Predicted tide: 0.8 ft at 0451; -0.2 at 1035; 2.0 at 1750 HST) (from Marine Advisers, 1961)

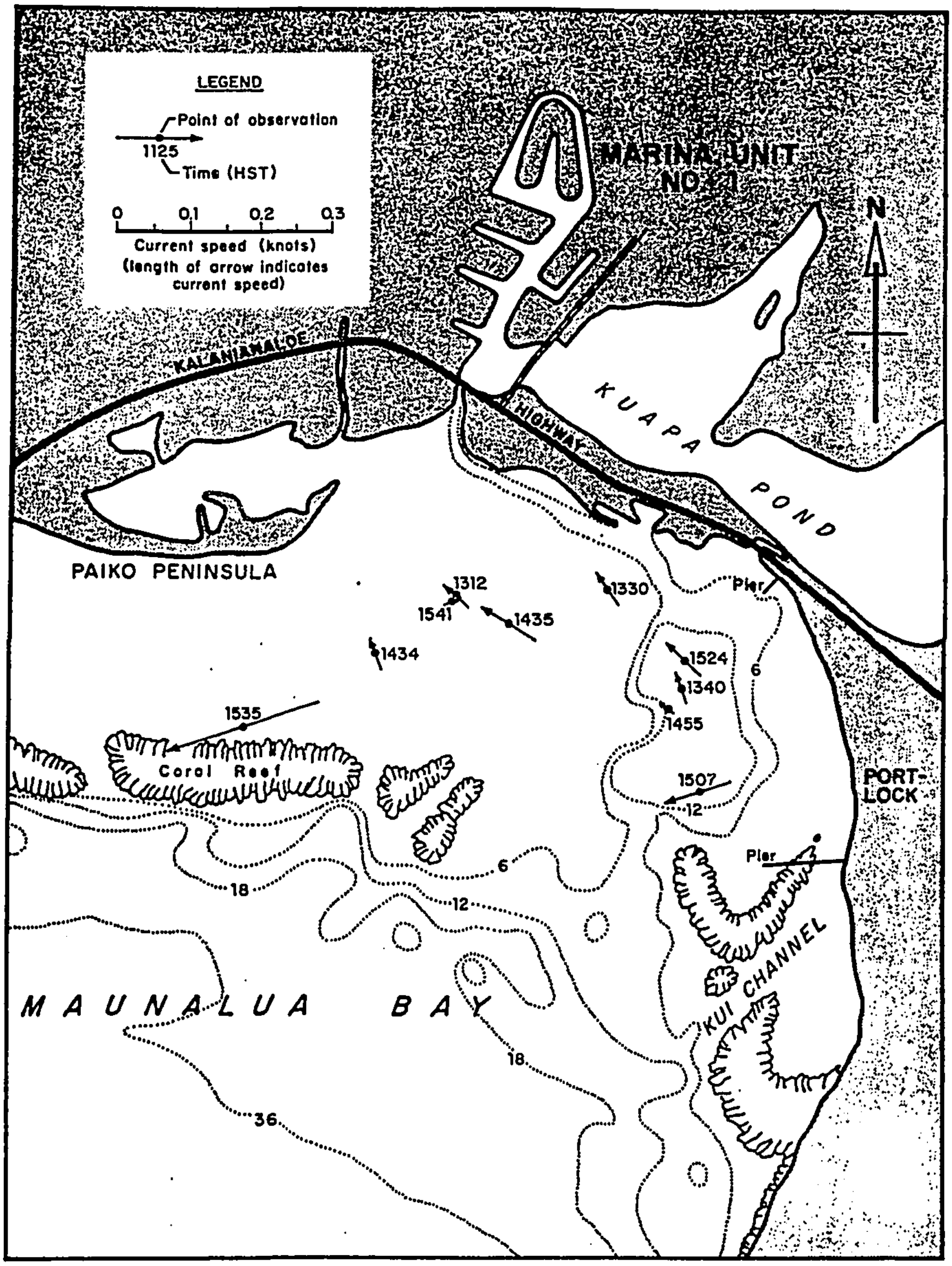


FIGURE A-3 "SURFACE" CURRENTS DURING MID FLOOD TIDE 2 MAY 1961
(Based on drogue tracking)
(Predicted tide: -0.2 ft at 1035; 2.0 at 1750 HST)
(from Marine Advisers, 1961)

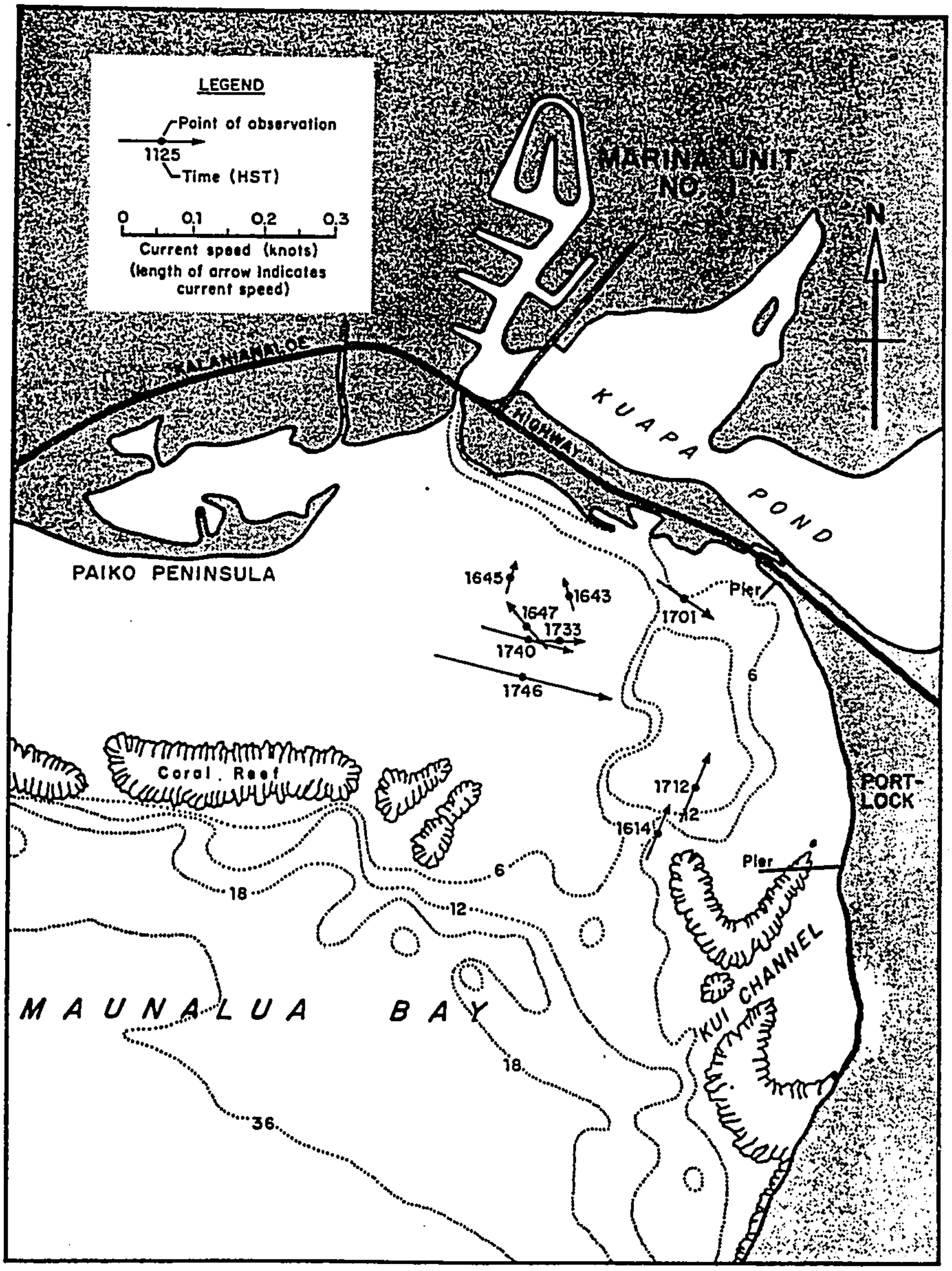


FIGURE A-4 "SURFACE" CURRENTS NEAR END OF FLOOD TIDE PERIOD
2 MAY 1961 (Based on drogue tracking)
(Predicted tide: -0.2 ft at 1035; 2.0 at 1750 HST)
(from Marine Advisers, 1961)

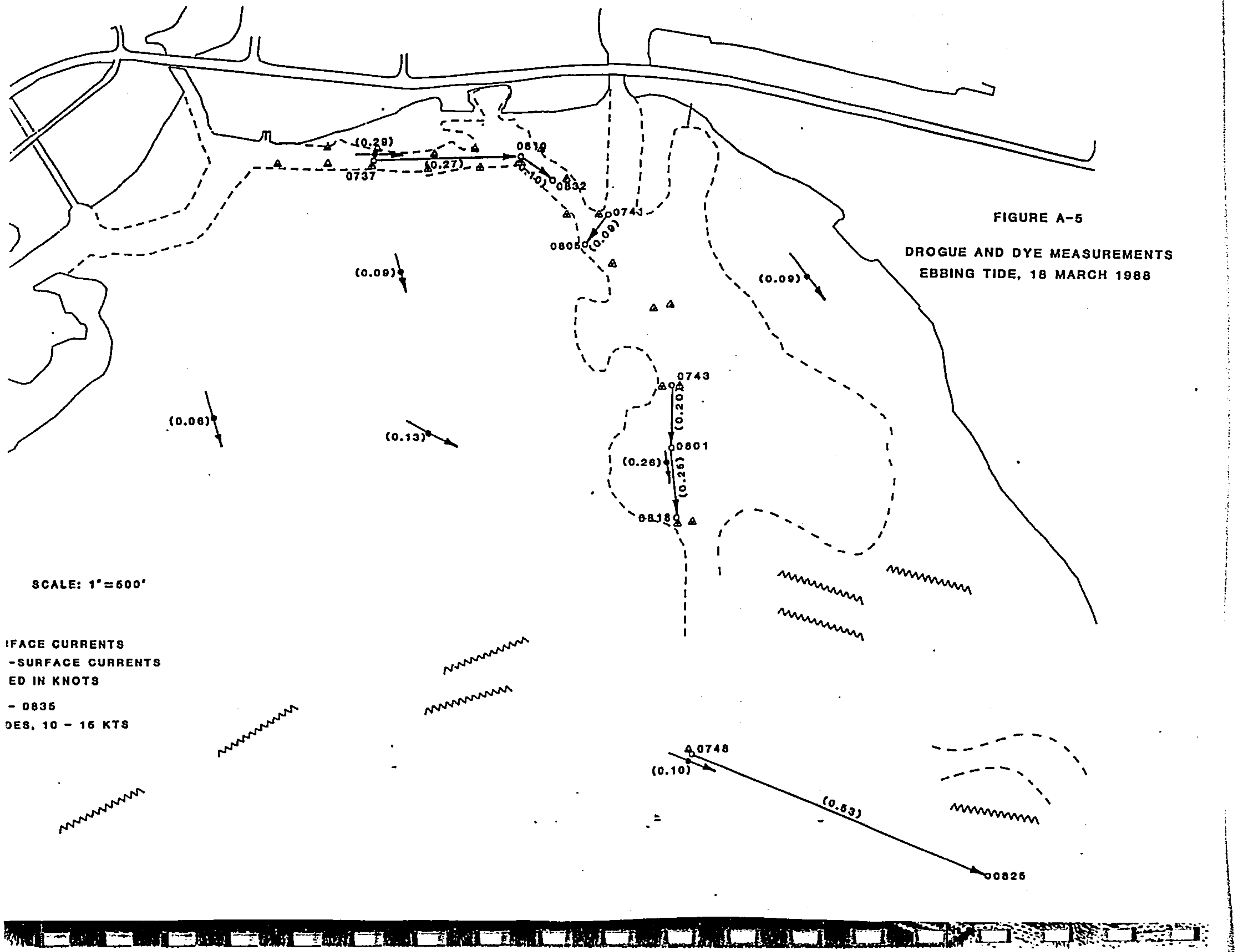


FIGURE A-5

DROGUE AND DYE MEASUREMENTS
EBBING TIDE, 18 MARCH 1988

CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

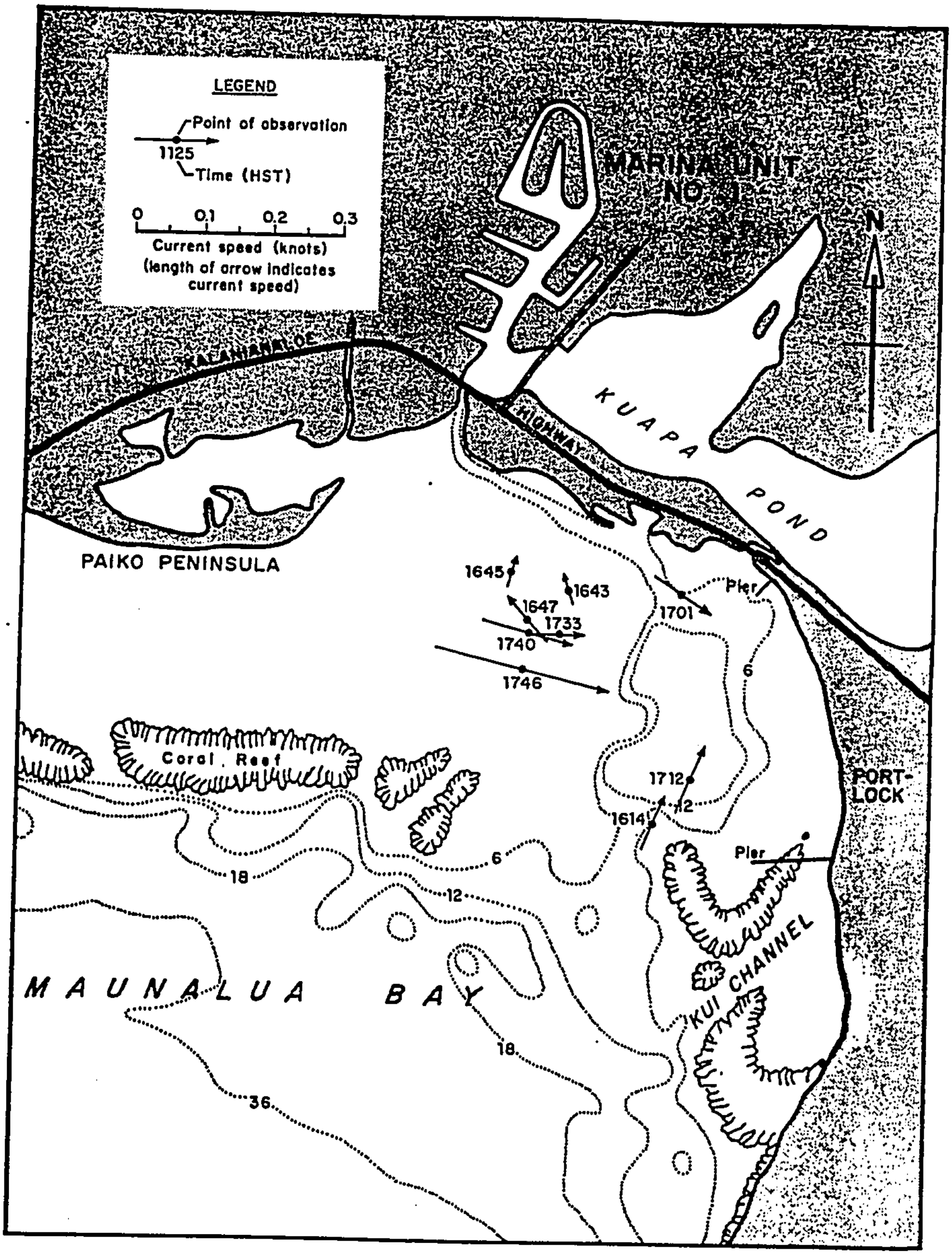


FIGURE A-4 "SURFACE" CURRENTS NEAR END OF FLOOD TIDE PERIOD
2 MAY 1961 (Based on drogue tracking)
(Predicted tide: -0.2 ft at 1035; 2.0 at 1750 HST)
(from Marine Advisers, 1961)

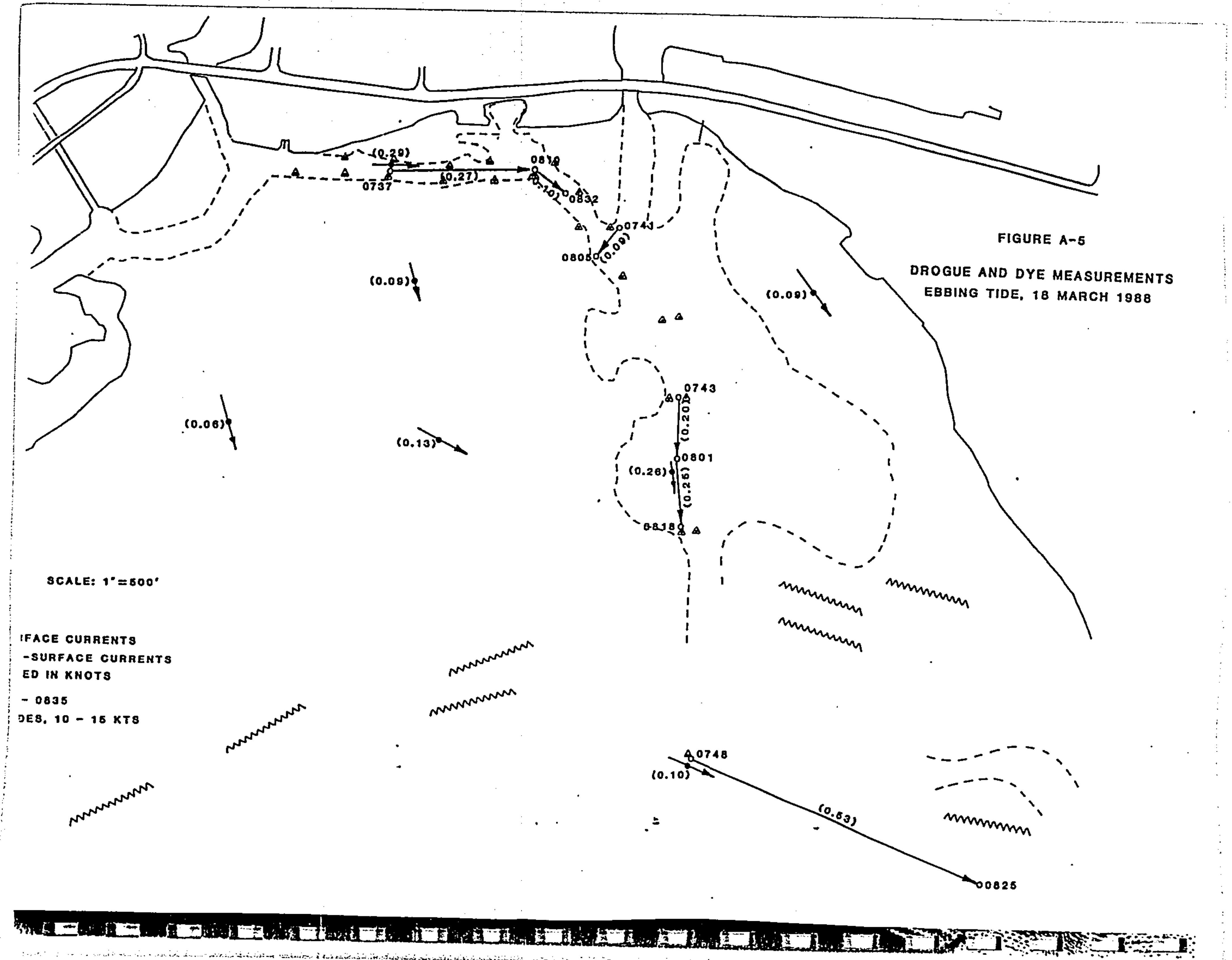


FIGURE A-5

DROGUE AND DYE MEASUREMENTS
EBBING TIDE, 18 MARCH 1988

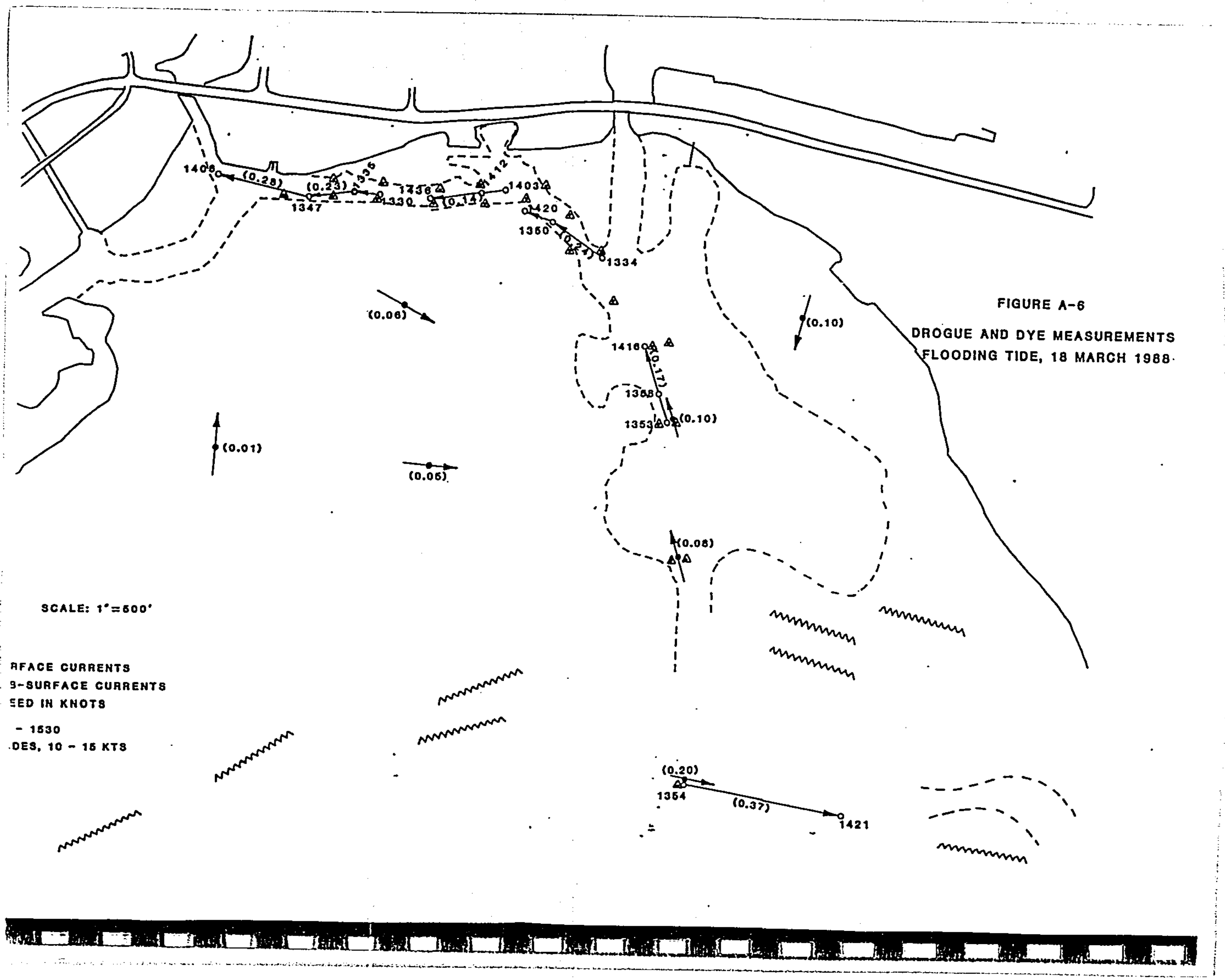


FIGURE A-6

DROGUE AND DYE MEASUREMENTS
FLOODING TIDE, 18 MARCH 1988

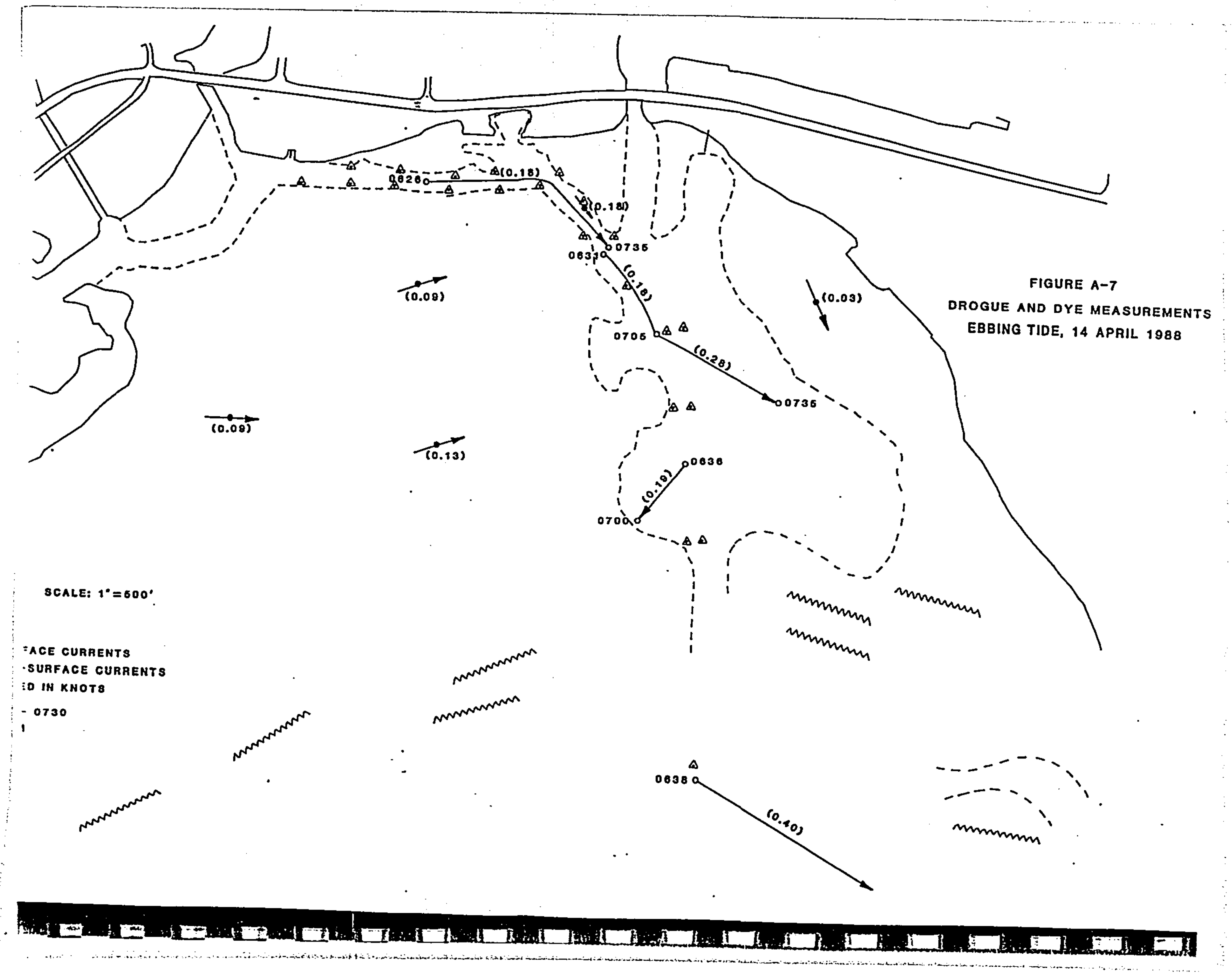


FIGURE A-7
DROGUE AND DYE MEASUREMENTS
EBBING TIDE, 14 APRIL 1988

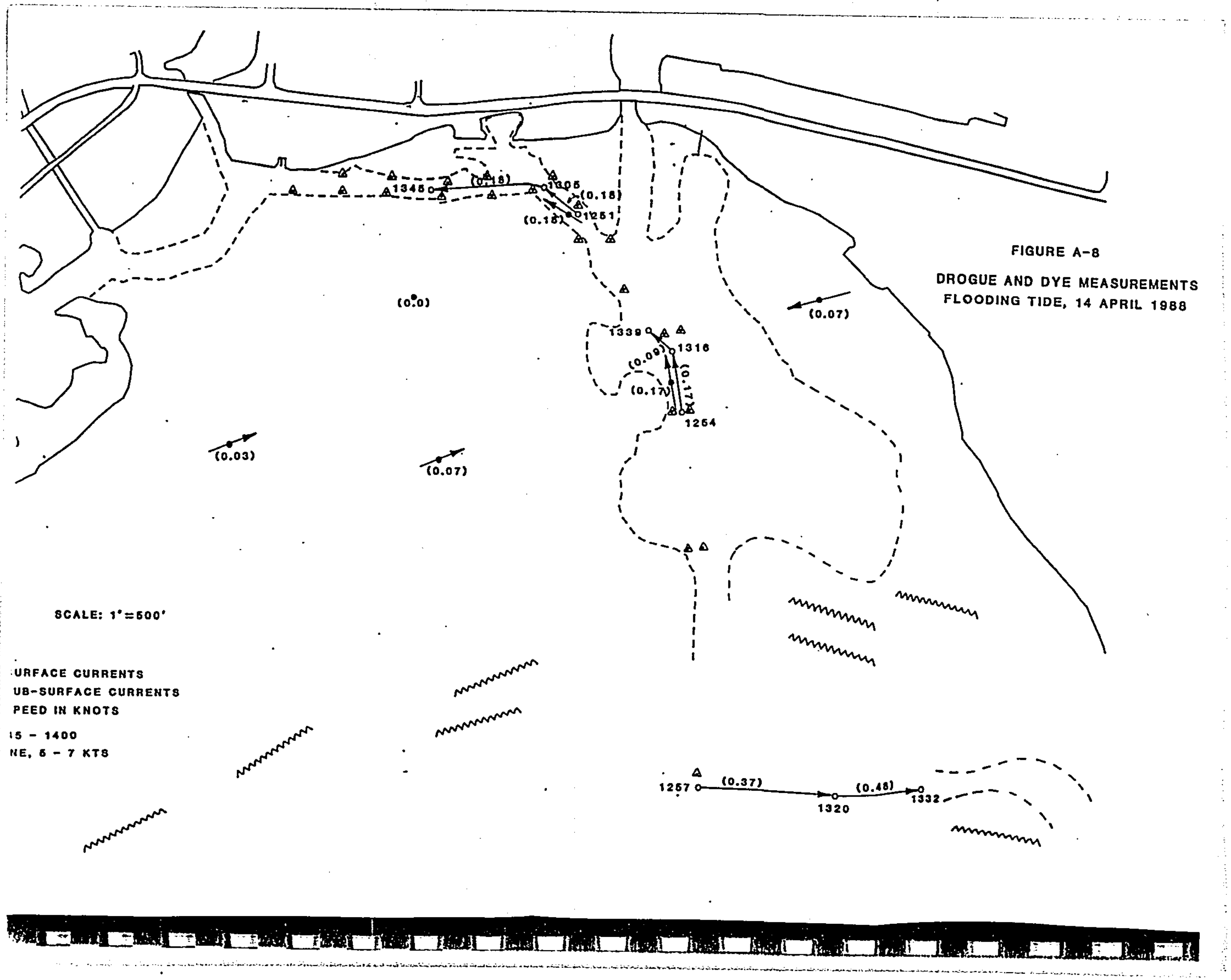


FIGURE A-8
DROGUE AND DYE MEASUREMENTS
FLOODING TIDE, 14 APRIL 1988
SCALE: 1"=500'
URFACE CURRENTS
UB-SURFACE CURRENTS
PEED IN KNOTS
15 - 1400
NE, 5 - 7 KTS
1345
1305
1251
(0.18)
(0.16)
(0.18)
(0.0)
(0.07)
(0.07)
(0.03)
1339
1316
1254
(0.09)
(0.17)
(0.17)
1257
(0.37)
1320
(0.48)
1332

APPENDIX D

MAUNALUA BAY TURBIDITY DATA

GROUPING FOR TURBIDITY STATIONS

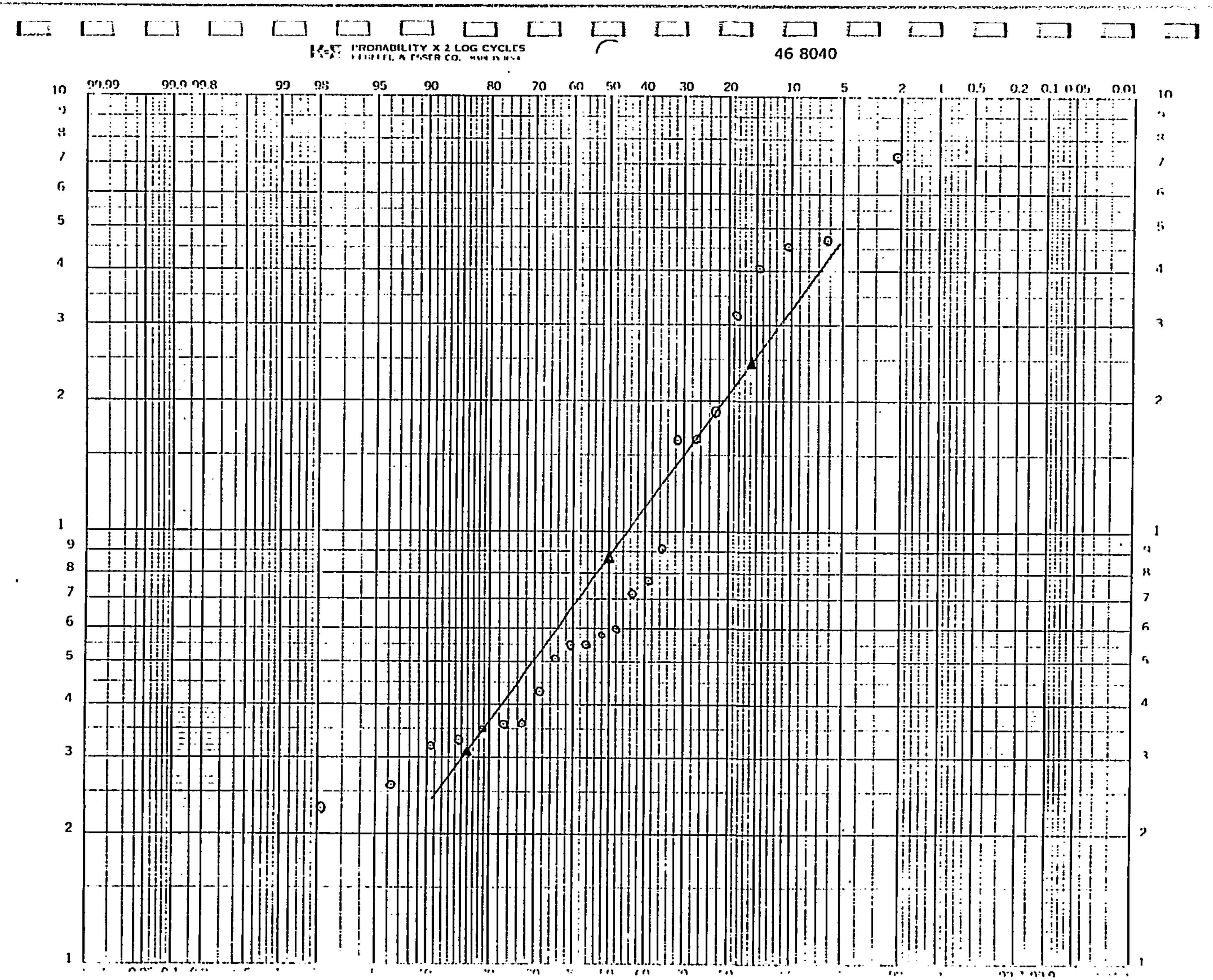
(Refer to Figure 4 in the text)

REEF FLAT	CHANNEL	MARINA ENTRANCE	SEAWARD OF REEF
1	6	5	4
2	10	9	13
3	11		14
7	12		17
8			18
15			19
16			

STUDY AREA SEAWARD WATER FROM THE REEF
DATE 3/19/88 4/13/88 AND 4/14/88
PARAMETER TURBIDITY

NUMBER OF DATA POINTS	24
MEDIAN	.590
SMALLEST VALUE	.230
LARGEST VALUE	7.320
MEAN	1.5317
STANDARD DEVIATION	1.8627
COEF. OF VARIATION	1.2161
GEOMETRIC MEAN	.8680
GEOMETRIC STANDARD DEVIATION	2.8158
84.1% FREQUENCY VE	2.4441
15.9% FREQUENCY VE	.3082

POINT	VALUE	F(I)
1	.230	.021
2	.260	.063
3	.320	.104
4	.330	.146
5	.350	.188
6	.360	.229
7	.360	.271
8	.430	.313
9	.510	.354
10	.550	.396
11	.550	.438
12	.580	.479
13	.600	.521
14	.720	.563
15	.770	.604
16	.910	.646
17	1.620	.688
18	1.630	.729
19	1.890	.771
20	3.160	.813
21	4.050	.854
22	4.560	.896
23	4.700	.938
24	7.320	.979

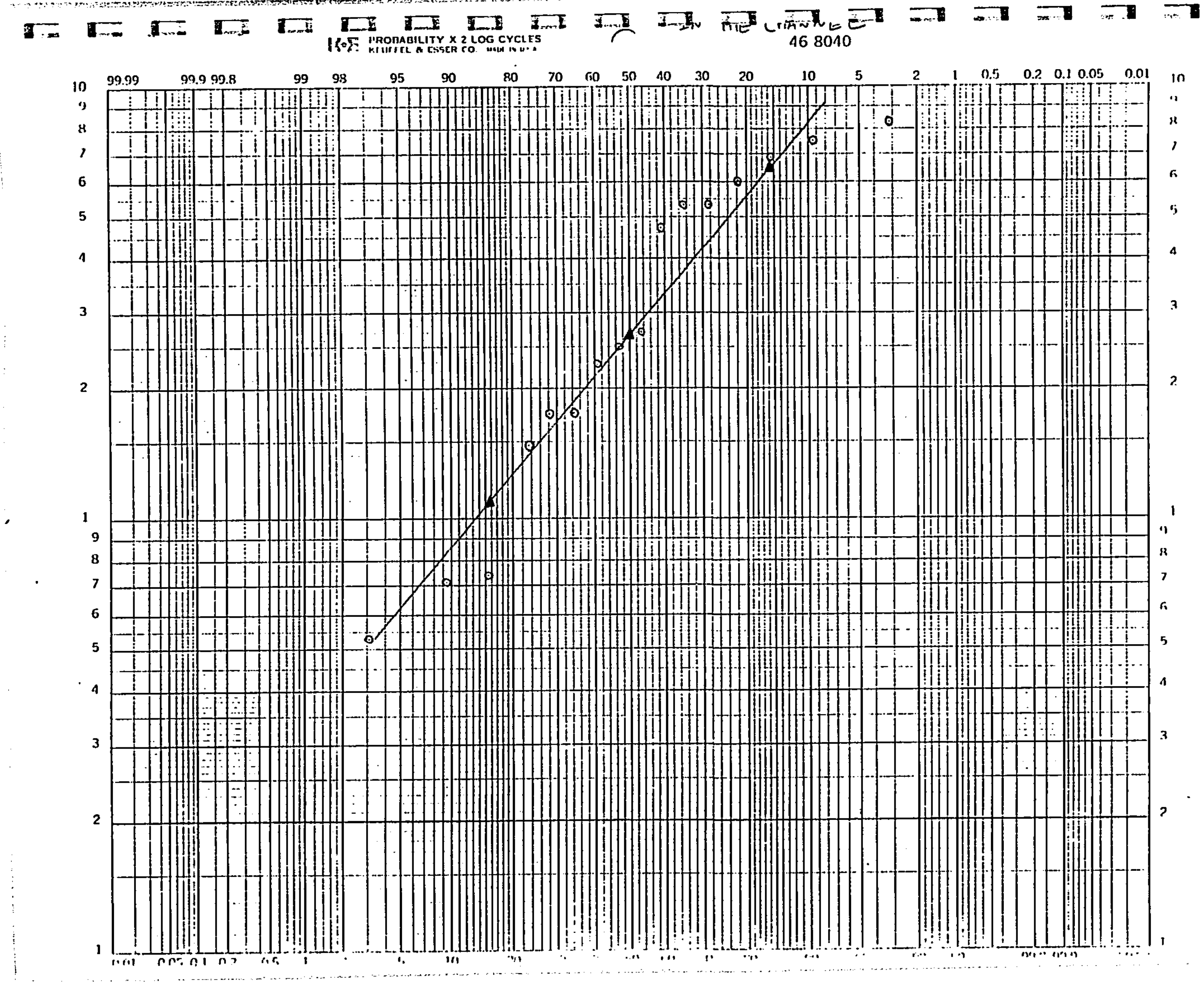


K&E PROBABILITY X 2 LOG CYCLES
KEUFFEL & ESSER CO.
46 8040
99.99
99.9 99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1 0.05
0.01

STUDY AREA IN THE CHANNEL
DATE 3/19/88 4/13/88 AND 4/14/88
PARAMETER TURBIDITY

NUMBER OF DATA POINTS	16
MEDIAN	2.605
SMALLEST VALUE	.530
LARGEST VALUE	8.280
MEAN	3.6644
STANDARD DEVIATION	2.6127
COEF. OF VARIATION	.7130
GEOMETRIC MEAN	2.6757
GEOMETRIC STANDARD DEVIATION	2.4419
84.1% FREQUENCY VE	6.5337
15.9% FREQUENCY VE	1.0957

POINT	VALUE	F(I)
1	.530	.031
2	.710	.094
3	.740	.156
4	1.480	.219
5	1.760	.281
6	1.760	.344
7	2.270	.406
8	2.500	.469
9	2.710	.531
10	4.720	.594
11	5.350	.656
12	5.370	.719
13	6.050	.781
14	6.890	.844
15	7.510	.906
16	8.280	.969

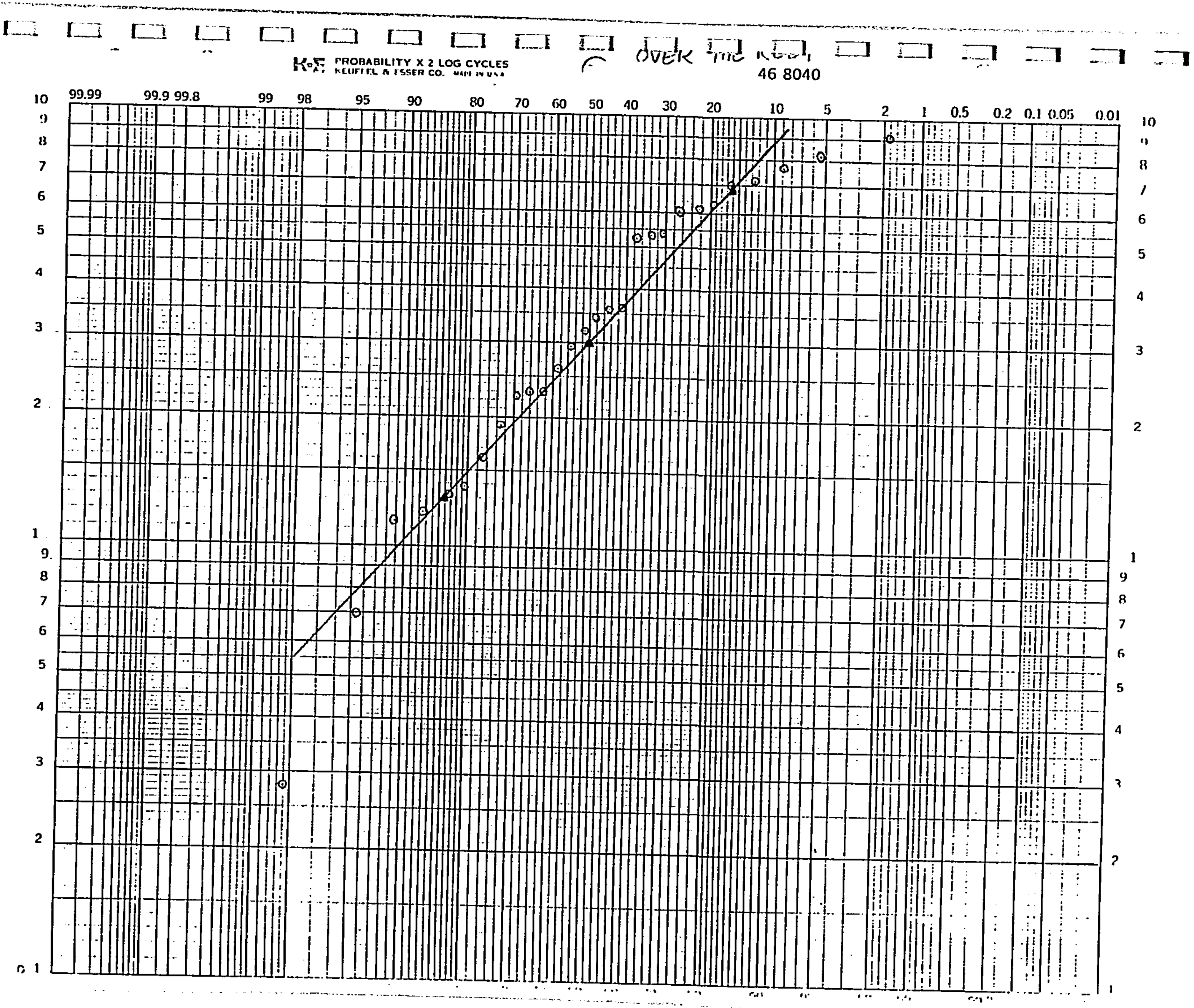


K&E PROBABILITY X 2 LOG CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 8040
99.99
99.9 99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1 0.05
0.01

STUDY AREA OVER THE REEF (MOANALUA BAY)
DATE 3/19/88 4/13/88 AND 4/14/88
PARAMETER TURBIDITY

NUMBER OF DATA POINTS	28
MEDIAN	3.320
SMALLEST VALUE	.280
LARGEST VALUE	9.100
MEAN	3.9146
STANDARD DEVIATION	2.5383
COEF. OF VARIATION	.6484
GEOMETRIC MEAN	2.9913
GEOMETRIC STANDARD DEVIATION	2.3068
84.1% FREQUENCY VE	6.9002
15.9% FREQUENCY VE	1.2967

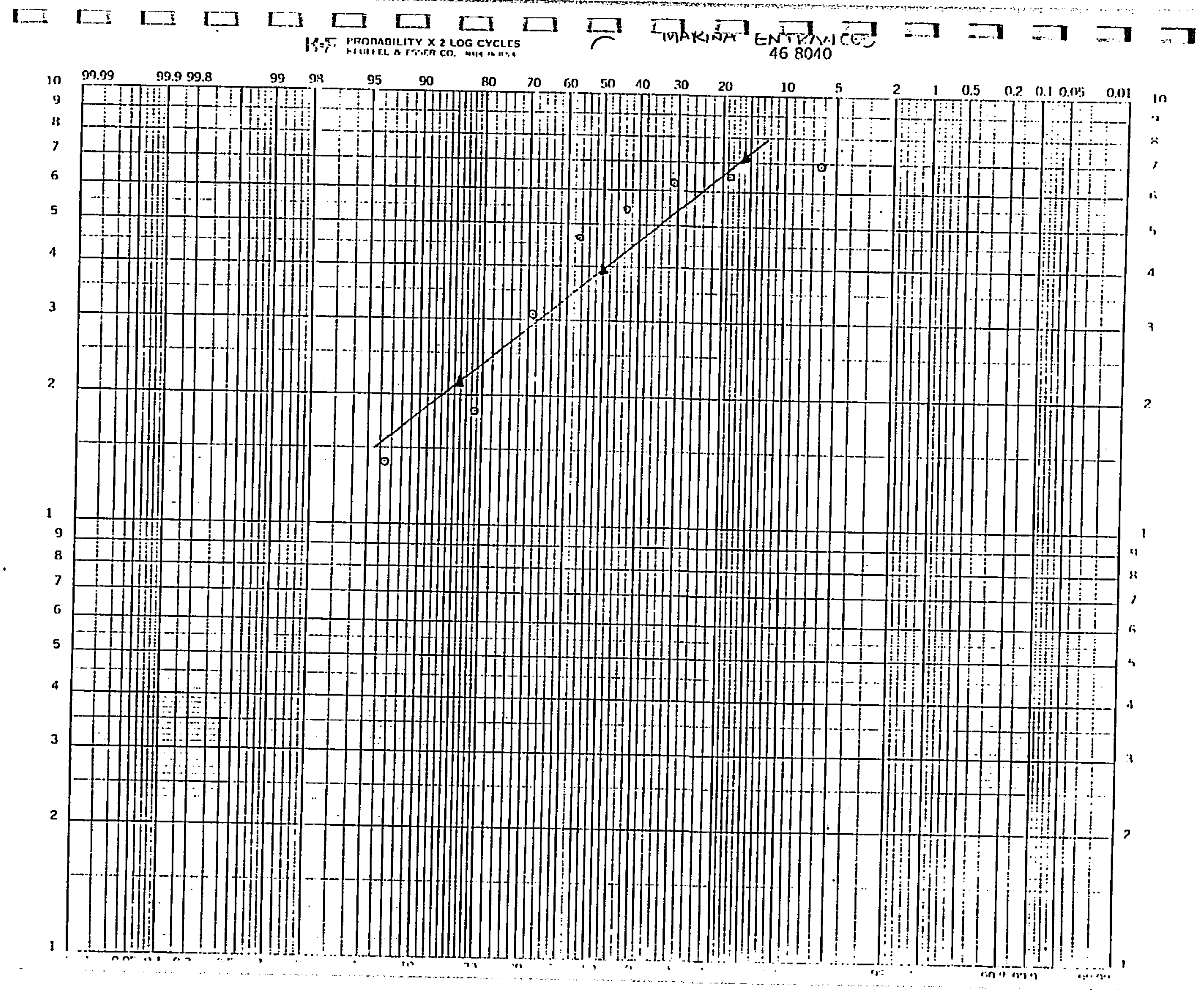
POINT	VALUE	F(I)
1	.280	.018
2	.700	.054
3	1.150	.089
4	1.200	.125
5	1.320	.161
6	1.380	.196
7	1.630	.232
8	1.910	.268
9	2.250	.304
10	2.300	.339
11	2.310	.375
12	2.620	.411
13	2.950	.446
14	3.200	.482
15	3.440	.518
16	3.600	.554
17	3.630	.589
18	5.250	.625
19	5.360	.661
20	5.380	.696
21	6.020	.732
22	6.130	.768
23	6.370	.804
24	7.000	.839
25	7.180	.875
26	7.750	.911
27	8.200	.946
28	9.100	.982


K&E PROBABILITY X 2 LOG CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 8040
99.99
99.9 99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1 0.05
0.01

STUDY AREA HAWAII-KAI MARINA ENTRANCES
DATE 3/19/88 4/13/88 AND 4/14/88
PARAMETER TURBIDITY

NUMBER OF DATA POINTS	8
MEDIAN	5.065
SMALLEST VALUE	1.400
LARGEST VALUE	6.920
MEAN	4.5275
STANDARD DEVIATION	2.1613
COEF. OF VARIATION	.4774
GEOMETRIC MEAN	3.9412
GEOMETRIC STANDARD DEVIATION	1.8449
84.1% FREQUENCY VE	7.2712
15.9% FREQUENCY VE	2.1363

POINT	VALUE	F(I)
1	1.400	.063
2	1.850	.188
3	3.100	.313
4	4.690	.438
5	5.440	.563
6	6.270	.688
7	6.550	.813
8	6.920	.938


K+E PROBABILITY X 2 LOG CYCLES
KEUFFEL & ESSER CO.
46 8040
MAKINA ENTKWICCO
99.99
99.9 99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1 0.05
0.01

STUDY AREA MAUNALUA BAY PAST REEF
DATE 1973
PARAMETER TURBIDITY (TU)

NUMBER OF DATA POINTS	13
MEDIAN	.71
SMALLEST NUMBER	.2
LARGEST NUMBER	4.9
MEAN	1.5092
STANDARD DEVIATION	1.5696
COEF. OF VARIATION	1.0400
GEOMETRIC MEAN	.8772
GEOMETRIC STANDARD DEVIATION	3.0388
84.1% FREQUENCY VE	2.6656
15.9% FREQUENCY VE	.2887

POINT	VALUE	F(I)
1	.200	.038
2	.240	.115
3	.320	.192
4	.340	.269
5	.430	.346
6	.490	.423
7	.710	.500
8	.990	.577
9	1.800	.654
10	2.300	.731
11	2.900	.808
12	4.000	.885
13	4.900	.962

(from Sunn, Low, Tom & Hara, 1974)

STUDY AREA MAUNALUA BAY CHANNEL
DATE 1973
PARAMETER TURBIDITY (TU)

NUMBER OF DATA POINTS	15.0000
MEDIAN	6.6000
SMALLEST NUMBER	1.4000
LARGEST NUMBER	20.3000
MEAN	6.5800
STANDARD DEVIATION	4.4709
COEF. OF VARIATION	.6795
GEOMETRIC MEAN	5.3979
GEOMETRIC STANDARD DEVIATION	1.9664
84.1% FREQUENCY VE	10.6142
15.9% FREQUENCY VE	2.7451

POINT	VALUE	F(I)
1	1.400	.033
2	2.000	.100
3	2.400	.167
4	3.000	.233
5	5.200	.300
6	5.600	.367
7	6.200	.433
8	6.600	.500
9	6.900	.567
10	6.900	.633
11	7.100	.700
12	8.000	.767
13	8.200	.833
14	8.900	.900
15	20.300	.967

(from Sunn, Low, Tom & Hara, 1974)

STUDY AREA HAWAII KAI MARINA EXITS
DATE 1973
PARAMETER TURBIDITY (TU)

NUMBER OF DATA POINTS	27.0000
MEDIAN	8.7000
SMALLEST NUMBER	3.0000
LARGEST NUMBER	23.0000
MEAN	9.1593
STANDARD DEVIATION	4.6502
COEF. OF VARIATION	.5077
GEOMETRIC MEAN	8.1532
GEOMETRIC STANDARD DEVIATION	1.6410
84.1% FREQUENCY VE	13.3792
15.9% FREQUENCY VE	4.9685

POINT	VALUE	F(I)
1	3.000	.019
2	3.300	.056
3	3.900	.093
4	4.900	.130
5	4.900	.167
6	5.800	.204
7	5.900	.241
8	6.200	.278
9	6.700	.315
10	6.800	.352
11	6.900	.389
12	7.700	.426
13	7.700	.463
14	8.700	.500
15	8.800	.537
16	9.000	.574
17	9.700	.611
18	9.900	.648
19	10.500	.685
20	10.500	.722
21	11.000	.759
22	11.500	.796
23	13.000	.833
24	14.000	.870
25	15.000	.907
26	19.000	.944
27	23.000	.981

(from Sunn, Low, Tom & Hara, 1974)

TABLE 5. WATER QUALITY CHANGES AFTER A STORM

Station	Turbidity (FTU)			Salinity* (0/00)			Temperature* (°C)			T.N. (ug/l)			T.P. (ug/l)			T. Coliform (No./100 ml)			F. Coliform (No./100 ml)		
	Day*			Day*			Day*			Day*			Day*			Day*			Day*		
	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5
1	0.35	0.35	0.45	33.90 33.79 33.87	34.05 34.04 34.05	33.68 33.73 33.78	25.42 25.40 25.35	25.08 25.50 25.55	25.70 25.68 25.50	219	214	208	7.8	44.2	14	-	-	-	-	-	-
2	2.1	6.5	7.0	33.10 33.34 33.63	32.87 33.30 33.73	33.22 33.38 33.60	25.12 25.35 25.32	25.16 24.42 24.70	25.05 25.10 25.10	270	423	455	16.3	32	24.8	< 5	< 5	< 2	< 5	< 5	< 2
3	7.1	7.0	7.6	33.45 33.30 33.45	32.42 32.50 32.52	32.89 32.90 33.30	25.20 25.10 25.24	25.25 25.10 25.02	24.98 24.90 25.05	284	626	348	35.7	78	27.9	-	-	-	-	-	-
4	9.0	5.0	8.8	31.21 31.30 32.66	32.64 32.70 33.00	32.93 32.96 33.00	25.20 25.18 25.15	25.65 25.30 25.10	25.18 25.15 25.02	656	538	298	50.4	49	40	< 100	< 5	< 2	40	< 5	4
5	27.0	13.0	16	32.46 32.44 32.44	32.88 32.86 33.00	32.58 32.66 32.55	25.53 25.58 25.62	25.74 25.53 24.65	24.75 24.66 24.65	592	443	617	107	71	71	-	-	-	-	-	-
6	25.0	9.5	14	31.09 31.04 31.39	31.55 31.36 31.40	31.00 31.80 31.82	25.00 25.04 25.06	25.00 25.86 24.99	24.70 24.75 24.05	1109	949	1042	90.7	73	55	1,000	< 10	700	200	5	600
7	33.0	18.0	20	31.00 -- 31.20	31.85 -- 31.76	31.65 -- 31.35	25.70 -- 25.70	24.98 -- 24.98	24.36 -- 24.53	1286	980	1042	118.6	79.1	98	2,000	200	900	1,000	100	800
8	16.0	10.0	15	31.85 -- 31.89	31.95 -- 32.20	32.26 -- 32.50	25.95 -- 26.00	24.84 -- 24.90	25.02 -- 24.82	475	519	508	51.2	50	47	1,000	30	1,000	500	< 10	800
9	5.1	5.0	6.2	26.08 26.20 26.40	31.92 32.04 32.00	32.20 32.30 32.35	25.30 25.32 25.30	25.78 25.60 25.36	25.10 25.02 24.90	549	380	431	47.3	71	33	< 10	< 10	< 2	40	< 10	< 2
10	4.8	3.3	6.4	31.00 31.35 31.60	32.30 32.34 31.42	32.60 32.83 32.58	26.00 26.00 26.00	26.00 25.95 24.80	26.00 25.13 25.10	466	359	477	29.5	26	24.8	-	-	-	-	-	-
11	9.0	4.0	6.5	32.70 -- 32.71	31.89 -- 31.80	32.38 -- 32.40	25.45 -- 25.50	25.76 -- 25.45	25.23 -- 25.30	388	398	304	25.6	19.4	20.2	-	-	-	-	-	-

* Days after storm, November 11, 1973.

* In situ readings taken at surface, mid-depth, and bottom.

(from Sunn, Low, Tom & Hara, 1974)

APPENDIX E

BIOLOGICAL ASSESSMENT FOR THE
PROPOSED INTRA-ISLAND FERRY
SYSTEM: HAWAII KAI TERMINAL

INTRODUCTION

The population of East Honolulu has grown dramatically in the last 10 years. The major road servicing this surburban area and connecting it to primary employment center, Honolulu, is the four lane Kalanianaole Highway. Traffic congestion during peak hours has prompted transportation officials to seek alternative methods of mass transit between these two points. Since Hawaii Kai is situated adjacent to the shoreline, one of the suggested alternatives is to develop an over-water ferry system. The intra-island ferry system has been selected as the most appropriate solution to alleviating the traffic problem.

On step in the implementation of such a ferry system is to construct adequate docking facilities at Maunalua Bay Beach Park in Hawaii Kai. This would include the construction of onshore facilities (passenger drop-off and waiting areas) as well as some construction activities in the water including the dredging of a turning basin, building of docking facilities and the widening of the existing boat channel. The in-water construction and dredging activities will impact surrounding marine communities. This study was undertaken to address these impacts. The study (1) reviews existing literature in an effort to describe past major construction activities that have impacted the marine ecosystem in the project area, (2) describes extant marine communities in the project area using information collected in the field, and (3) assesses possible impacts that may occur to these communities with this development.

EARLY IMPACTS

The Hawaii Kai Marina was constructed on the site of Kuapa Pond. Kuapa Pond was important as a fishpond for the raising of mullet (*Mugil cephlus*) 'awa (*Chanos chanos*) and aholehole (*Kuhlia sandvicensis*) since prehistoric times and was one of the largest ponds in the Hawaiian Islands (Sakoda 1975). The pond was separated from Maunalua Bay by a narrow rock-faced sand spit or wall. This wall was about 1.5km in length and was breached by two makahas (openings to the sea). In the late 1930's Kalanianaole Highway was built along this sand strip, widening the barrier between the pond and the sea. Two culverts were constructed to provide water exchange between the pond and the bay; the main channel at the site of the present entrance to Hawaii Kai Marina was increased to 12m in width. In this relatively unmodified state, Kuapa Pond probably served as a repository or settlement basin for terrigenous materials generated by storm water runoff from the surrounding valleys thus protecting the nearby coral reefs of Maunalua Bay.

Years ago channels affronting Maunalua Bay Beach Park probably existed approximately where they do today and were created by freshwater and terrigenous inputs from Kuliouou Stream and Kuapa Pond (AECOS 1979). Dredging was first undertaken on the entrance channel through the reef to Kuapa Pond during World War II to service the military installation at nearby Koko Crater. This dredging operation probably served to widen a pre-existing natural channel through the reef. Work on the Hawaii Kai Marina commenced in 1959 with the dredging of portions of Kuapa Pond. This dredging and filling resulted in the size of Kuapa Pond being reduced from 208 to 103ha; concurrently the average depth of the basin was increased from 0.75 to about 2m (Clark 1977). The marina is used for recreational boating, water sports and fishing activities and the filled portions comprise part of the residential development of Hawaii Kai. During this time the 12m wide channel into Kuapa Pond was widened from 12 to 76m and a new bridge constructed; an access channel paralleling and adjacent to the shore was cut from the boat channel easterly for 800m past the Maunalua Bay Beach Park boat ramp to the mouth of Kuliouou Stream and Paiko Lagoon. This channel is approximately 45m in width and 2.5m in depth. The material from this operation was used to create the present beach park and boat launching area at Maunalua Bay (Sakoda 1975). Presently these channels serve as collection points for the discharge of freshwater and terrigenous materials from Paiko Lagoon, Kuliouou Stream and the two marina entrances.

These construction activities altered some benthic communities by their removal; also the dredging as well as occasional runoff due to storms must have contributed to the sediment loading in the nearshore waters affronting the Hawaii Kai Marina. However, as noted by AECOS (1979), these waters were turbid prior to the dredging of the marina and disturbance to adjacent lands. The turbidity was due to the flow of water from Kuapa Pond and resuspension of fine materials on the reef flat. AECOS (1979) noted that the turbidity had not lessened following marina construction because boat traffic served to keep materials in suspension; hence visibility at that time was "limited to about 5 feet on the murky inner reef flat". These observations and the long history of construction in the area suggest that high particulate loading in the water column has been the norm for at least 50 years.

MATERIALS AND METHODS

The fieldwork that serves as the database for this study was carried out in March and April 1988. Marine communities residing in a 450m wide arc or band extending from Paiko Lagoon on the west, about 1.2km easterly along the shore and seaward in the existing boat channel for 1.3km were examined (Figure 1).

The quantitative sampling of macrofauna of marine communities presents a number of problems; many of these are related to the scale on which one wishes to quantitatively enumerate organ-

Figure 1. Approximate area encompassed by this survey of the marine communities in the area affronting Maunalua Bay Beach Park shown in crosshatching.

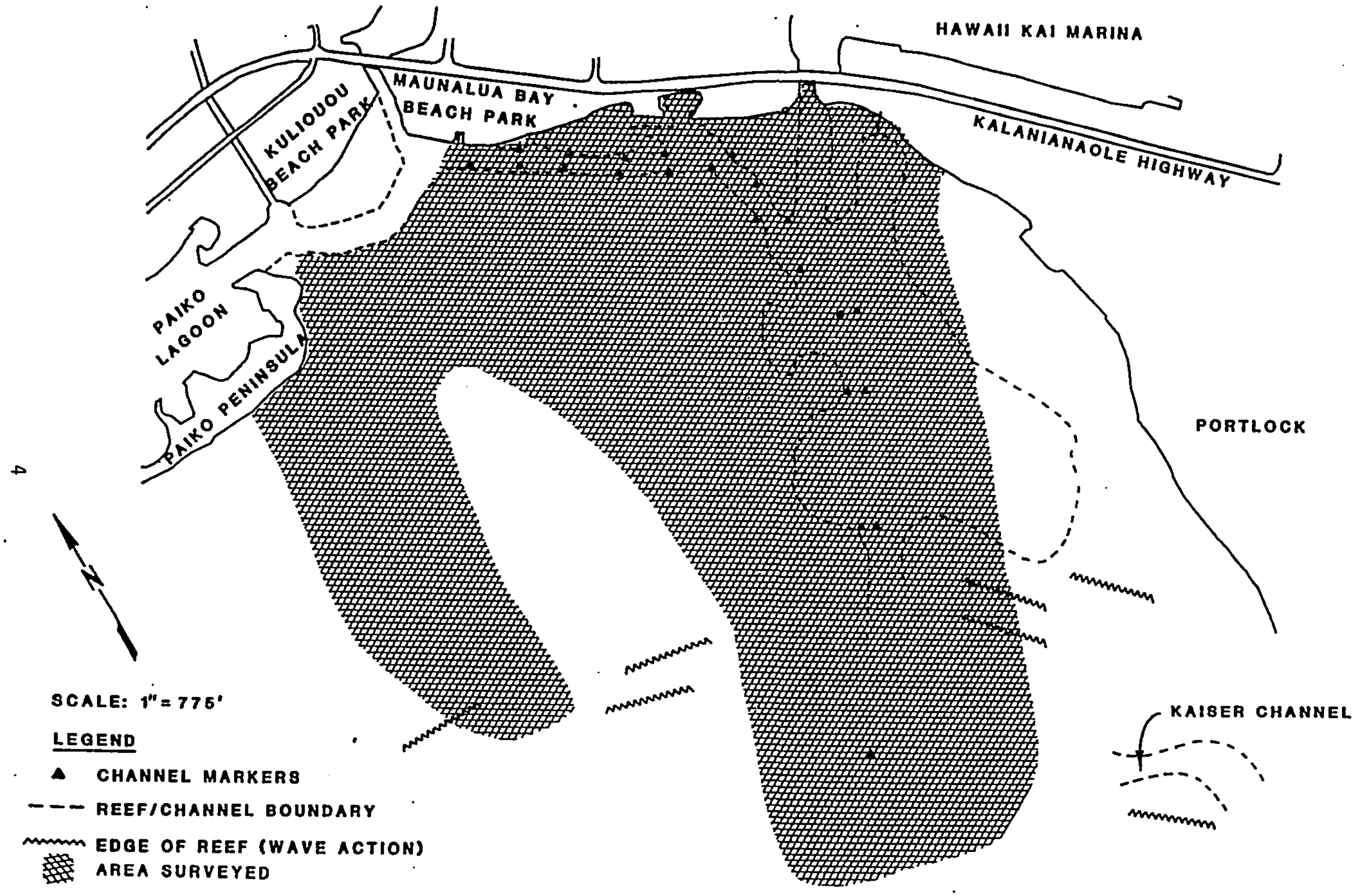


FIGURE 1 AREA ENCOMPASSED BY 1988 BIOLOGICAL SURVEY

ism abundance. Marine communities affronting the Maunalua Bay Park may be spatially defined in a range on the order of a few hundred square centimeters (such as the community residing in a Pocillopora meandrina coral head) to major biotopes covering many hectares. Recognizing this ecological characteristic, we designed a sampling program that attempted to delineate major extant communities in the limits of the study area and to quantitatively describe these communities. Thus, a number of methods were used.

To obtain an overall perspective on the extent of the major communities or "zones" occurring in the study area, a diver either swam or where shallow enough, walked over most of the study area from shore seaward to the reef crest. This exercise allowed the qualitative delineation of three major biotopes based partially on large structural elements (e.g., amount of sand, mud, hard substratum, fish abundance, coral coverage or dominant benthic species). Within each of these, stations were erected and quantitative studies were conducted, including a visual enumeration of fish, counts along benthic transect lines and cover estimates in benthic quadrats. Besides these quantitative measures, a qualitative reconnaissance was made in the vicinity of each station by swimming and noting the presence of species not encountered in the transects. Most of the assessments were carried out using SCUBA; snorkeling was used at stations situated in water less than 1.5m in depth.

The location of stations were subjectively chosen as being representative of a given biotope. Immediately following site selection, a visual fish census was undertaken to estimate the abundance of fishes. These censuses were conducted over a 20 x 4m corridor and all fishes within this area to the water's surface were counted. A single diver equipped with SCUBA, transect line, slate and pencil would enter the water, count and note all fishes in the prescribed area (method modified from Brock 1954). The 20m transect line was paid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., cross coral mounds, sand flats, and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (20m in length) has proven adequate in sampling many Hawaiian benthic communities.

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels (family Muraenidae) and nocturnal species, e.g., squirrelfishes (family Holocentridae), aweoweos (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief although some fishes with cryptic habits or protective coloration (e.g., the nohus, family Scorpaenidae; the flatfishes, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water (a major problem in the present survey) and species of fishes which move quickly and/or are very numerous may be difficult to count. Additionally, bias related to the experience of the diver conducting counts should be considered in making any comparisons between surveys or areas. In this case, the same individual (Brock) carried out all census work. In spite of the above drawbacks, the visual census technique probably provides the most accurate nondestructive assessment of diurnally active fishes presently available (Brock 1982).

After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals) was undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2cm in some dimension (without disturbing the substratum) were censused in a 20 x 4 m area. As with the fish census technique, this sampling methodology is quantitative for only a few invertebrate groups, e.g., some of the echinoderms and holothurians. Most coral reef invertebrates (other than corals) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical relief very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small necessitates the use of methodologies beyond the scope of this survey (e.g., see Brock and Brock 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censusing techniques used here attempted only to assess those few macroinvertebrate species that are diurnally exposed.

Exposed sessile benthic forms such as corals and macrothalloid algae were quantitatively surveyed by use of quadrats and the point-intersect method. The point-intersect technique only notes the species of organisms or substratum type directly under a point. Along the previously set fish transect line, 40 such points were assessed (once every 50cm). These data have been converted to percentages. Quadrat sampling consisted of recording benthic organisms, algae and substratum present as a percent cover in five one-meter-square frames placed at five-meter intervals along the transect line established for fish censusing (at 0, 5, 10, 15, and 20m).

During the course of the fieldwork, notes were taken on the number of turtles seen within the study area.

Simple methods of data reduction and analysis have been used and are described where met with in the text. Diversity (H') is calculated as described by Pielou (1966), where:

$$H' = -\sum p_i \ln p_i$$

and p_i is that proportion of the individuals censused belonging to species i. This is the Shannon-Wiener index.

RESULTS

In total 3 biotopes were recognized affronting Maunalua Bay Beach Park in this study (Figure 2); these were the reef flat biotope, the channel floor biotope and the biotope of limestone mounds situated seaward of the fringing reef. Five quantitative stations were established to sample the marine communities in the reef flat and channel floor biotopes and one station sampled the biotope of limestone mounds. One small area (approximately 700m^2) that is biologically very different from surrounding communities was discerned; this area is located on the eastern side of the Hawaii Kai boat channel about 0.5km from shore and the benthos is dominated by live corals. One quantitative station was established to sample this area. Other than the channel floor biotope, the lines delineating the boundaries of the biotopes in Figure 2 are not sharp, rather there exists a zone of transition or ecotone between each biotope. The locations of the biotopes are shown in Figure 2 and Figur 3 presents the locations of the 12 quantitative stations sampled in this study. The marine communities at each station are discussed by biotope below:

Reef Flat Biotope

This biotope affronts Maunalua Bay Park and extends from the shoreline to the crest of the fringing reef about 900m offshore. the biotope is situated on an old limestone bench that has a veneer of fine terrigenous mud and rubble which is most apparent within 250m of shore; more seaward, limestone substratum is visible between pockets of muddy sand and rubble. The dimensions of these pockets of sedimentary material range from 2 x 5m to over 60 x 100m spaced 10 to 100m apart. Much of this biotope is in water less than 1m in depth and is exposed at low tide.

In general benthic communities in the reef flat biotope may be characterized as being highly disturbed along the inner portions and dominated by sessile filter and suspension feeding forms. Further offshore, the algae and a number of invertebrate and fish species that are usually seen on Hawaiian reefs may be found.

Stations 1,3,11 and 12 sampled the inner (nearshore) portions of the reef flat biotope and Station 6 was established to survey the more seaward part of this biotope. The substratum

Figure 2. Approximate boundaries of the three biotopes defined in this study. These are 1 - reef flat biotope, 2 - the channel floor biotope, and 3 - the biotope of limestone mounds. An area of high coral coverage is shown as crosshatching.

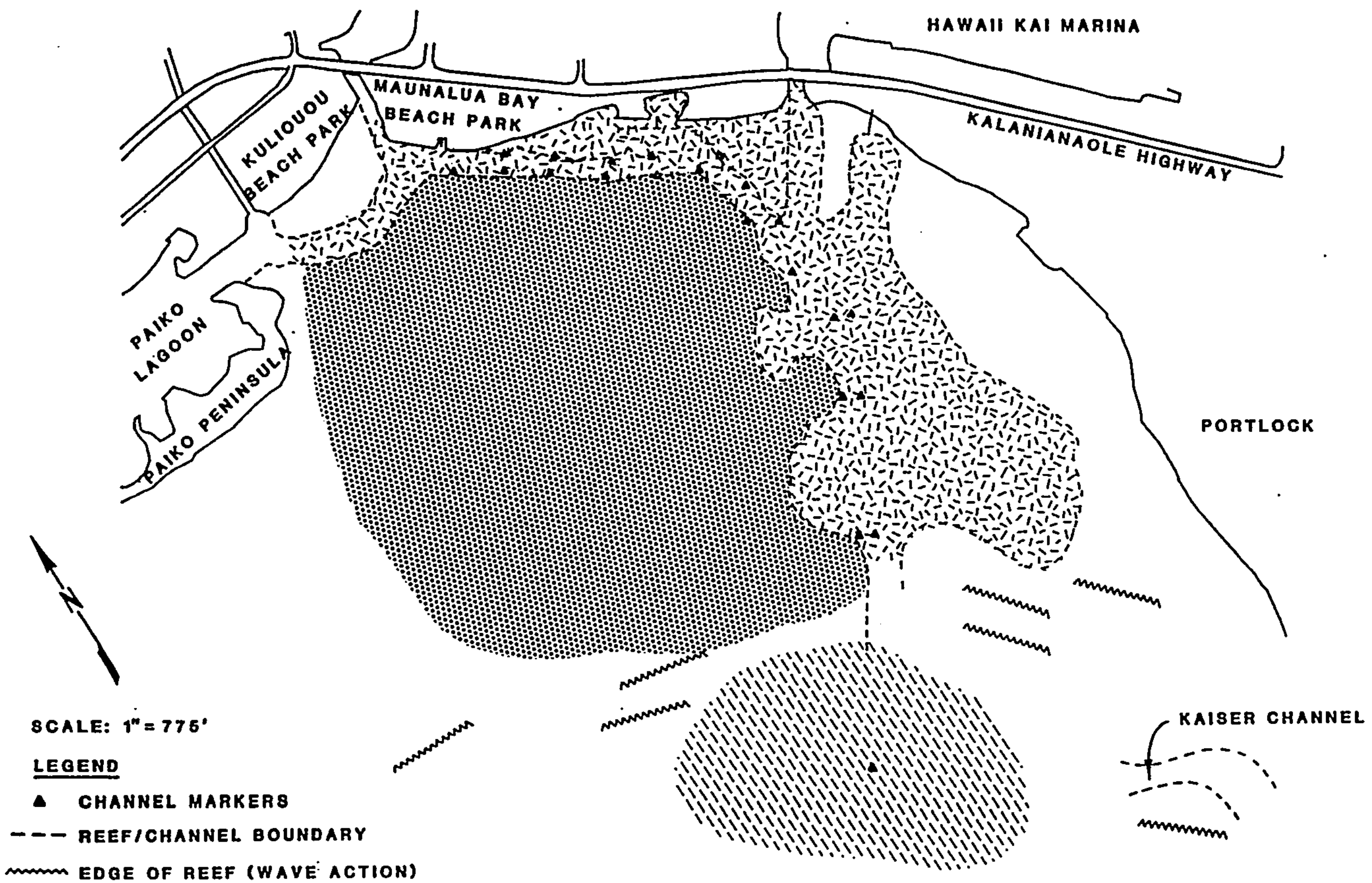


FIGURE 2 BIOTOPE AREAS DEFINED BY THE BIOLOGICAL SURVEY

Figure 3. The location of the 12 quantitative stations established to sample the marine communities in the area affronting Maunalua Bay Beach Park in this study.

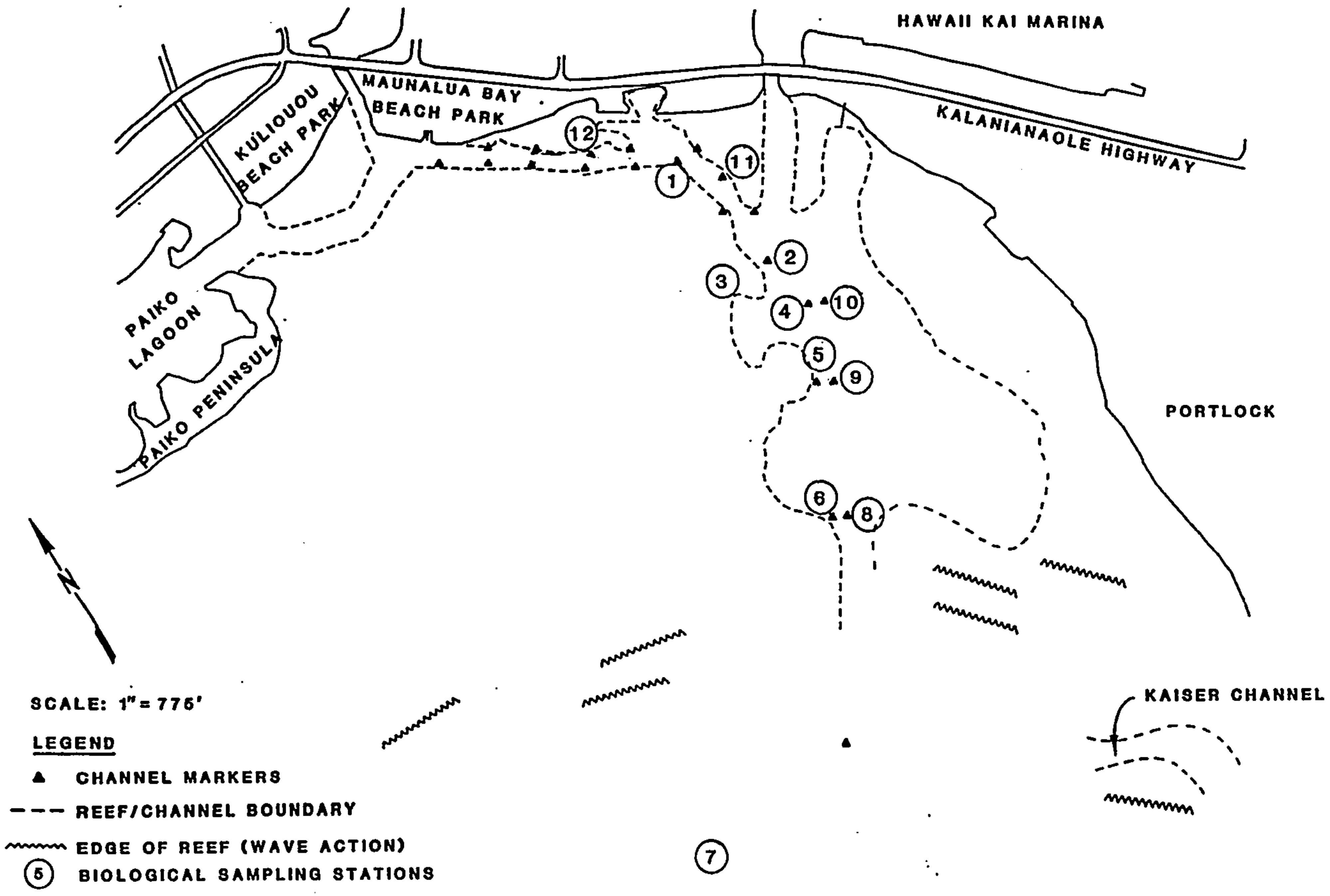


FIGURE 3 LOCATION OF QUANTITATIVE BIOLOGICAL SAMPLING STATIONS

in the inner area is dominated by mud with more rubble being apparent at the edges of the dredged channel that bisects the biotope. Where hard substratum occurs, a number of algae and sessile invertebrates can be found; dominant algal species include Acanthophora spicifera, Spyridia filamentosa, Halimeda opuntia and Hypnea musciformis. Exposed sessile invertebrates include the soft coral (Anthelia edmondsoni), the feather duster worm (Sabellastarte sanctijosephi), the terebellid worm (Thelepus setosus), tubeworm (Ficopomatus enigmaticus), a number of sponge species (Zygomycale parishi, Mycale cecilia, Plakortis simplex, Toxadocia violacea and several unidentified species), the rock oyster (Ostrea sandvicensis), bryozoans (Schizoporella unicornis and Bugula neritina) and occasionally small colonies of the coral, Pocillopora damicornis. Motile invertebrates commonly seen include the swimming crab (Thalamita integra) and the xanthid crab (Leptodius sanguineus).

Fishes are not a conspicuous part of the fauna of the reef flat biotope. Species usually encountered include the o'opu (Asterropteryx semipunctatus), the cardinalfish (Foa brachygramma) and the o'ili'uwi'uwi (Pervagor spilosoma). Near the channel edges on the reef flat were seen juvenile kaku (Sphyraena barracuda), pua (Mugil cephalus), shortfin molly (Poecilia mexicana) and the tilapia (Tilapia melanotheron). Besides these species, fishermen "whip" for papio (omilu - Caranx melampygus and threespot papio - Carangoides orthogrammus) on the reef flat and in the adjacent channels and net fishermen target on 'awa (Chanos chanos) and 'anae (Mugil cephalus). Occasionally, crab fishermen will set their nets in the area catching samoan and swimming crabs (Scylla serrata and Portunus sanguinolentus).

Station 1 was established along the edge of the dredged channel adjacent to marker 11 about 95m from the shoreline (see Figure 3). The substratum at this station is mud and rubble. Water depth ranged from about 1 to 2.5m (along the channel edge). The results of the quantitative survey conducted at Station 1 are given in Table 1. The dominant macroinvertebrates encountered at this station were sponges (Mycale cecilia) and feather duster worms (Sabellastarte sanctijosephi). Only one fish species, the o'opu (Asterropteryx semipunctatus) was censused, but in the vicinity of this station was seen the cardinalfish (Foa brachygramma). During the census the visibility at Station 1 was about 15cm.

Station 3 also sampled the reef flat biotope and was established about 380m offshore near the edge of the boat channel affronting Maunalua Bay Beach Park (Figure 3). More hard substratum and less mud was present at this station than at the

Table 1. Summary of the benthic survey conducted at Station 1 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 1 to 2.5 m; mean coral coverage is 0% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Algae					
Acanthophora spicifera					
Soft Corals			0.5		1
Anthelia edmondsoni					
Mud		0.25			
Rubble	46	17.75	34.5	44	87
Hard Substratum	49	82	65	51	12
	6			5	

B. 40-Point Analysis

Species	Percent of the Total
Mud	51
Rubble	49

C. Invertebrate Census (20x4 m)

Species	Number
Phylum Annelida	
Thelepus setosus	4
Sabellastarte sanctijosephi	8
Phylum Porifera	
Zygomycale parishi	2
Mycale cecilia	6

D. Fish Census (20x4 m)

1 Species
3 Individuals
Diversity (H')=0

preceding one; water depth was 1.5m and the visibility about 30cm. Table 2 presents the results of the quantitative survey conducted at Station 3. Four macrothalloid algal species were censused, and the soft coral (Anthelia edmondsoni) was present. Two coral species, Pocillopora damicornis and Montipora verrucosa, comprised a mean coverage of 0.8 percent at this station. The most abundant macroinvertebrate present was the feather duster worm (Sabellastarte sanctijosephi). Two fish species were censused and the most common was the o'opu (Asterropteryx semipunctatus). In the vicinity of this station were seen the algae, Hypnea musciformis and Avrainvillea amadelpha, as well as the 'omaka (Stethojulis balteata).

Station 11 sampled the reef flat biotope near channel marker 10 about 115m offshore (Figure 3). Water depth at this station was 0.8m and the visibility about 60cm. The substratum at this station was comprised of mud and rubble in near equal proportions. Table 3 presents the results of the quantitative survey at Station 11. Five algal species comprised a mean overall cover of about 4.9 percent; the most common species was the bubble alga, Dictyosphaeria cavernosa. One coral species, Pocillopora damiccornis, was censused and had a mean coverage of 0.5 percent. Five sponge species were present but the feather duster worm (Sabellastarte sanctijosephi) was the most abundant macroinvertebrate encountered. Four fish species were censused and the o'opu (Asterropteryx semipunctatus) was the most common. In the vicinity of this station were seen the moa (Ostracion meleagris), the mamo (Abudefduf abdominalis) and the coral Cyphastrea ocellina.

Station 12 sampled the reef flat biotope in the area proposed to become the turning basin for the intra-island ferry near present channel marker number 16. The substratum at this station is comprised of rubble and muddy sand; water depth was about 0.8m and the visibility at the time of sampling was 40cm. Table 4 presents the results of the quantitative survey carried out at Station 12. The most abundant alga present was Acanthophora spicifera and three limu (algal) species were present having an overall coverage of 15.8 percent. No live corals were encountered in the quantitative survey but nearby one small colony of Pocillopora damicornis was seen and several recently dead colonies were noted. The most abundant macroinvertebrate species in the 20 x 4m census area was the sponge, Plakortis simplex; the only other invertebrate species in this area was the ubiquitous feather duster worm (Sabellastarte sanctijosephi). The only fish species in the quantitative census was the o'opu (Asterropteryx semipunctatus). In the vicinity of this station were seen the goby (Bathygobius fuscus), the limu (Hypnea cervicornis and the swimming crab (Thalamita edwardsi).

Station 6 was established about 800m from shore near channel

Table 2. Summary of the benthic survey conducted at Station 3 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 1.5 m; mean coral coverage is 0.8% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Algae					
Acanthophora spicifera	2				
Spyridia filamentosa		0.5			
Halimeda opuntia	2				
Sporolithon erythraeum				1	0.1
Soft Corals					
Anthelia edmondsoni	3	2			
Corals					
Montipora verrucosa	1	3			
Pocillopora damicornis				0.1	
Mud	8	6	97		
Rubble	84	48.5	3		
Hard Substratum		40		98.9	99.9

B. 40-Point Analysis

Species	Percent of the Total
Mud	26
Rubble	38
Hard Substratum	36

C. Invertebrate Census (20x4 m)

Species	Number
Phylum Annelida	
Sabellastarte sanctijosephi	16
Phylum Mollusca	
Plakobranchus ocellatus	1

D. Fish Census (20x4 m)

2 Species
4 Individuals
Diversity (H')=0.35

Table 3. Summary of the benthic survey conducted at Station 11 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 1 m; mean coral coverage is 0.5% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Algae					
Spyridia filamentosa	0.5		1		
Hypnea musciformis	0.1		3		
Halimeda opuntia			0.1		
Dictyosphaeria cavernosa		18			
Laurencia obtusa				2	
Corals					
Pocillopora damicornis	0.01	2	0.25		
Mud	59.39	51	55.65	38	8
Rubble	40	20	40	60	92
Hard Substratum		9			

B. 40-Point Analysis

Species	Percent of the Total
Algae	
Spyridia filamentosa	1
Mud	47
Rubble	52

C. Invertebrate Census (20x4 m)

Species	Number
Phylum Porifera	
unidentified sponge sp.	1
Zygomycale parishi	4
Plakortis simplex	4
Mycale cecilia	1
Toxadocia violacea	3
Phylum Annelida	
Sabellastarte sanctijosephi	21

D. Fish Census (20x4 m)

4 Species
17 Individuals
Diversity (H')=0.62

Table 4. Summary of the benthic survey conducted at Station 12 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 0.8 m; mean coral coverage is 0% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Algae					
Hypnea musciformis	0.5		0.1		
Acanthophora spicifera		0.1	3	65	10
Dictyosphaeria cavernosa				0.5	
Mud/Sand	64.5	24.9	11.9	12.5	65
Rubble	35	75	85	22	25

B. 40-Point Analysis

Species	Percent of the Total
Algae	
Acanthophora spicifera	7
Mud/Sand	68
Rubble	25

C. Invertebrate Census (20x4 m)

Species	Number
Phylum Porifera	
Plakortis simplex	8
Phylum Annelida	
Sabellastarte sanctijosephi	7

D. Fish Census (20x4 m)

1 Species
4 Individuals
Diversity (H')=0

marker 1 in water 2 to 3m in depth affronting the Maunalua Bay Beach Park (Figure 3). Visibility at the time of sampling was 1m. This station sampled the ecotone or zone of transition between the reef flat biotope and the biotope of limestone mounds. The station is located in the vicinity of the reef crest and is exposed to impinging surf; the substratum at this station is more typical of that found on coral reefs being comprised of sand, rubble and some live coral. In this area rubble is the dominant substratum type. Overall, coral coverage averages about 3 percent and macrothalloid algae have a mean coverage of about 1 percent. Several individual Porites lobata coral heads were seen in the area whose diameters exceeded 1.2m. Table 5 presents the quantitative information gathered at Station 6. Six coral species were found in the quadrat survey having a mean coverage of 2.6 percent. The most common coral species was Porites lobata. Interestingly, one colony of the coral Porites (Synaraea) convexa was in the census area; this species is not often encountered in the shallows of Oahu's south shore. Eight algal species were in the transect area having a mean coverage of 1.3 percent. The most common limu species was Avrainvillea amadelpha. The most abundant exposed macroinvertebrate was the green sea urchin (Echinometra mathaei); also seen was one small he'e or octopus (Octopus cyanea). Three species of fishes (4 individuals) were censused and the o'opu (Asterropteryx semipunctatus) was the most common. In the vicinity of this station were seen hinalea lau'wili (Thalassoma duperrey), ma'i'i'i (Acanthurus nigrofuscus), o'ili'uwi'uwi (Pervagor spilosoma), moa (Ostracion meleagris), black sea cucumber (Holothuria atra), soft coral (Palythoa tuberculosa), black sea urchin (Tripneustes gratilla), wana (Echinothrix diadema), white sea urchin (Pseudoboletia indiana) and the corals Psammocora (Stepanaria) stellata and Porites evermanni.

Biotope of Limestone Mounds

Seaward of the reef crest and reef flat biotope affronting the Maunalua Bay Beach Park is the biotope of limestone mounds. This biotope commences about 900m from shore in about 3.5m of water and extends seaward at least an additional 300m to a depth of 6m or more. This biotope is characterized by low mounds or patches of emergent limestone substratum that ranges in size from 10 x 15m to more than 30 x 80m. These patches are spaced from 30 to over 100m apart being separated by sand.

Benthic communities in this biotope are not well developed; little shelter or cover is available for motile forms and the scoured appearance of much of the limestone suggests that occasional wave energy must move sand over much of the limestone abrading sessile forms. A number of coral species were seen in the biotope including Porites lobata, Pocillopora meandrina, Montipora verrucosa, M. patula and Cyphastrea ocellina but

Table 5. Summary of the benthic survey conducted at Station 6 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 2 to 3 m; mean coral coverage is 2.6% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Algae					
Sporolithon erythraeum	2				
Mesophyllum mesomorphum			0.1		
Porolithon onkodes				0.2	
P. gardineri				0.5	
Avrainvillea amadelpha	1	0.7	0.5		
Dictyota divaricata			0.1		
Amphiroa fragilissima		0.1	0.1		
unidentified Cyanophyta sp.			0.2		1
Soft Corals					
Anthelia edmondsoni			0.1	0.1	0.75
Corals					
Porites lobata	4			0.1	7
P. (Synaraea) convexa				0.3	
Montipora flabellata		0.5			
Pocillopora meandrina				0.25	
P. damicornis				0.1	
Pavona varians				0.5	
Sand	48				2
Rubble	45	98.7	98.9	97.95	89.25

B. 40-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	1
Rubble	99

C. Invertebrate Census (20x4 m)

Species	Number
Phylum Mollusca	
Octopus cyanea	1
Conus lividus	1
Phylum Echinodermata	
Echinometra mathaei	94

D. Fish Census (20x4 m)

3 Species
4 Individuals
Diversity (H')=0.69

coverage does not exceed 4 percent. Macroalgae are present but coverage is less than 8 percent. Where shelter is found in this biotope, fishes may also be seen. One interesting observation made during the survey of fish communities in this area is the high frequency of encounter with moray eel species which may be related to the scant shelter available for these normally cryptic species.

Station 7 was established to sample the biotope of limestone mounds. This station was located about 1.2km offshore of the park and about 150m WSW of the "Blinker Bouy" marking the entrance channel to the Hawaii Kai marina in 3.3m of water. The station was conducted on a emergent limestone mound approximately 100m in length and 45m in width with the long axis oriented parallel to shore. Sand isolates the limestone and the next closest emergent hard substratum is more than 60m away. Table 6 presents the results of the quantitative survey conducted at Station 7. Four species of corals were found in the quadrat survey and mean coverage was estimated at 3.2 percent with both Porites lobata and Pocillopora meandrina being about equally common. The most important alga at this station at the time of sampling was the red coralline, Sporolithon erythraeum. The most abundant invertebrate species in the census were the green sea urchin (Echinometra mathaei) and the black sea urchin (Tripneustes gratilla). Twelve species of fishes were found in the fish census and the most common species were the damselfishes, Chromis ovalis and C. vanderbilti. In the vicinity of this station were seen the humuhumu hi'u kole (Melichthys vidua), 'alo'ilo'i (Dascyllus albisella), manini (Acanthurus triosetgus), palani (A. dussumieri), pualu (A. mata), kihikihi (Zanclus cornutus), damselfish (Stegastes fasciolatus), moano (Parupeneus multifasciatus), toby (Canthigaster jactator), 'ulae (Synodus binolatus), lau wiliwili (Chaetodon miliaris), hinalea 'aki lolo (Coris gaimard), wrasse (C. venusta), puhi 'oni'o (Gymnothorax meleagris), puhis (G. eurostus, G. petelli and Gymnomuraena zebra), puhi kapa (Echidna nebulosa), snake eel (Uropterygius tigrinus), limu (Botryocladia skottsbergii), sea cucumber (Actinopyge mauritiana) and one Porites lobata coral head that was approximately 2m in diameter. Also seen in the vicinity of this station was one small (estimated straightline carapace length of 35cm) green sea turtle (Chelonia mydas).

Channel Floor Biotope

The channel floor biotope is restricted to the areas where channels bisect the reef flat biotope. Porbabaly years ago smaller channels existed approximately where they do today and were created by the discharge of low salinity water from Kuapa Pond, Paiko Lagoon and Kuliouou Stream into the reef environment. Dredging has undoubtly increased the physical size of these channels and impacted the extant biota. The communities of the chan-

Table 6. Summary of the benthic survey conducted at Station 7 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 5 m; mean coral coverage is 3.2% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Algae					
Sporolithon erythraeum	2	1		2	12
Porolithon onkodes	1				
P. gardineri			4	0.5	
Corals					
Porites lobata	1		3	0.75	2
Pocillopora meandrina	1.5	2	0.5	2	0.1
Montipora patula			2		0.5
M. verrucosa				0.5	0.1
Sand	5	4	4		
Rubble		25			
Hard Substratum	89.5	68	86.5	94.25	85.3

B. 40-Point Analysis

Species	Percent of the Total
Algae	
Sporolithon erythraeum	4
Corals	
Porites lobata	1
Pocillopora meandrina	1
Sand	2
Rubble	7
Hard Substratum	85

C. Invertebrate Census (20x4 m)

Species	Number
Phylum Annelida	
Loimia medusa	3
Phylum Echinodermata	
Echinothrix calamaris	1
Echinostrephus aciculatum	2
Tripneustes gratilla	20
Echinometra mathaei	57
Holothuria atra	1

D. Fish Census (20x4 m)

12 Species
52 Individuals
Diversity (H')=1.89

nel floors are extremely depauperate, residing on or in a substratum of very fine mud of terrigenous origin that may be more than 1m in thickness. Invertebrates occasionally seen in this disturbed habitat include the burrows of the shrimp, Alpheus mackayi and occasionally the burrows of larger crab species (?? Thalamita integra, Scylla serrata, Portunus sanguinolentus or Podophthalmus vigil??). These larger burrows occur in estimated densities from $1/100m^2$ to $1/350m^2$; in no cases were the inhabitants seen. Few fishes are encountered in this biotope but as noted above, tilapia (Tilapia melanotheron), kaku (Sphyraena barracuda), and pua (presumably Mugil cephalus) may be seen along the channel edges on the reef flat and occasionally small papio (Caranx melampygus and Carangoides orthogrammus) are caught by fishermen there. It should be noted that no nehu (Stolephorus purpureus) were seen yet they have been seen in the area on previous occasions (personal observation). In other highly disturbed soft sediment biotopes (e.g., between the patch reefs of southern Kaneohe Bay, Smith et al. 1981) the burrows of Alpheus mackayi are often shared by a commensal goby, Psilogobius mainlandii. No Psilogobius were seen in this survey but due to their cryptic habits, the species may have been missed. Poor visibility (10 to 80cm) hampered census work near the channel floor except at Station 8 due to its distance offshore. Five stations (Numbers 2,4,8,9 and 10; see Figure 3) quantitatively sampled the channel floor biotope and only one (No. 8) was situated on sand rather than mud. Besides these stations, a qualitative reconnaissance was carried out in the channel floor biotope near Stations 11 and 12; additionally a short survey was made of the channel floor offshore of the boat ramp at Maunalua Bay Beach Park.

Station 2 was established adjacent to channel marker 7 about 310m from shore in the boat channel. Water depth at this station was 3.3m and the visibility was about 15cm The substratum at this station was a fine terrigenous mud. Table 7 presents the results of the quantitative survey carried out at this station. No fishes, limu or invertebrates were seen at this station or in the vicinity of it. The burrows of Alpheus mackayi occurred in an estimated density of $200/m^2$.

Station 4 also sampled the channel floor biotope. This station was conducted adjacent to channel marker 5 approximately 500m from shore in 4.6m of water. The substratum at this location is fine terrigenous mud and the visibility on the bottom was 10cm or less at the time of sampling. Table 8 details the information collected at this station; no fishes, invertebrates or algae were encountered in this survey but the burrows of Alpheus mackayi occurred in an estimated density of $225/m^2$.

Station 10 was established directly across the channel (to the west) of the previous station. This station was located near

Table 7. Summary of the benthic survey conducted at Station 2 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 3.3 m; mean coral coverage is 0% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Mud	100	100	100	100	100

B. 40-Point Analysis

Species	Percent of the Total
Mud	100

C. Invertebrate Census (20x4 m)

Species	Numbers
Phylum Arthropoda	
Alpheus mackayi burrows	200/m^2

D. Fish Census (20x4 m)

No fishes seen

Table 8. Summary of the benthic survey conducted at Station 4 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 4.6 m; mean coral coverage is 0% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Mud	100	100	100	100	100

B. 40-Point Analysis

Species	Percent of the Total
Mud	100

C. Invertebrate Census (20x4 m)

Species	Numbers
Phylum Arthropoda	
Alpheus mackayi burrows	225/m^2

D. Fish Census (20x4 m)

No fishes seen

channel marker 6 about 500m from shore in 4.5m of water. Underwater visibility at the time of sampling was about 80cm. Table 9 presents the results of the quantitative survey conducted at this station. No macroinvertebrates, fishes or algae were seen in this survey either in the 20 x 4m census area or outside of it. Again the burrows of Alpheus mackayi dominated the substratum and occurred in an estimated abundance of 190/m^2.

Station 9 was carried out adjacent ot channel marker 4 approximately 680m from shore in 4.6m of water. Again the substratum was fine terrigenous mud and the visibility was less than 1m at the time of sampling. Table 10 presents the results of the quantitative survey carried out at this station; no fishes, invertebrates or algae were found at this station either within or outside of the census area. The burrows of Alpheus mackayi occurred in an estimated density of 200/m^2.

Station 8 (Figure 3) was established about 800m from shore next to channel marker 2 in 2.5m of water. The substratum at this location is sand with some terrigenous mud and the underwater visibility was about 2m at the time of sampling. This change in conditions may be related to the distance of this station from land (and the discharge points of freshwater and mud) as well as because of the proximity of wave energy that improves circulation. Table 11 presents the results of the survey carried out at this station. No algae or fishes were seen in this survey but one haole crab (Portunus sanguinolentus) was found. No alpheid shrimp burrows were present probably due to the shifting nature and grain size distribution of the substratum.

A short qualitative reconnaissance of the channel floor biotope in the vicinity of channel markers 11 and 12 as well as in the area affronting the boat ramp was made. As expected, underwater visibility was poor (10 to 30cm), the substratum was comprised of fine terrigenous mud and no fishes, invertebrates or limu were seen. At all sites Alpheus mackayi burrows covered the substratum. These qualitative observations confirm the uniformity of channel floor biotope through most of the Hawaii Kai boat channel.

Station 5 was established approximately 20m east of channel marker 3 about 515m from the shore. At this point the water depth on the adjacent reef flat is about 1m; here the reef flat slopes away to about 3m in depth to the channel floor. Over a linear distance of approximately 70m along the channel edge in this area is a well-developed Porites compressa coral community. The width of the Porites band is about 10m, thus it covers about 700m^2. Within this community coral coverage averages about 50 percent. Biologically the area was judged to be sufficiently different to warrant a more quantitative assessment; Station 5 was established to sample this community. The station sampled an

Table 9. Summary of the benthic survey conducted at Station 10 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 4.5 m; mean coral coverage is 0% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Mud	100	100	100	100	100

B. 40-Point Analysis

Species	Percent of the Total
Mud	100

C. Invertebrate Census (20x4 m)

Species	Numbers
Phylum Arthropoda	
Alpheus mackayi burrows	190/m^2

D. Fish Census (20x4 m)

No fishes seen

Table 10. Summary of the benthic survey conducted at Station 9 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 4.6 m; mean coral coverage is 0% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Mud	100	100	100	100	100

B. 40-Point Analysis

Species	Percent of the Total
Mud	100

C. Invertebrate Census (20x4 m)

Species	Numbers
Phylum Arthropoda	
Alpheus mackayi burrows	200/m^2

D. Fish Census (20x4 m)

No fishes seen

Table 11. Summary of the benthic survey conducted at Station 8 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 2.5 m; mean coral coverage is 0% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Mud	100	100	100	100	100

B. 40-Point Analysis

Species	Percent of the Total
Sand/Mud	100

C. Invertebrate Census (20x4 m)

Species	Numbers
Phylum Arthropoda	
Portunus sanguinolentus	1

D. Fish Census (20x4 m)

No fishes seen

area with water depths ranging from 1 to 2.5m along the edge of the reef flat and boat channel. At the time of sampling, visibility was about 1m. Substratum at this station was primarily live coral (Porites compressa the dominant species) or limestone. On the channel floor (west of the station) the substratum was mud and on the reef flat to the east it was a mix of muddy sand and rubble.

The results of the quantitative survey carried out at Station 5 are given in Table 12. Two coral species (Porites compressa and P. lobata) were found in the quadrat survey having a mean coverage of 54 percent. The soft coral, Anthelia edmondsoni was also present as was the alga, Halimeda opuntia. Only one macroinvertebrate, the feather duster worm (Sabellastarte sanctijosephi) was encountered in the census and two species of fishes (the o'opu - Asterropteryx semipunctatus and the puhi - Echidna nebulosa) were counted in the 20 x 4m area. In the vicinity of Station 5 were seen the corals (Montipora patula, Pavona varians, Pocillopora damicornis, P. meandrina), limu (Acanthophora spicifera and Avrainvillea amadelpha), black sea urchins (Tripneustes gratilla), o'ili'uwi'uwi (Pervagor spilosoma), toby (Canthigaster jactator), lau'ipala (Zebrasoma flavescens), lau wiliwili nukunuku'oi'oi (Forcipiger flavissimus), wrasse (Labroides phthirophagus), manini (Acanthurus triostegus), puhi laumilo (Gymnothorax undulatus) and kumu (Parupeneus porphyreus).

Casual observations made during the survey work suggest that much of the study area receives heavy recreational use. The boat channels serve as the conduit for boat traffic in and out of the Hawaii Kai Marina as well as servicing the nearby boat ramp; the reef flat area serves as the location for several (up to 5?) jet-ski operators and fishermen occasionally use the shoreline. Surfers use the reef margins both to the east and west of the study site. We noted one commercial operation, a team of akule (Selar crumenophthalmus) net fishermen with a spotter plane unsuccessfully attempt to catch a school of akule just seaward of the reef affronting the Maunalua Bay Beach Park. Further seaward in the biotope of limestone mounds we saw some recreational SCUBA diving activity.

DICUSSION

This survey of the marine communities in the area affronting Maunalua Bay Beach Park has defined three biotopes based on major structural elements. These are the reef flat biotope, the channel floor biotope and seaward of the fringing reef, the biotope of limestone mounds. The quantitative data collected from the 12 stations sampling these biotopes suggest that the marine communities are for the most part, poorly developed and have low diversity. These attributes are typical of marine

Table 12. Summary of the benthic survey conducted at Station 5 affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. Results of the 5 m^2 quadrat sampling of the benthic community present (expressed in percent cover) are given in Part A; a 40-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth 1 to 2.5 m; mean coral coverage is 54% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 1	2	3	4	5
Algae					
Halimeda opuntia		0.5	0.5		
Soft Corals					
Anthelia edmondsoni		1	2.5	1	2
Corals					
Porites compressa	100	2	38	48	74
P. lobata				7	
Mud/Sand		10	3		
Rubble		3	6	5	7
Hard Substratum		83.5	50	39	17

B. 40-Point Analysis

Species	Percent of the Total
Corals	
Porites compressa	52
Mud/Sand	3
Rubble	4
Hard Substratum	41

C. Invertebrate Census (20x4 m)

Species	Number
Phylum Annelida	
Sabellastarte sanctijosephi	8

D. Fish Census (20x4 m)

2 Species
9 Individuals
Diversity (H')=0.24

communities exposed to or impacted by negative environmental influences; environmental perturbation in marine communities frequently results in a reduction in species numbers and a simplification of community structure and function (Brock and Smith 1985).

A summary of the quantitative data collected at the 12 stations examined in this study is presented in Table 13. Overall, only 2 macrothalloid algal species, 4 macroinvertebrate species and 2 fish species were encountered in the average census of 80 square meters of substratum; mean coral coverage was 5 percent. These values are extremely low relative to most Hawaiian marine habitats sampled using the same techniques and suggest that marine communities in the area are severely impacted by low environmental quality.

Sources of environmental perturbation in the study area include the input of freshwater, fine mud of terrigenous origin, and possibly pesticides as well as heavy metals. Also fine carbonate material derived from the reef platform has contributed to the local sediment loading. A perusal of the available literature (WRRC 1973, AECOS 1979) suggests that high sedimentation, and periodic freshwater inudation has been occurring since the commencement of marina construction in 1959. These impacts to the marine communities continue to occur particularly with high rainfall conditions. Perhaps the greatest rainfall related impact to the reef communities affronting the Maunalua Bay Beach Park occurred on 31 December 1987 - 1 January 1988 when the highest sustained rainfall ever recorded on East Oahu occurred. In a 24 hour period approximately 63cm (25 inches) fell on the Koolau mountains in the Hawaii Kai drainage basin. The effect of this storm was excaberated by heavier than usual rainfall during the two weeks preceding the event which probably saturated the soil. The 1 January storm triggered massive erosion in the Hawaii Kai watershed with tons of rock, sediment and personal property being carried to the sea and deposited on the reefs in Maunalua Bay and elsewhere. Some indication of the magnitude and duration of this event and its impact may be derived from the presence of a cell of turbid water approximately 3 miles in length and about 2 miles in width carrying considerable debris derived from land (presumably from Hawaii Kai) that remained in Maunalua Bay for more than 45 days following the storm. During this time, this cell oscillated under tidal influence between Waikiki and Portlock (personal observation).

While sampling the study area in March and April 1988, considerable fine mud up to 40cm in thickness was encountered over much of the inner reef flat. Very few algal or invertebrate species were seen in the mud areas. It appears that the mud and large volume of freshwater that emanated from Kuliouou Stream and the marina as a result of the storm probably severely impacted

Table 13. Summary of the number of fish, invertebrates and algal species in the 20x4 m census area at 12 stations (representing 3 biotopes) affronting the Maunalua Bay Beach Park surveyed in this study. Grand means are presented at the foot of the table.

Biotope and Location	Number of Species: Algae	Invertebrates	Fish	Coral Coverage (%)
Reef Flat				
Station 1	1	5	1	-
3	4	5	2	0.8
6	8	10	3	2.6
11	5	7	4	0.5
12	3	2	1	-
Channel Floor				
Station 2	-	1	-	-
4	-	1	-	-
8	-	1	-	-
9	-	1	-	-
10	-	1	-	-
Limestone Mounds				
Station 7	3	12	12	3.2
Coral Rich Habitat				
Station 5	1	4	2	54
Mean	2.1	4.2	2.1	5.1

marine communities over much of the study area.

In 1975 the U.S. Army Corps of Engineers noted that little biological information was available on the marine communities in the area affronting Hawaii Kai Marina or Maunalua Bay Beach Park (U.S. Army Corps of Engineers 1975). This situation has not changed much since then. The U.S. Army Corps of Engineers (1975) reported that around Paiko Lagoon one could find ghost crabs (Family Ocypodidae) and ama'ama crabs (Graspus graspus); in the lagoon were crabs (Thalamita integra, Charybdis hawaiiensis, Macropthalamus telescopis, Metopograpsus messor), alpheid shrimps, polychaete worms (Marphysa), blennies (Istiblennius gibbifrons), gobies (Bathygobius fuscus), aholehole (Kuhlia sandvicensis), mollies (Poecilia latipinna), mullet (Mugil cephalus), and awa (Chanos chanos). Also noted were a number of marine fishes within the confines of the Hawaii Kai Marina including upapalu (Apogon sp.), ala'ihi (Adioryx diadema), lau'ipala (Zebrasoma flavescens), mane'one'o (Z. veliferum), uhu (Scarus sp.), aholehole (Kuhlia sandvicensis), lae (Scromberoides laysan), hihimanu (Aetobatus narinari) and nehu (Stolephorus purpureus). Presumably these same species were present or would transit through the waters affronting the Maunalua Bay Beach Park. The report mentioned at that time, the bay waters affronting the marina were used for net, spear and pole fishing; opelu and akule fishing also occurred in the area. The only quantitative data presented (i.e., coral coverage and echinoderm abundance estimates) were made in an undefined location in 12m of water off Portlock well outside of the boundaries of the present study.

None of the fish species mentioned in the 1975 study were encountered in the present quantitative surveys. However, qualitative observations made in March 1988 noted 4 of the 15 fish species seen previously. These four species are the aholehole (Kuhlia sandvicensis), mexican molly (Poecilia mexicana not P. latipinna as previously reported), mullet (Mugil cephalus) and awa (Chanos chanos).

AECOS (1979) summarized an earlier study (ECI 1975) of the communities offshore of the Hawaii Kai Marina. This early study found that coral on the shallow reef flat near Koko Marina entrance channel occurred as small colonies (species were Cyphastrea ocellina and Pocillopora damicornis); also present were 6 species of fish (dominant species was the 'omaka or Stethojulis balteata) and the alga, Acanthophora spicifera. Today this area is mostly covered by fine mud and only a few very small colonies of the coral Pocillopora damicornis were seen. The alga Acanthophora spicifera is still found in this area but the 'omaka was absent in this survey.

AECOS (1979) further notes that "The western margin of the large, mud bottom depression inside Ku'i Channel harbors a number of coral species on large boulders. The highest coral cover occurs on a reef spur that projects into the basin. Corals are generally most abundant between 3 and 6 feet deep. Below this the bottom is too heavily silted for coral attachment and growth. Thickets of Porites compressa and large heads of Porites lobata are found on boulders on the bottom. The green alga, Dictyosphaeria cavernosa, has overgrown the lower portions of P. compressa thickets. On the shallow reef flat, only Pocillopora damicornis is common. The soft coral, Anthelia edmondsoni, is abundant on the rubble slope along the western edge of the basin." The reef spur referred to above is the same location sampled at Station 5 where some Porites compressa and P. lobata remain. Over the intervening 13 years the abundance of coral appears to have significantly decreased along the western channel edge. No live corals were found on the boulders mentioned above and no Dictyosphearia cavernosa was seen in this area during the 1988 survey.

As additional evidence of change, AECOS (1979) noted in 1975 that "...an abundance of benthic algae occurs on the shallow platform west of the Ku'i Channel. Algal growth is densest (approaching 100% cover) just behind the reef margin in the surf zone. Codium edule, Halimeda sp., and Enteromorpha sp. are the dominant species. Algal cover declines shoreward from the reef margin, The blue-green alga, Lyngbya sp. is epiphytic on much of the Halimeda. The marine angiosperm, Halophila ovalis is abundant on the silty-sand of the reef flat." Both Stations 5 and 6 in the present study were located near to the area referred to above; 9 algal species were found having a mean coverage of 0.8 percent. If the present stations are representative of the outer reef flat, algal cover has significiantly declined.

With respect to fish, AECOS (1979) stated "At least 53 fish species are recorded -- most associated with the area of high coral cover -- from the western edge of the basin inside of Ku'i Channel. Stethojulis balteata, juvenile Scarus sp., and Thalassoma duperrey are most abundant. Less common are Adioryx lacteoguttatus, Apogon maculiferus, Parupeneus porphyreus, Chaetodon trifasciatus, Dascyllus albisella, Abudefduf abdominalis, Chromis ovalis, Stegastes fasciolatus, Acanthurus nigrofuscus, A. triostegus and Ctenochaetus strigosus." In the April 1988 survey only two fish species were found in the quantitative survey at Station 5 (the same locality as above) and neither were in the previous survey. Eight other fish species were encountered in the vicinity of Station 5 in 1988 and two of these (manini - Acanthurus triosequs and kumu - Parupeneus porphyreus) were recorded in the 1975 work. In the approximate location of Station 6 (present survey) AECOS (1979) found "...only 12 fish species ...Stethojulis balteata and Thalassoma duperrey are the most abundant. Fishes are probably limited by the lack of cover and strong surge...". In 1988, three fish species were seen, one of which (the 'omaka - Stethojulis balteata) was seen 13 years earlier at this location. AECOS (1979) noted that the black sea urchin (Tripneustes gratilla) and the coral, Porites lobata were at this station in 1975; in 1988 both were also recorded.

In the biotope of limestone mounds AECOS (1979) reported that 7 coral species were present. The two most common species were Pocillopora meandrina and Porites lobata. The report also notes that the black sea urchin (Tripneustes gratilla), green sea urchin (Echinometra mathaei) and wana (Echinothrix diadema) were also in the area. The 1988 survey conducted at Station 7 in the biotope of limestone mounds found 4 coral species with a mean coverage of 3.2 percent and the same two species were most important in terms of coverage. Also present were 4 species of sea urchins. Changes in this biotope appear to have been less over the years probably due to the distance away from potential sources negative impacts (i.e., along the shoreline).

These comparisons suggest that considerable change has occurred in the marine communities shoreward of the Maunalua Bay fringing reef. These changes are manifested as significant decreases in species numbers and coverage probably in response to a lessening of water quality characteristics. The changes may have occurred gradually since the time of the 1975 study or they may have been abrupt as a result of the January 1988 storm. The significant decrease in corals along the western edge of the entrance channel and the lack of any evidence of recently killed corals suggests that these changes have been chronic in nature and ongoing for some time. Irrespective of how they have occurred, the result is the same: the extant marine communities affronting the Maunalua Bay Beach Park are poorly developed and the community structure suggests a highly disturbed environment.

Project Impacts Due to Dredging

If the proposed ferry system is developed to service Hawaii Kai, some dredging of the present entrance channel will be required; also dredging of a turning basin adjacent to the shoreline will be necessary. It is expected that approximately 60,000 cubic yards (45,875m^3) of material will be removed. This will result in the direct loss of benthic communities residing in the area slated for removal; in the proposed turning basin, benthic communities are poorly developed and thus little impact is forseen. The widening of the entrance channel could impact the existing live coral at Station 5 (Figure 3) if the western channel edge is considered for removal. Based on the presence of this coral and the need to probably remove less material from the eastern side, it is recommended that the entrance channel widening be restricted to the eastern side of the channel. Once the material is removed, it is to be dumped at the EPA approved dump site approximately 7 miles offshore of Honolulu alleviating potential impacts in the vicinity of Maunalua Bay created by the disposal of this material.

Dredging will disturb the soft sediment deposited on the reef flat and on the channel floors, thus high turbidity conditions may be expected during this activity. Marine communities within the fringing reef are presently subjected to considerable turbidity. During the April 1988 survey, underwater visibility was often less than 30cm. Apparently, high turbidity has existed for some time in this area (WRRC 1973, ECI 1975, AECOS 1979) and in the inner bay areas, most extant species appear to be those with high tolerance to mixohaline water and low water transparency. Many of the invertebrate species encountered in the inner reef area are species known to be suspension or filter feeding forms (sponges, polychaetes, etc.). These heterotrophic forms are known to be common in areas receiving high particulate loading resulting in turbidity (Brock and Smith 1985). The high turbidity may explain the lack of algae below about 1.5m in depth within the fringing reef margin.

Dredging will temporarily increase the size of the area impacted by high turbidity. Based on current studies, it is expected that dredging during trade wind conditions will result in a plume of turbid water that will move seaward under the influence of the wind. Once offshore, the turbid water will be diluted and advected out of the area. When little or no wind is blowing and dredging is occurring, transport of the plume will be minimal with tide generated currents moving the plume. During periods of ebbing tide, the turbid water will be transported offshore and to the east and during flood tide, it will move into the marina. Potential impacts due to turbidity could be greatest on benthic communities seaward of the reef margin in the biotope of limestone mounds. However within the boundaries of the present survey, benthic community development in the biotope of limestone mounds does not appear to be diverse or particularly high in species numbers. Benthic community structure and coral coverage increases somewhat with greater depth offshore (personal observations), but as the turbidity plume is carried seaward, dilution due to mixing and advection occurs, lessening any potential impact.

Project Impacts On Fishing

The development of the Hawaii Kai ferry system could impact the quality of fishing that may occur in the area affronting the Maunalua Bay Beach Park and the Hawaii Kai Marina. During construction impacts on fishing quality could potentially occur due to increased noise and turbidity. Daily, the area presently receives high noise input from boat traffic and jet-ski operations. This suggests that the impact on noise on fishing may be negligable over present levels of impact during construction but turbidity levels are expected to increase during this period.

Following the completion of the construction phase, turbidity levels should return to conditions approximating the present. As noted above, the inshore area is presently quite turbid and any fish or invertebrate of commercial or recreational fishing interest, will be species tolerant of existing conditions. Thus following completion of the project, any species that is presently targeted by fishermen in the area should be present. It should be noted that during the field work no evidence of fishing in the inner reef area was noted; this may be related to the high level of use that this area receives from jet-ski operators and to the high degree of habitat degradation that has occurred in these inshore areas.

A highly variable relationship exists between the creation of new surfaces in benthic communities, algal growth and ciguatera in resident reef fishes (Randall 1958). New surfaces for algal colonization in coral reefs may be brought about by dredging, construction or by storms denuding reef surfaces. The mechanisms involved with the development of ciguatera are not well known and in some cases, dredging has not resulted in a ciguatera problem (Bagnis 1973). The organism identified as being responsible for the disease is Gambierdiscus toxicus; environmental monitoring for G. toxicus can be conducted and it may provide a margin of safety for individuals consuming fishes from areas following extensive man-induced disturbance. Other ways that are being developed to alleviate the problem include use of the "poke stick" test to test if the flesh of individual fish has ciguatoxin and if a person is afflicted with the disease, to administer mannitol which shows promise in alleviating the symptoms.

Project Impacts On Paiko Lagoon Waterbird Sanctuary

The only remaining waterbird habitat along the Maunalua Bay coast is found at Paiko Lagoon about 450m to the west of the proposed ferry turning basin. The lagoon is a valuable feeding and resting area for the aeo or Hawaiian Stilt (Himatopus mexicanus knudseni) and has been designated as a wildlife sanctuary and refuge despite declines in the numbers of aeo using the site in recent years (AECOS 1979). The State of Hawaii improved the habitat in 1972 by limited dredging and constructing nesting islets in the lagoon. The lagoon is surrounded by dwellings on the landward (mauka) border and along the proximal part of the peninsula that forms part of the lagoon perimeter. Because Paiko Lagoon is one of the few easily accessible waterbird sanctuaries, several studies have been conducted there (Lum 1970, Allen and Lum 1972, Shallenberger 1977).

With the construction and operation of the intra-island ferry at Maunalua Bay Beach Park, potential impacts could impinge on the Paiko Lagoon waterbird sanctuary. One possible impact could be noise, but as mentioned above, considerable noise is presently generated in the area affronting the park by watercraft and jet-skis. Another impact could arise from increased turbidity levels in Paiko Lagoon generated by nearby dredging. The increased turbidity could impact the food supply of the birds. However, the lagoon has a net seaward flow of water because of a freshwater spring feeding into it, suggesting that the net transport of particulate material would be out of the lagoon. Additionally, the lagoon is presently a mud basin thus forage species are those able to survive in this substratum type. This suggests that any additional turbidity, if it were to occur, will not affect the present forage base.

Project Impacts on Whales and Turtles

Offshore and about 500m west of the blinker bouy marking the Hawaii Kai boat entrance channel is a well-known green sea turtle (Chelonia mydas) resting area. This site is known as "Turtle Canyon" and is located in water between 9 to 11m in depth (Balazs et al. 1987). Dive tour operators take their clients to this location. Balazs et al. (1987) note that the site is apparently used by juvenile turtles. One small turtle was seen in the present survey approximately 250m to the east of "Turtle Canyon".

Further offshore, humpback whales (Megaptera novaeangliae) are frequently seen. This endangered species migrates to the Hawaiian Islands each November and remains in island waters for calving and breeding through April when it migrates north (Shallenberger 1979). During the whale "season" humpbacks transit through Maunalua Bay usually inside of the 100 fathom isobath. The NMFS has maintained a list of sightings in Maunalua Bay for the last 3 or 4 years; this qualitative data has been compiled from sightings that have been made from a Wailalae Iki vantage point (Mr. J. Naughton, NMFS, personal communication). The data show consistent sightings of whales in Maunalua Bay from January though April.

Research in Maui attribute declines in nearshore whale abundance to boat traffic (Glockner-Ferrari and Ferrari 1987) but the correlation has not been positively established. Considerable boat traffic transits through Maunalua Bay at the present time.

Impacts that may occur with the construction of the ferry docking facility that could impact whales and green sea turtles include the generation of noise particularly due to blasting. Complete mitigation with respect to whales and blasting may be achieved by curtailing blasting during the months of April through October. To our knowledge no data exist showing impacts (positive or negative) with noise and the presence of green sea turtles.

Once clear of the entrance channel the route of ferry is presently unknown. However, the presence of green sea turtles thoughtout Maunalua Bay and offshore of Waikiki in waters less than 40m and the seasonal occurrence of humpback whales further offshore suggests that some thought be given to the route of the ferry. To avoid these endangered species, it is recommended that on exiting the Hawaii Kai channel, the ferry move directly seaward until well offshore prior to steering to the west and maintain a course that remains well offshore. Such a course will keep the rapidly moving ferry well away from divers in Maunalua Bay. A last recommendation might be on entering the Hawaii Kai channel that the speed of the ship be considerably slowed to reduce the propagation of waves that could erode the edges of the channel producing turbidity particularly during periods of low tide.

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APPENDIX I

Results of the quantitative 20x4 m visual fish censuses conducted at the 12 stations affronting the Maunalua Bay Beach Park, Hawaii Kai, Oahu. No fish were observed at stations 2, 4, 8, 9 and 10, therefore these stations have been omitted. Numbers in the body of the table are counts of individual fishes. Totals and a diversity index (H') are given at the end of the table. Depths measured during the 12 surveys range from 0.5 to 5 m.

FAMILY and Species	STATION 1	3	5	6	7	11	12
ACANTHURIDAE							
<u>Acanthurus</u> <u>triostegus</u>						1	
<u>Acanthurus</u> <u>nigroris</u>					3		
APOGONIDAE							
<u>Foa</u> <u>brachygramma</u>						2	
BALISTIDAE							
<u>Rhinecanthus</u> <u>rectangulus</u>					1		
<u>Rhinecanthus</u> <u>aculeatus</u>					1		
BLENNIIDAE							
<u>Plagiotremus</u> <u>ewaensis</u>					1		
CIRRHITIDAE							
<u>Cirrhitus</u> <u>pinnulatus</u>					2		
GOBIIDAE							
<u>Asterropteryx</u> <u>semipunctatus</u>	3	3	8	2		13	4
LABRIDAE							
<u>Stethojulis</u> <u>balteata</u>				1	8		
<u>Thalassoma</u> <u>duperrey</u>					11		
<u>Macropharyngodon</u> <u>geoffroy</u>					2		
MONACANTHIDAE							
<u>Pervagor</u> <u>spilosoma</u>		1			1		
MURAENIDAE							
<u>Echidna</u> <u>nebulosa</u>			1			1	
POMACENTRIDAE							
<u>Chromis</u> <u>vanderbilti</u>					9		
<u>Chromis</u> <u>ovalis</u>					12		
<u>Plectroglyphidodon</u> <u>johnstonianus</u>					1		
TETRAODONTIDAE							
<u>Canthigaster</u> <u>jactator</u>				1			
Total Number of Species	1	2	2	3	12	4	1
Total Number of Individuals	3	4	9	4	52	17	4
Diversity (H')	0	0.35	0.24	0.69	1.89	0.62	0

APPENDIX F
TRAFFIC ASSESSMENT

MAUNALUA BAY FERRY TERMINAL
TRAFFIC IMPACT ASSESSMENT FOR
INTERSECTION OF KALANIANAOLE HIGHWAY AND KEAHOLE STREET

Kalanianaole Highway is a principal arterial, a State highway linking Kailua to Honolulu via Makapuu Point. Keahole Street is a four-lane primary accessway to Hawaii Kai from Kalanianaole Highway. A channelized left-turn storage lane and separate left turn signalization is available for westbound traffic on Kalanianaole Highway to turn into the park and boat launching area where the ferry terminal will be sited. This left turn movement is currently restricted from 5:00 to 8:30 AM, except on Saturdays, Sundays and holidays.

To determine the nature of traffic related impacts of the proposed project, the signalized intersection of Kalanianaole Highway and Keahole Street was qualitatively assessed for potential traffic congestion and hazards. The assessment is based on a prior study prepared for Kaiser Development Company entitled Hawaii Kai Transportation Management Study and Hawaii Kai Transportation Management Study Intersection Analysis Worksheets (prepared by Wilbur Smith and Associates September 3, 1985). The study identified future travel needs within the Hawaii Kai community and along the Kalanianaole Highway corridor between Hawaii Kai and Interstate Route H-1. Increased travel anticipated from additional residential and commercial development within Hawaii Kai, other new developments identified in the East Honolulu area, and increased tourist/recreational travel along Kalanianaole Highway was reflected in this study which assessed traffic conditions in the year 1994. The study recommended implementation of a transportation program including ridesharing measures to encourage increased use of buses, vanpools and carpools, and roadway modifications to provide sufficient capacity at traffic bottlenecks.

At the Kalanianaole Highway/Keahole Street intersection, the Hawaii Kai Transportation Management Study projected that by 1994, left-turn movement from Kalanianaole Highway to Keahole Street could exceed intersection capacity during the evening peak hour of traffic if no mitigation measures were implemented. To alleviate this condition, the study recommended the addition of a second left turn lane along Kalanianaole Highway for eastbound traffic turning onto Keahole Street. Development of this second left turn lane is presently proceeding. Operation of the intersection during the 1994 morning peak hour of traffic is not anticipated to exceed capacity. Based on these findings, operation of the intersection is not anticipated to exceed capacity in the year 1994, exclusive of ferry terminal development.

The Hawaii Kai Transportation Management Study did not specifically consider development of the ferry terminal which is projected to be operational in 1989. Based on the study, however, a traffic assessment assuming the operation of the ferry terminal anticipates that it will not increase traffic to a level which would exceed the capacity of the Kalanianaole Highway/Keahole Street intersection. The primary anticipated traffic impact of the project will be a redistribution of traffic at the intersection. The ferry terminal is not anticipated to generate a significant volume of "new" traffic inasmuch as ferry users during the peak hour are assumed to consist primarily of commuters who would otherwise enter the subject intersection to travel along Kalanianaole Highway if the project were not developed.

Among ferry users whose associated traffic pattern would be redistributed without the likelihood of exceeding intersection capacity are residents of Hawaii Kai, Kalama Valley and Portlock, both east and south of the ferry terminal area, who normally commute along Kalanianaole Highway through the Keahole Street intersection, and residents who live in the Hawaii Kai area north of the intersection who normally commute along Keahole Street and Kalanianaole Highway. Instead of continuing along their normal route, ferry users would be diverted to the ferry terminal. Drivers who would drop-off these ferry users are assumed to return to residences or visit commercial establishments in Hawaii Kai and are likely to travel in traffic lanes opposing the flow of peak traffic, i.e., eastbound along Kalanianaole Highway and northbound along Keahole Street during the morning peak hour. Thus, they would not contribute significantly to the primary flow of traffic. The anticipated redistribution of traffic associated with ferry users who reside south, east and north of the intersection of Kalanianaole Highway and Keahole Street is shown in Table 1.

Ferry users whose associated traffic may increase projected traffic volumes are residents of Kuliouou and Niu Valley or other areas west of the subject intersection who would not normally use the Kalanianaole Highway/Keahole Street intersection. These ferry users would generate additional traffic along Kalanianaole Highway at the intersection, however, their traffic pattern would be opposite the primary flow of morning and afternoon traffic and, therefore, should not contribute significantly to the primary flow. If these ferry users are dropped off at the ferry terminal, traffic would probably be added to the primary traffic flow direction along Kalanianaole Highway as drivers return to residences. This additional traffic is not anticipated to be of a volume which would result in a major adverse impact at the intersection of Kalanianaole Highway and Keahole Street.

Adverse traffic impacts along Kalanianaole Highway are not anticipated as a result of development of the proposed project. Assuming operation of the ferry system at capacity during the morning and evening peak traffic hours, a reduction in traffic along Kalanianaole Highway may be anticipated. While additional traffic would be generated by residents who live west of the ferry terminal, the reduction in traffic associated with residents who live north, east and south of the ferry terminal is anticipated to exceed generated traffic and result in a net decrease in traffic along Kalanianaole Highway. It is also noted that drivers returning to residences in the Kuliouou and Niu Valley areas west of the ferry terminal are anticipated to travel only a short distance along Kalanianaole Highway to return to these residences.

The State of Hawaii, Department of Transportation, Highways Division is planning the addition of two traffic lanes along Kalanianaole Highway for

TABLE 1

ANTICIPATED REDISTRIBUTION OF TRAFFIC AT THE INTERSECTION OF KALANIANAOLE HIGHWAY AND KEAHOLE STREET

MORNING PEAK TRAFFIC HOUR

Traffic Movement Without Project	Traffic Movement With Project
Right Turn from Keahole Street to Kalanianaole Highway	Southbound Through at Keahole Street to Ferry Terminal
Westbound Through Along Kalanianaole Highway	Left Turn from Kalanianaole Highway to Ferry Terminal

EVENING PEAK TRAFFIC HOUR

Traffic Movement Without Project	Traffic Movement With Project
Left Turn from Kalanianaole Highway to Keahole Street	Northbound Through at Keahole Street from Ferry Terminal
Eastbound Through Along Kalanianaole Highway	Right Turn from Ferry Terminal To Kalanianaole Highway

high occupancy vehicles (HOV) in the roadway median between the Interstate Route H-1 freeway and Hawaii Kai. These improvements would extend east past the intersection of Kalanianaole Highway and Keahole Street. Construction of improvements in the vicinity of the subject intersection is planned to begin in 1991. It is noted that traffic congestion may be anticipated during construction of these improvements in the vicinity of the subject intersection. Upon completion of construction, however, operation of the intersection can be anticipated to improve.

To assure that traffic flow is facilitated and to minimize potential hazard at the Kalanianaole Highway/Keahole Street intersection, the following measures should be considered:

- Remove restriction on left turn movement from Kalanianaole Highway into the site.
- Provide left turn signalization for traffic proceeding from the site onto Kalanianaole Highway.
- Modify signing and striping along Kalanianaole Highway and Keahole Street.
- Adjust traffic signal indication timing.