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Revised

ENVIRONMENTAL IMPACT STATEMENT

HONOKOHAU HARBOR

20 November 1975

For OEQC

DEPARTMENT OF TRANSPORTATION
STATE OF HAWAII

Prepared By

Harbors Division

REVISED
ENVIRONMENTAL IMPACT STATEMENT

ADMINISTRATIVE ACTION

for

DEVELOPMENT OF HONOKOHAU BOAT HARBOR, HAWAII

THIS STATEMENT FOR IMPROVEMENT WAS DEVELOPED IN ACCORDANCE WITH THE ENVIRONMENTAL IMPACT STATEMENT REGULATIONS, STATE OF HAWAII, AND IS SUBMITTED PURSUANT TO:

Chapter 343
Hawaii Revised Statutes

Nov. 10, 1975
Date

Melvin E. Lepine
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11/11/75
Date

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Director

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GRAPHICS

HONOKOHAU SMALL BOAT HARBOR

ENVIRONMENTAL IMPACT STATEMENT

for

completion of the harbor

(Revised 20 November 1975)

Introduction

The purpose of this EIS is to provide public disclosure of the environmental consequences of completing the construction of Honokohau Harbor, just north of Kailua-Kona.

The existing first increment of the harbor was completed in 1970. Developed water and land areas total about 20 acres. The State Department of Transportation now proposes the completion of the harbor to meet the boating needs of the area to year 2010. Water and land areas will total about 65 acres. Incremental construction is planned.

Summary of Environmental Impact

The harbor is near the southern boundary of a National Historic Landmark of some 1000 acres which is rich in historic/archeolog-ical sites. Accordingly, a major concern is the visual impact which the harbor facilities will have on adjacent areas wherein preservation is planned for archeological/historic sites. The harbor will not physically encroach on any such sites of significant value.

Completion of the harbor will serve as a catalyst to resort and residential development in the Kona districts. Unless there are adequate controls on the scale and pace of such development, there is concern about threats to life-style of some area residents as an indirect social impact of the harbor.

Because of the large volume of seaward groundwater flows (1½ to 2 mgd), the harbor has and will continue to have exceptionally good flushing. Pollutant levels in the harbor water are very low. There is good mixing and dilution at the interface with the ocean. Completion of the harbor will have negligible impact on the high quality of coastal water in the vicinity.

As beneficial impacts, harbor completion will broaden opportunities for enjoyment of the outstanding fishing grounds of the Kona Coast and will result in additional community income to this area which relies heavily on tourism.

Alternatives include no expansion, partial expansion, southerly expansion, and other harbor locations.

I. PROJECT DESCRIPTION

The initial increment of Honokohau Harbor was created in 1970 by blasting and excavating a section of the southern shoreline of Honokohau Bay.

A. Location

The harbor is located about 3 miles northwest of the center of Kailua-Kona, and about 4 miles southeast of the airport at Keahole Point. See Figures 1 & 2

B. Objectives

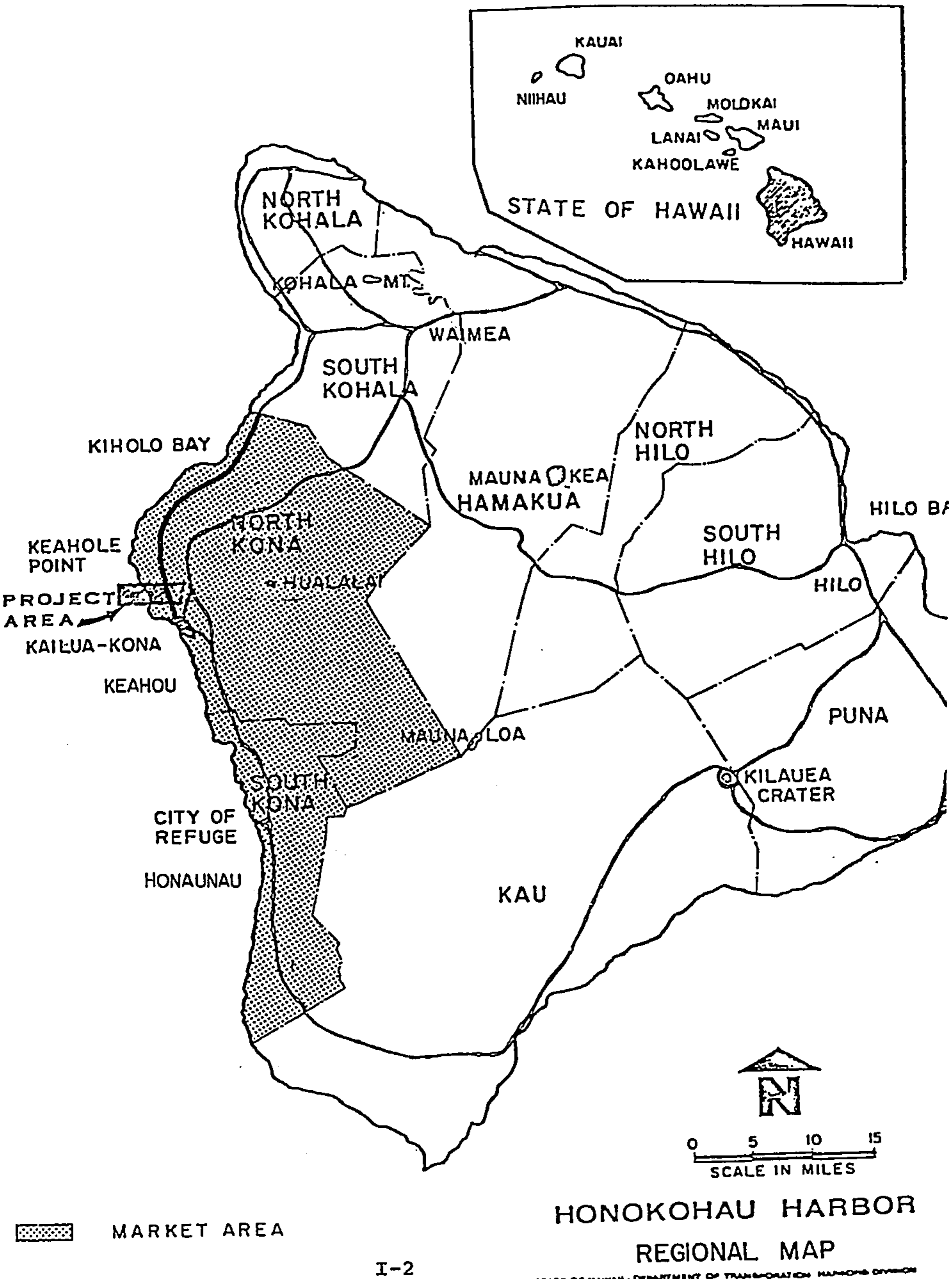
The objectives of the project discussed in this EIS are to complete the Honokohau Small Boat Harbor to meet boating needs of the area to the year 2010, to do so in a manner compatible with other planning in the area, with due regard for environmental concerns as well as economy.

C. Summary Characteristics of the Project

Details are given in Section IIa - Environmental Setting

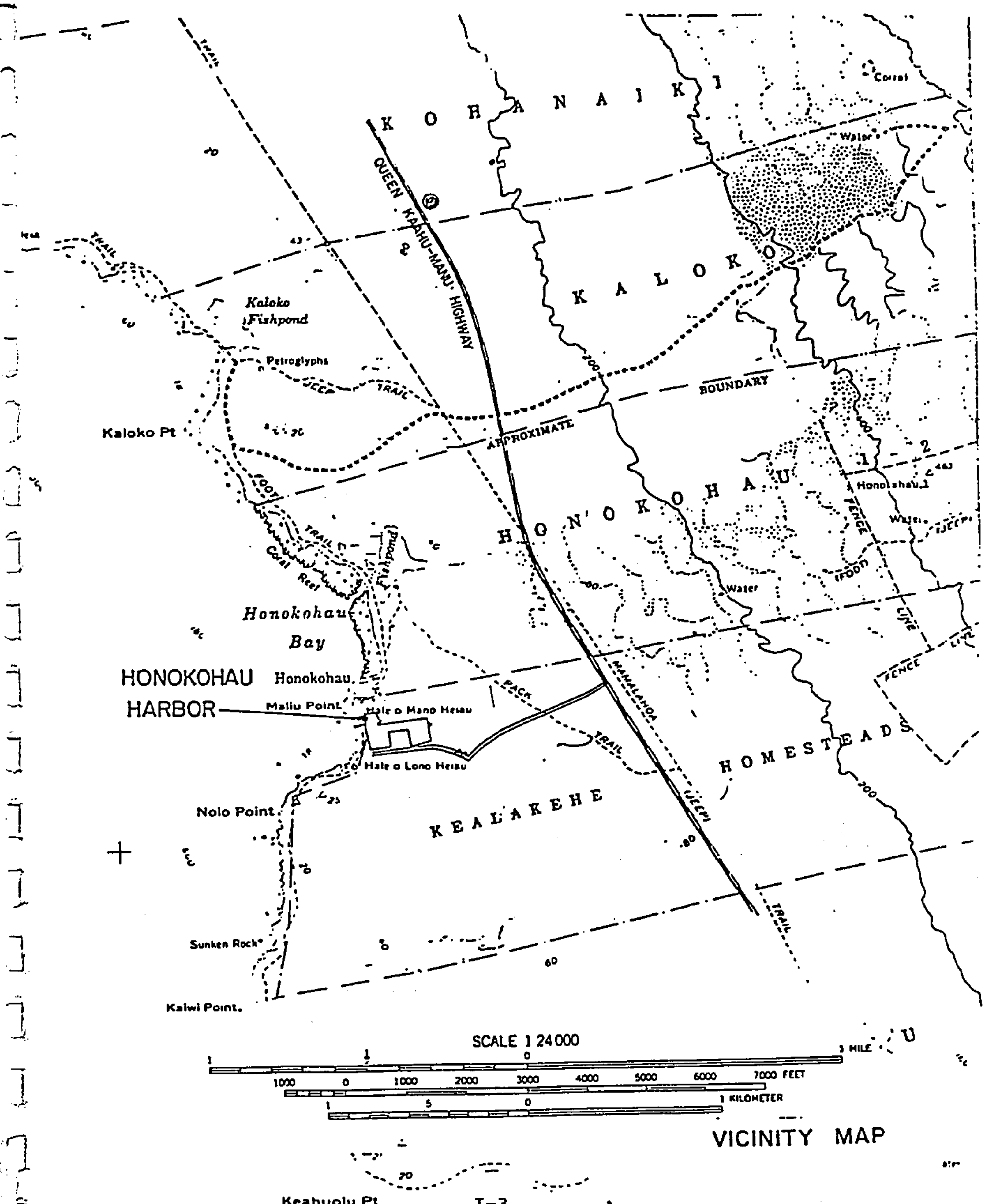
1. Technical

Figure 3 depicts ultimate development of the harbor as proposed in a December 1970 plan prepared for the State Department of Transportation Harbors Division by Daniel Mann Johnson & Mendenhall.



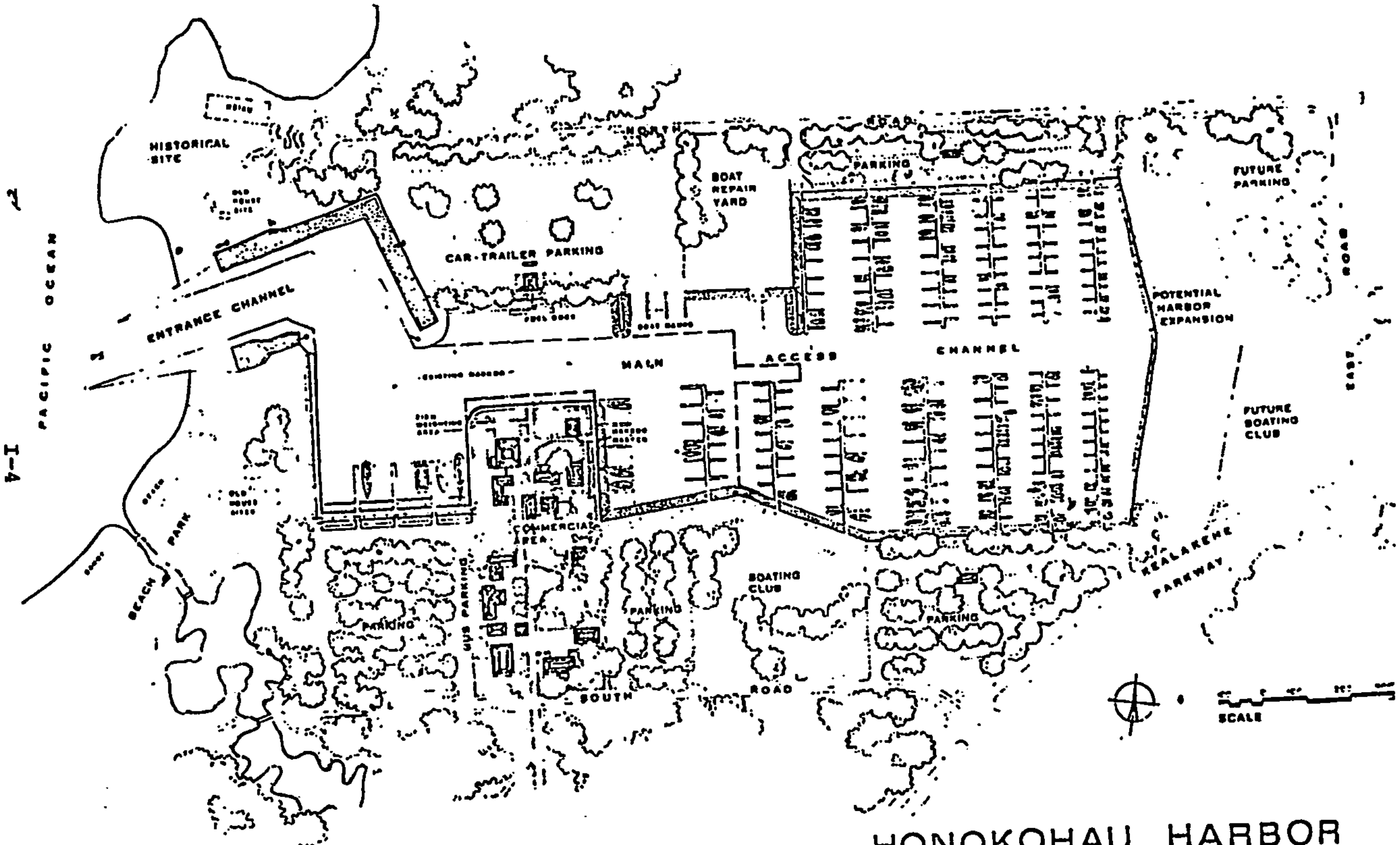
HONOKOHAU HARBOR
REGIONAL MAP
STATE OF HAWAII · DEPARTMENT OF TRANSPORTATION HARBORS DIVISION
DANIEL, MANN, JOHNSON & MENDENHALL

FIGURE 1



VICINITY MAP

FIGURE 2



HONOKOHAU HARBOR
DEVELOPMENT PLAN

STATE OF HAWAII DEPARTMENT OF TRANSPORTATION HARBORS DIVISION
DANIEL, MANN, JOHNSON & MENDENHALL

FIGURE 3

Key features of the harbor include:

- Slips for approx. 450 boats
- Launch ramps to accommodate 350 launchings/day at peak
- Boat Repair facilities
- Fueling dock
- Fish weighing stations & tournament area
- Administration office & meeting rooms
- Parking for cars & car/trailers
- Restrooms
- Space allowances for commercial facilities & boating club(s). (Clubs to be in non-exclusive facilities)

Water area requirement is about 25 acres. Adjacent shore facilities, including roads, require about 40 acres.

Subsequent to the 1970 plan, it has been determined that petroglyphs of archeological value in an area north of the main access channel should be preserved. A major 1973-74 study of historical/archeological resources in the adjacent areas by the Honokohau Study Advisory Commission has also been conducted since preparation of the 1970 plan. Reports were published in March 1975 by the National Park Service - Department of Interior.

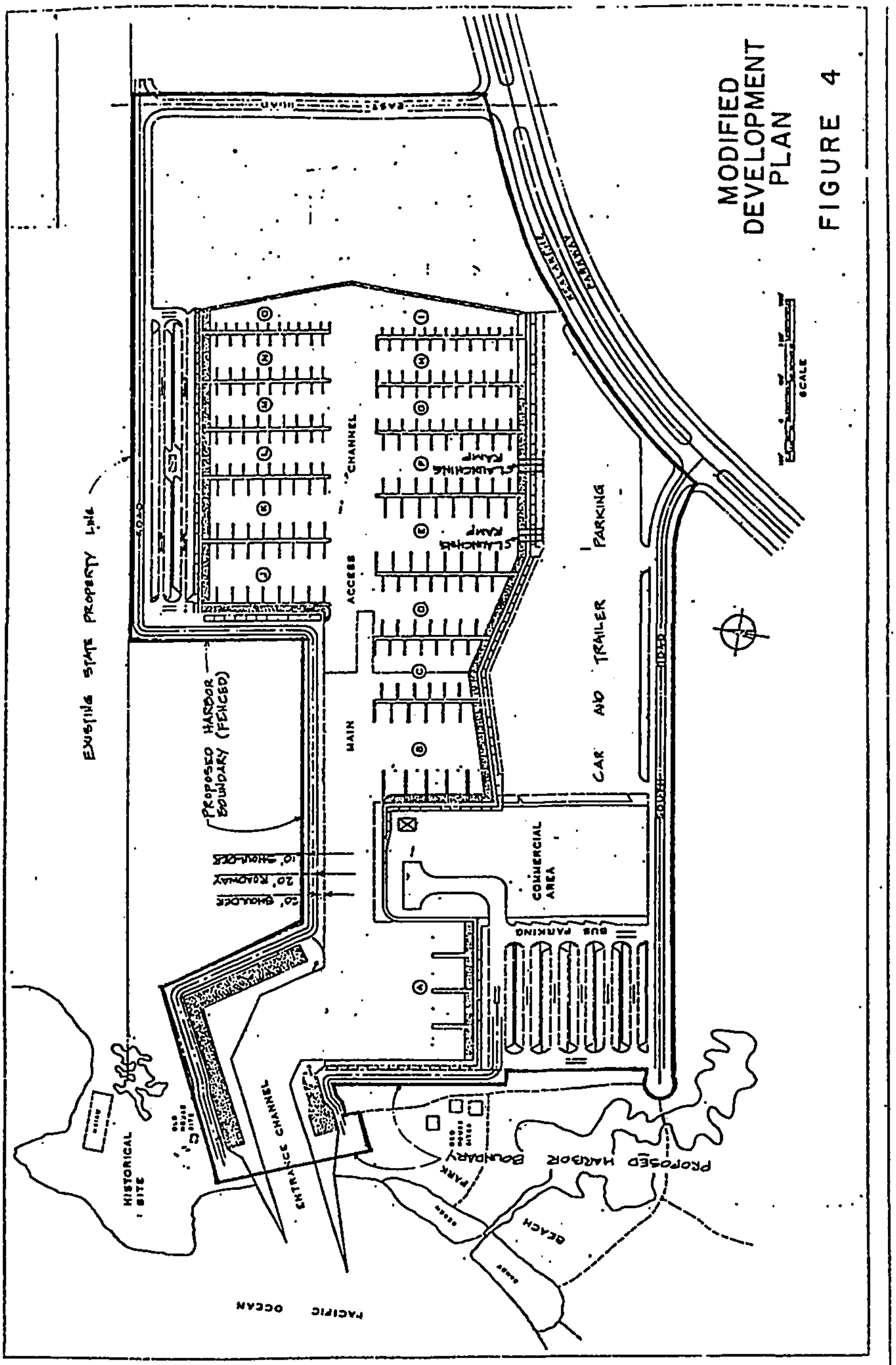
There have also been subsequent revisions of population forecasts.

In view of the above events, it is recognized that some modification of the 1970 plan will be required. Alternatives are discussed in Section VIII of this EIS. Exact dimensions, locations, specifications, etc. for the selected alternate must await subsequent detailed design efforts. Figure 4 is a proposal for modification submitted recently by Harbors Division to minimize impacts on the petroglyph field. This configuration is currently favored by the State Department of Transportation.

2. <u>Economic Factors</u> - See Environmental Setting - Sec. II
3. <u>Social Factors</u> - See Environmental Setting - Sec. II
4. <u>Environmental Factors</u> - See Environmental Setting - Sec. II

D. Public Funds

It is proposed to use State appropriated funds for excavation and dredging, berthing facilities, launch ramps, roads, utilities, and restrooms. The remainder of the facilities may be provided by either State funds or private funds (on lease basis) or some combination. At 1975 price levels, roughly $12,000,000 will be required for completion of basic facilities. A balance of $2,400,000 is presently available from prior State appropriation.



MODIFIED DEVELOPMENT PLAN

FIGURE 4

E. Phasing & Timing

Subject to acceptance of this Environmental Impact Statement, the obtaining of clearances related to the National Historic Landmark, and other approvals required by Public Law 92-346 by late 1975, it is proposed that design work for the next increment of the harbor be finished by fall of 1976. That increment will consist primarily of excavation/dredging (to the extent of available funds) plus an additional launch ramp. Construction of that increment is proposed for completion in 1977.

F. Summary Technical Data

An Archeological Reconnaissance Survey of the harbor area (including adjacent areas which might be considered in alternate design/layout schemes) was conducted in March 1975 by the Bishop Museum staff. Appendix A is the report of that survey. The report stresses the importance of nearby historic/archeological sites and the attendant need for aesthetic consideration in design of harbor facilities but concludes that (except for the petroglyph field) there are no sites in the immediate vicinity of the harbor which would preclude its completion as planned.

Much of the work undertaken in order to prepare this Environmental Impact Statement consisted of field measurements at and near the harbor site by the Oceanic Foundation in the spring of 1975. This baseline data, tabulated in Appendix B provides a good insight into harbor characteristics, including present water quality, circulation and current patterns, sediments, chemical and biological factors. The data show that the exceptionally high outflow of clear brackish groundwater (over 1 1/2 million gallons per day) is a dominating influence that effects other harbor characteristics - i.e. exceptional water quality is maintained by the resultant excellent flushing during both flood and ebb tides. The groundwater flow may have seasonal fluctuations corresponding to rainfall. These data obtained during a period of low rainfall indicate that the 1-1/2 mgd calculated flow is conservative.

G. Historic Perspective

Interest in construction of an all-weather small boat harbor for the Kona area during the 1950s spurred interest in a search for the best site.

This culminated in a Preliminary Engineering Report of October, 1960 by R. M. Towill Engineers which stated "all aspects being considered no other site along the Kona coast is as favorable".

Subsequent model testing, together with oceanographic studies resulted in the configuration of the harbor's first increment as it now exists. The U.S. Army District Engineers' Survey Report of 1963 and Design Memorandum of 1968 provided criteria for design. Construction of the existing first increment was completed in 1970. Federal funds were used for the basic navigation and protective features, and State funds for the remainder.

In 1962 a Dept. of Interior survey identified Honokohau Settlement as having national historic significance. The same area was declared eligible for National Historic

Landmark status in 1963. The approximate area of the National Historic Landmark, which includes the harbor site, is shown in Figure 12. No specific boundary has been established.

II. THE EXISTING ENVIRONMENT (SETTING)

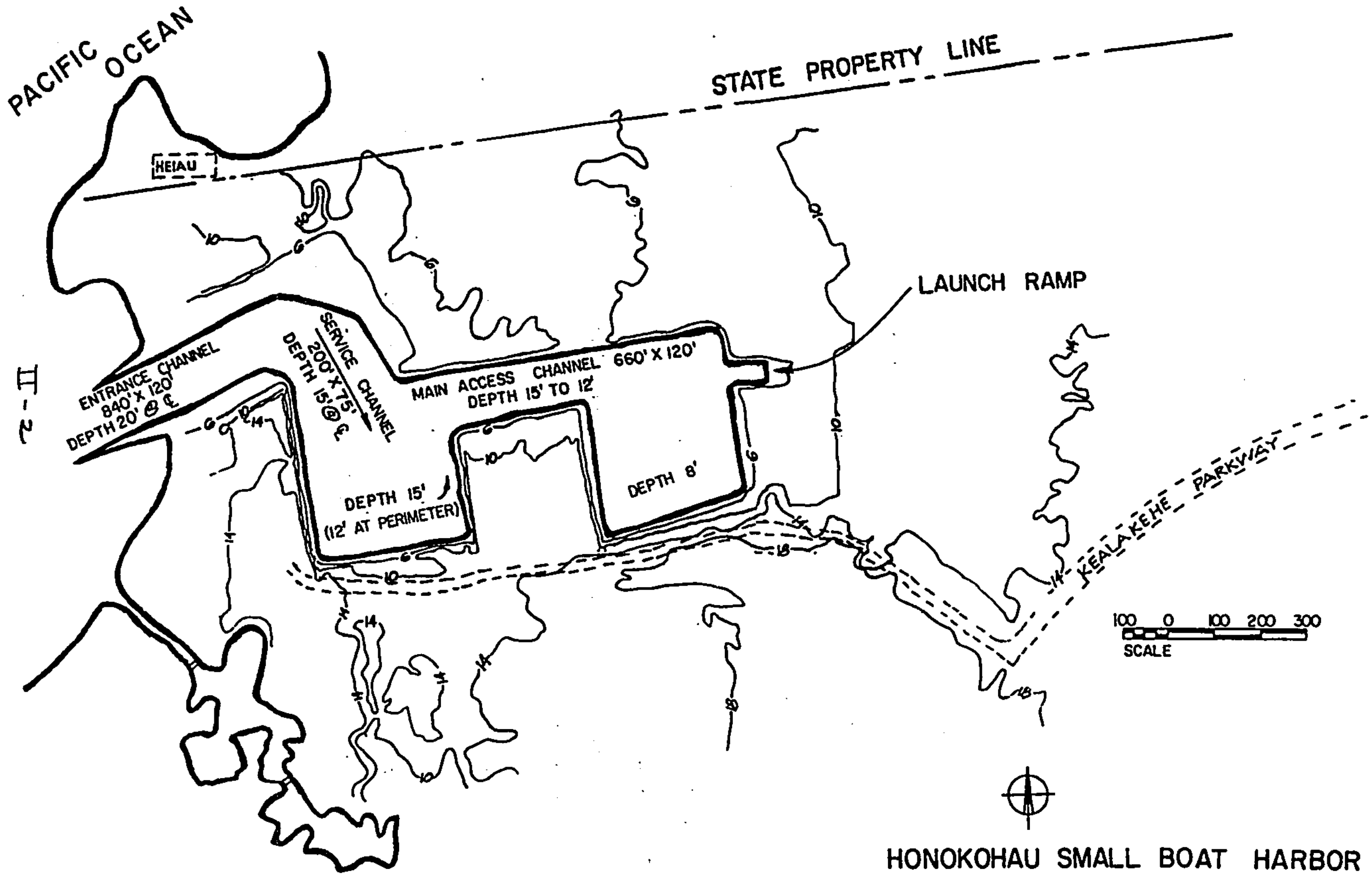
Primary unique environmental resources of this area today include:

ARCHEOLOGICAL/HISTORIC SITES of particular significance in adjacent areas
FISHING GROUNDS nearby which are exceptional
SMALL BOAT HARBOR - initial increment already in existence
AESTHETICS - exceptional views/open space/climate

Figure 5 shows the extent of the harbor as it presently exists. Water area is about 10 acres. Adjacent shore facilities (primarily unimproved parking, comfort station, and unpaved roads encompass another 10 acres. About 50 boats are accomodated with temporary moorings. There is one launch ramp. Figures 6 and 7 show selected 1975 photos of the site.

A. Physical Characteristics of the Project Site & Surrounding Area

1.a <u>Topography</u> - The land around the harbor site is relatively flat, but as seen from the contours in Figure 5, elevations to the south are generally higher than those to the east and north.

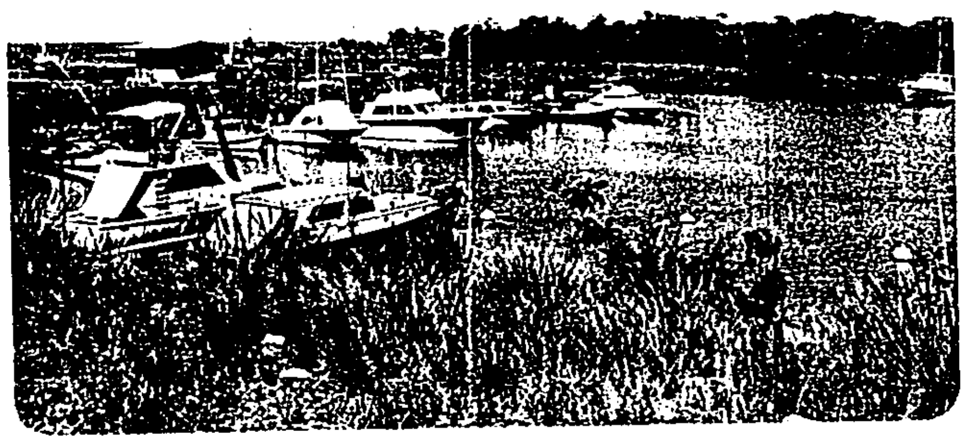


HONOKOHAU SMALL BOAT HARBOR

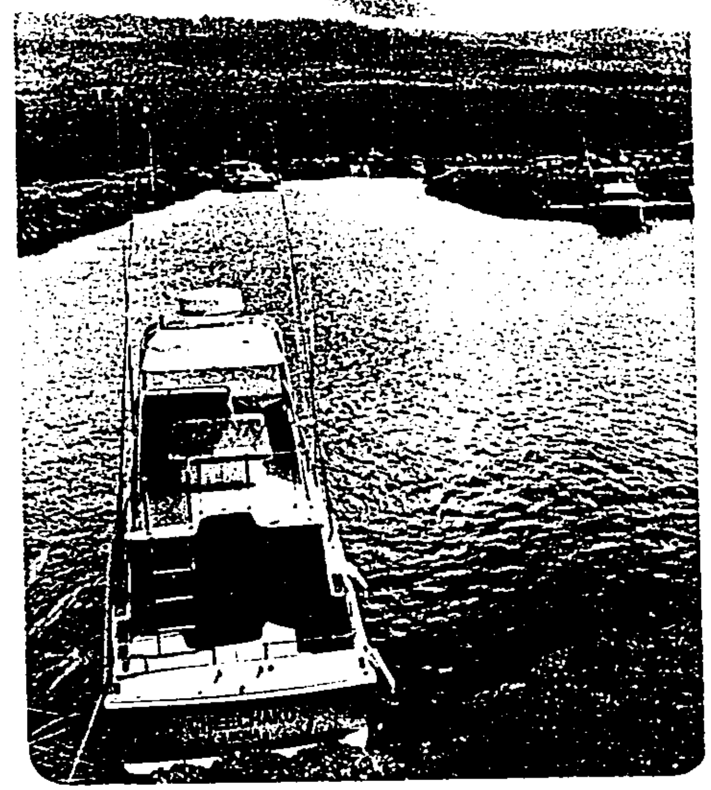
EXISTING LAYOUT

FIGURE 5

LOOKING SEAWARD FROM LAUNCH RAMP



LOOKING NORTHWEST ACCROSS INNER BASIN

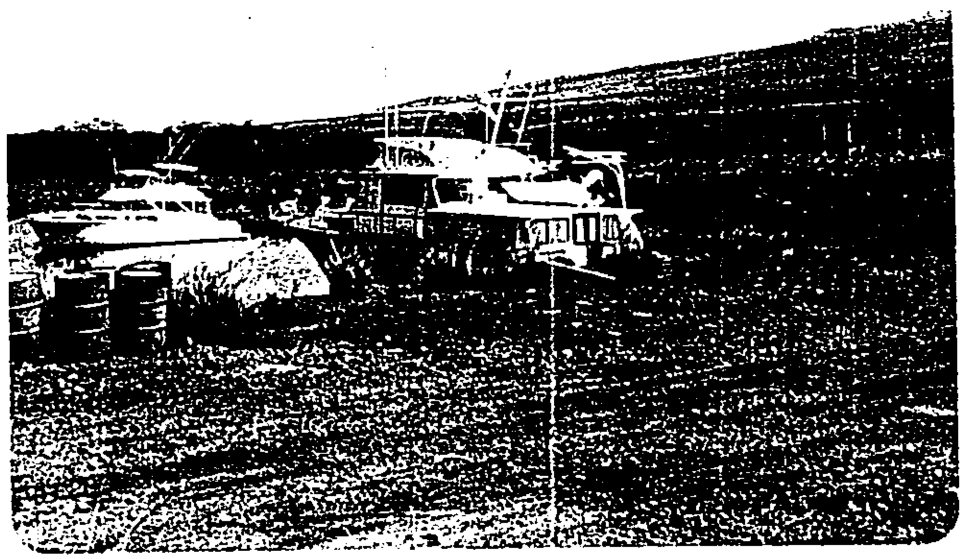


LOOKING INLAND ALONG AXIS
OF MAIN ACCESS CHANNEL

PHOTOS — EXISTING HARBOR

FIGURE 6

LOOKING NORTHEAST ACROSS
INNER BASIN



LOOKING NORTHEAST ACROSS OUTER BASIN

LOOKING DUE SOUTH ALONG WEST WALL
OF OUTER BASIN

PHOTOS – EXISTING HARBOR

FIGURE 7

1.b Geology & Soils - Honokohau Harbor was created in 1970 by blasting and excavation of a section along the southern shoreline of Honokohau Bay. The coastal area is comprised of prehistoric lava flows from the Hualalai Volcano. The lava is pahoehoe dominantly (with interspersed Aa) and is characterized as alkaline olivine basalts (MacDonald and Abbott, 1970). These lavas are highly porous and permeable and commonly contain lava tubes. The area is classified as well drained to excessively drained. The rocks of Hualalai are grouped under the Hualalai Volcanic Series (Stearns & MacDonald 1946). Typically, little soil material exists in the area. Where present the soil is of thin depth, brown to black in color, and may be expected to have high levels of iron and aluminum and low levels of silica and bases which are usually leached away. Soil material falls in the Great Soil Group of "red desert, reddish brown, low humic latisol, lithosol" and is dominantly lithosol (Soil Cons. Service, 1972; Detailed Land Classification, 1965). The slope of the land is generally less than 15%, with slopes less than 1% near the harbor. The area is classified as unsuitable to machine tilling. The Master Productivity Index of the area is less than 30, yielding a Master Productivity Rating of "E" which corresponds to a Land Type Classification of "very poor". (Land Study Bureau, 1965). The harbor site itself is predominantly pahoehoe.

1.c Landforms & Unique Physical Features - Within one to two miles north of the harbor site are Kaloko & Aimakapa fishponds, Aiopio fish trap, and several other brackish water ponds. The brackish ponds are an interesting feature of the entire coast. Their presence is related to the young geologic age of the area. These ponds occur mainly in low-lying lava flows having depressions which are sufficiently deep to extend into the water table. They are depositional features in a'a and fractures or collapsed bubbles in pahoehoe (Maciolek and Brock, 1974).

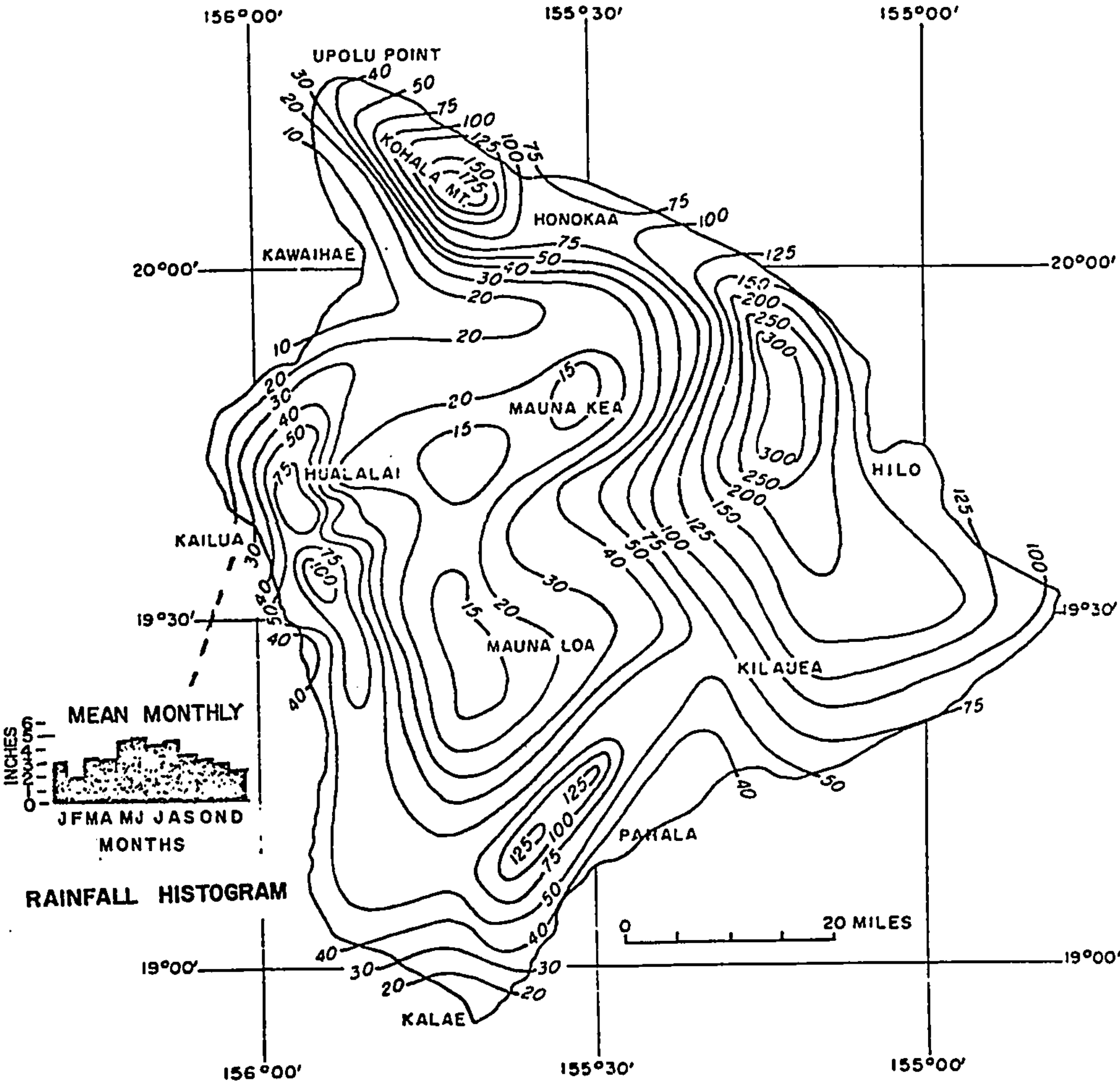
The Honokohau shoreline is predominantly rough lava and rocky in appearance, owing to the geologic recency of volcanic activity which inhibits beach development. Coral formations exist in the bay. The area does not support a "reef" as such; most of the substrate is basaltic rock with a thin veneer of calcium carbonate cover. A small pocket beach lies to the south of the harbor, and a larger sandy beach exists to the north of the harbor in the bay center. The sand reservoir of the area is low and seasonal fluctuations in the amount of beach sand are expected to follow the pattern for the western beaches of Oahu, Kauai, and Molokai (Moberly and Chamberlain, 1964). Beach erosion occurs with the commencement of the winter Kona storms and accretion occurs during the period of northeast winds and waves.

1.d Visual Factors - Except for a few oases of green adjacent brackish water sources, the area inland of the coast for a mile generally appears as a barren desolate landscape to the newcomer. However, the generally rugged shoreline with interspersed coves, the fishponds, the marine life, the adjacent surf, and the contrasting lava masses make an impressive natural setting.

1.e Climate and Meteorology - Climate is extremely mild. Temperatures normally run from 67°F to 83°F with an annual average of 75°F at sea level. There are on-shore breezes during a normal day, which increase to 8 to 10 knots by late afternoon. The Kona Coast is known for its 90 mile stretch of calm water from Upolo Point to South Point.

The isohyetal map (Figure 8) shows that the mean annual rainfall in the Honokohau area is 20-30 inches. Atypical of the general island pattern, only minimal orographic rainfall occurs; this is due to the interception of tradewinds by the volcanic peaks of Mauna Kea, Mauna Loa, and Hualalai. The area is characterized by sunny mornings with cloudy and/or rainy afternoons. At sea level the average temperature is 75°F. Sea breeze circulation, generated by differences in land and water temperatures, causes the majority of rainfall. This type of precipitation, typically spotty and variable in duration and intensity, produces a much higher mean rainfall than other leeward areas. Precipitation is highest in the warmer summer months when the land-ocean temperature difference is greatest. This is illustrated by the monthly rainfall histogram for nearby Kailua shown in Figure 8.

The harbor is exposed to the prevailing winds which are



ISOHYETAL MAP

Distribution of mean annual rainfall, in inches, on the island of Hawaii. Based on period 1931-55, National Weather Service. (Davis and Yamanaga, 1973).

ISOHYETAL MAP
AND
RAINFALL HISTOGRAM

FIGURE 8

predominantly southerly and westerly. A wind rose for the area is shown in Figure 9. In the Kona area, sea to land breezes become the dominant influence because the tradewinds are deflected by the adjacent high mountain masses.

Historically, tsunami waves have reached about ten feet in height along the Kona Coast (Cox, 1961).

1.f The Adjacent Coast and Ocean - The coastal sediments in Honokohau Bay originate mainly from the biological activities of reef building organisms, and to a lesser extent, through coastal erosion and wind. The basaltic composition of the terrain affects the coastal morphology in that the weathering products are chiefly removed from the land surface in solution, suspension, amorphous substances, or finegrained particles, and normally are not deposited in the nearshore environment (Inman, Gayman & Cox, 1963). The rocky headlands of Noio point to the south and Kaloko and Ke-ahole points to the north protect the bay shore from waves approaching from certain directions resulting in lower wave energy within the bay. Wave induced transportation of sediments into deep water and wind transport mainly account for

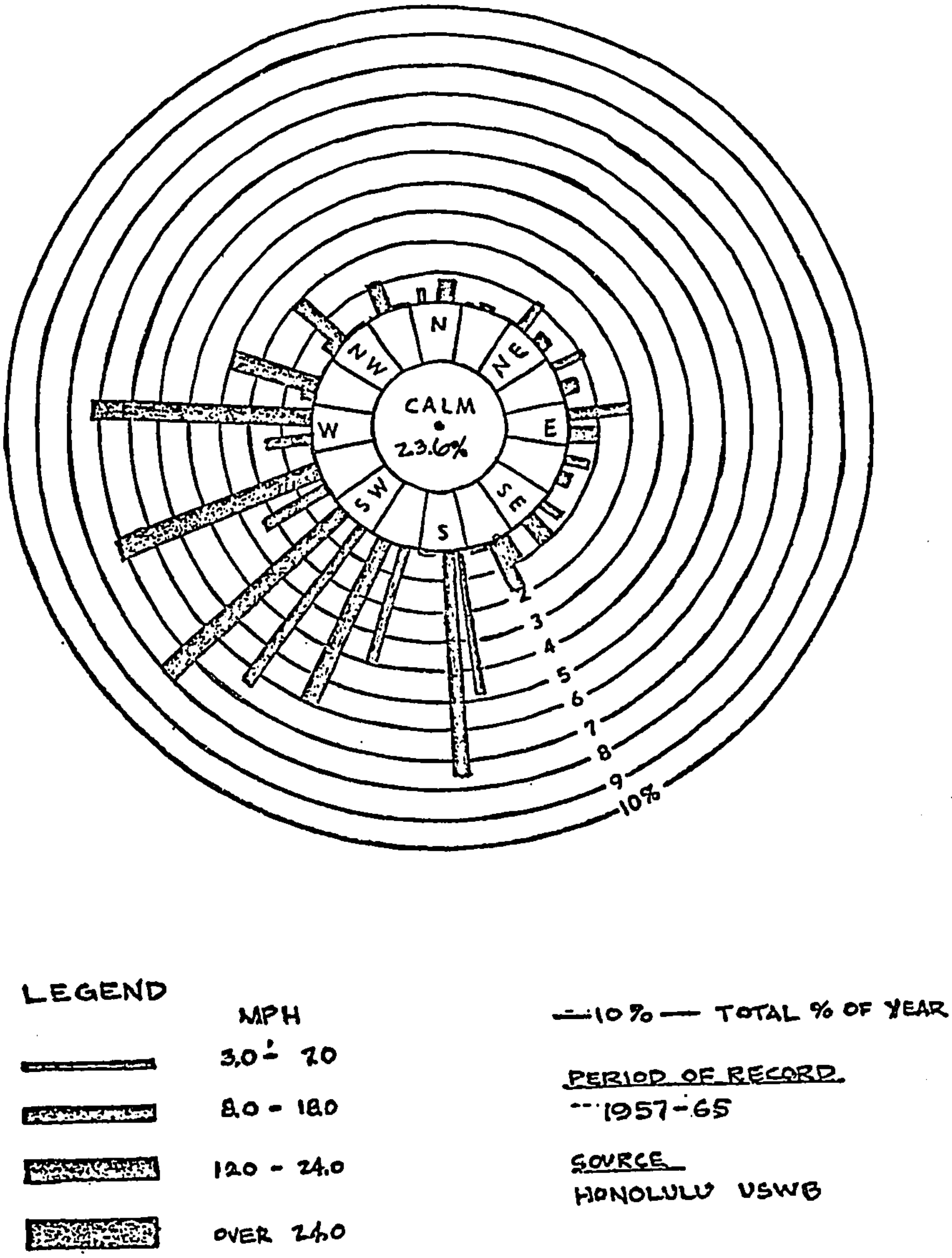


Figure 9 Annual wind rose at Kailua-Kona Airport.

sediment losses from the local beaches. Nearly all of the energy available along the coast for deforming beaches and transporting sediment occurs in the form of ocean waves (Moberly and Chamberlain, 1964). Those most responsible for affecting the Honokohau area are the Kona storm waves which are most likely to occur in late winter and early spring; and waves of the southern swell which are generated by winter storms in the Antarctic affecting Hawaiian seas in summer and early autumn. Kona storm waves commonly have heights of 10-15 feet and 8-10 second periods while the typical southern swell produces 1-4 foot waves with periods of 14-22 seconds (Patzert, 1969).

Offshore currents in the vicinity of Honokohau are best characterized by their extreme variability. Three major factors influence these current patterns. The results are generally unpredictable in an empirical sense. Under certain conditions large-scale ocean circulation exerts an effect on this area by means of the north equatorial current. Locally, seasonal winds passing through the Alenuihaha Channel generate large-scale eddies to the west of the island of Hawaii. These factors in combination with a complex pattern of tidal currents are responsible for the variable current phenomena along the west coast of Hawaii.

2.0 <u>Ground Water Hydrology</u> - Due to the highly permeable substrate and low rainfall, there are no perennial streams near Honokohau. No perched groundwater or dike impounded water is known in the area, certainly not close to shore (Cox et al, 1969; Adams et al, 1969). The greatest groundwater reservoir for the area, and the entire island, is near sea level where fresh water recharge from rainfall accumulates in widespread bodies floating on the slightly heavier seawater(Dept. Land & Natural Res.), 1970). The interface of this dynamic Ghyben-Herzberg system is brackish, resulting from the mixing of fresh and sea water (Wentworth, 1942; Swain, 1973). The basal water is brackish to saline at the shore and for several thousand feet to several miles inland (Davis and Yamanaga, 1968). In dry areas such as Honokohau where freshwater exchange is small and tidal influence is felt, the effect of mixing may extend such that the entire lens is brackish for more than a mile inland (Adams et al, 1969; Dept. Land Nat. Res., 1970). Drilling at Kalaoa well near Ke-ahole showed that the basal groundwater along the North Kona Coast is brackish two to three miles from the shore (Dept. Land & Nat. Res., 1968).

Movement is continuous within the water body as fresh water recharge percolates into the lens at the water table and moves laterally to the sea. The thickness of the brackish lens depends on the magnitude of mixing caused by tides and the variation in recharge (Davis and Yamanaga, 1968). Mixing is greatest near the shore due to the proximity to tidal fluctuations (Adams et al, 1969). Water quality characteristics vary considerably from place to place,due to variations in the mixing extent. The water table gradient in the Honokohau area is approximately 1 foot per mile seaward (Dept. of Land & Nat. Res., 1968).

Continuous freshwater addition via rainfall infiltration and movement down the slope toward the shore necessitates a means of outflow. Most of this groundwater escapes into the sea as diffused flows along the shore, and at a few places it is concentrated in large springs (Fisher et al, 1966). The largest known concentrated flow is into Waiakea Pond in Hilo where the freshwater component of discharge is approximately 100 million gallons per day (Hirashima, 1967). Here the recharge rate via rainfall is much greater than in the Kona area. For comparison, other spring flows are: 10-20 million gallons per day (mgd) at Reeds Bay (Hilo); 25-30 mgd at Ninole Springs (Punaluu); and 10-15 mgd at Kawaa Springs (Dept. of Land and Nat. Res., 1970).

Diffuse groundwater discharge along the shore is a characteristic hydrological feature and has been shown to occur around the entire island (Fisher et al, 1966; Doty, 1968; 1969; Adams and Lippley, 1968; Cov et al, 1969). Experts feel that a substantial part of the island rainfall discharges perennially at the shore. This discharge appears to be most prevalent in embayments, but it is not known if this is a true pattern or if it is only more easily detected in bays because of the reduced wave energy.

The groundwater flux in the Honokohau area is comparatively low because of the small recharge resulting from the generally low rainfall and high evapotranspiration (Cox et al, 1969). The average daily recharge in the wet zone on the west Hualalai slope probably amounts to several tens of millions of gallons per day (Davis and Yamanaga, 1968). Brackish water discharge in the Honokohau shoreline area has been estimated to be a few million gallons per day per mile (Cox et al, 1969). The oceanographic analyses of this report suggest 1.5-2 mgd of brackish water discharge into the present harbor. Figure 10 is an infra-red image depicting thermal anomolies of the groundwater discharge at Honokohau prior to creation of the harbor. Excavation of the harbor has displaced the natural discharge points in the immediate area landward. Thus, groundwater now simply flows out through the harbor prior to entering the ocean.

2.1 <u>Harbor Characteristics</u> - Harbor waters (limited area next to boat docking facilities) are designated as Class B according to State Water Quality Standards. At Honokohau field measurements show the actual water quality in all essential respects to be far better than required for Class B or even for Class A waters (for swimming, diving, aesthetic enjoyment and propagation of aquatic life). The data also show that in the ocean immediately outside the channel entrance, dilution and advection is so high that water quality is virtually the same as in the open ocean.

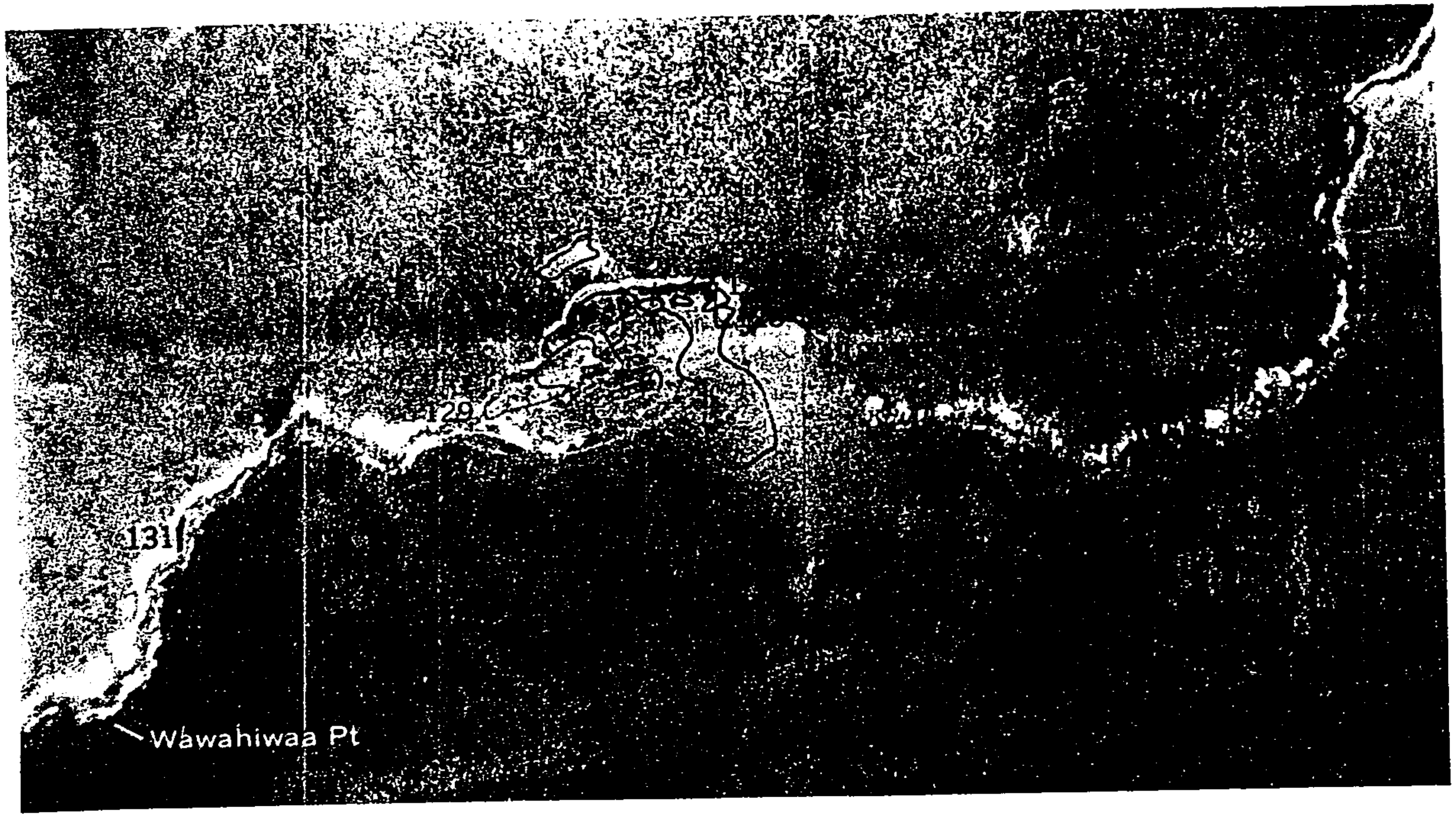


FIGURE 10
INFRA-RED PHOTO
PRIOR TO CONSTRUCTION
HONOKOHAU HARBOR

The physical, chemical, and biological aspects of the harbor aquatic environment are dominated by the inflow of groundwater. Turbidity is low because of the excellent flushing characteristics. Nutrients which enter in the groundwater are high at the surface and low in the subsurface layer. The average residence time of harbor waters is about 12 hours, which represents roughly 6-10 times better flushing than expected without groundwater effects. Honokohau is uniquely better than most harbors in this respect. The existing harbor has been shown to be a suitable environment for phytoplankton and zooplankton (small, suspended plants and animals, respectively), corals, molluscs, echinoderms and fishes. Dilution and advection processes outside the harbor are so high that there is not significant difference from clear open ocean water.

2.11 Physical Oceanography - Field data in Appendix B (p. 7-22) show the details of temperature, salinity, turbidity and dissolved oxygen within the harbor. An outstanding feature of these results is the presence of a cold surface layer lying upon a warm oceanic layer; this is maintained by the continuous inflow of cool brackish water through the harbor walls and floor. Vertical gradients are thus established between the less dense, cool, brackish surface waters and the subsurface oceanic layer (Appendix 8, Figures 2-10). Water temperatures range from 20.5°C at the surface to 24.5°C at the bottom. Salinity data describe a 1-1 1/2 meter surface layer consisting of waters from 18-34 ‰ lying upon the oceanic waters (35 ‰). Vertical, spatial and tidal variations of these parameters are described in Appendix B. Dissolved oxygen levels in the mauka basin ranged from 4.53 ml O_2/l at the surface to 5.83 ml/O_2 near the bottom. In the makai basin oxygen measured 5.44 ml O_2/l at the surface and 5.18 ml O_2/l in the subsurface layer. Oxygen levels in both areas and depths are near saturation concentrations for the existing temperature and salinity conditions. This is an indicator of favorable conditions.
Low turbidity conditions prevail within the harbor as a whole. In the morning, before sunlight triggers biological activity (e.g., phytoplankton turbidity) it is usually possible to see the harbor bottom at all locations. Turbidity results are expressed as "percent transmittance" which is the inverse of turbidity; thus high percent transmittance connote low turbidity and vice versa. Percent transmittance is nearly always greater than 90%,

and values show non-systematic vertical, spatial and tidal turbidity variations within the harbor. This good water clarity is maintained by the persistent outflow of surface ground water (1.5-2 mgd) which serves to continuously flush the harbor. Immediately outside the harbor, turbidity measurements range from 98-99.8 percent transmittance, indicating extremely clear water.

The harbor has an unusual two-layered current circulation pattern which produces excellent flushing. The pattern is caused by the groundwater which rises through and mixes with water from the lower layer, producing a large volume of surface water which continually flows out of the harbor. Furthermore, deep water is constantly supplied to replace what has mixed and flowed out at the surface. In this way, an effective pumping action is created which draws deep water into the mauka basin. This pattern of deep inflow and surface outflow dominates the circulation and, although modified by the tide, its main features persist throughout the tidal cycle.

The interface of these two layers occurs at about 1.75 meters. During flood tide, the inflow into the back basin is confined to the northern third of the channel and has a mean speed of 2.3 m/min giving a deep inflow rate of 63 m^3/min. At the same time the upper layer outflows across the entire width of the channel at a mean speed of 1.8 m/min, giving an outflow rate of 122 m^3/min. The tidal volume of the inner basin increases at

12 m^3/min under these conditions and the budget calculation thus gives a rate of 71 m^3/min for brackish water input in the back basin.

In the outer harbor during flood tide, water in the lower layer enters at a mean rate of 153 m^3/min. A small part of this (19.3 m^3/min) raises the tidal level of the outer harbor. Mixing has the net effect of moving deep water up into the surface layer at a rate of 70.5 m^3/min. In the surface layer there is a flux from the inner basin of 122 m^3/min; as it traverses the outer harbor its volume is increased by net exchange from the lower layer so that 192.5 m^3/min flows out through the harbor entrance channel. The mean surface outflow speed is 3.7 m/min, and the deep inflow speed is 0.9 m/min.

During ebb tide, the outer harbor develops a stronger recirculation pattern. Subsurface water flows into the back basin at 135 m^3/min and the bulk of this (119.7 m^3/min) is resupplied within the outer harbor by a net exchange from the upper layer. Budget calculations indicate a very small subsurface outflow (3.2 m^3/min) through the entrance channel. Outflow speeds in the entrance channel at ebbing tide are 3.8 m/min for the upper layer and 0.02 m/min in the lower layer.

The net flow through the back basin is about ten times what it would be if it were caused by tidal action alone, and the net exchange for the entire harbor is over six times larger than would be produced solely by the tides. The resident times of the various harbor regions are all about 12-13 hours.

For the most part, sediment depth within the harbor ranges from 1-25 cm. Both the entrance and interconnecting channels show a very thin ($\leq$ 5 cm) sediment cover, probably as a result of more rapid currents in these areas. On the floor of the mauka basin rocky outcroppings predominate, separated by isolated sediment pockets about 10 cm deep. Sediment in the makai basin which support large mollusc communities are similar in depth to the mauka basin but also show isolated deep pockets or mounds in the southerly region. Sediments are fine black pumice throughout the entire harbor and appear to be residuals of ground lava rock. Comparison with earlier measurements, which described a sediment range of 5-20 cm, suggests that the sediment load has not changed dramatically in the past five years. The existing sediment load appears to be largely the result of initial blasting activities which created the harbor. Other comparatively small amounts of sediment may be derived from the large urchin population (which scrapes the basaltic rocks during feeding), input along with the groundwater incursions and wind. The sediments have low organic content, ranging from 0.79-2.81% (by weight), and values show no distributional trends about the harbor. These basaltic-silt sediments found within the harbor were not found in adjacent areas outside the harbor, indicating that if these sediments are exiting from the harbor they are rapidly voided from the nearby coast via natural processes. During the Spring 1975 field measurements in the harbor, divers observed a substantial quantity of bottom debris from boaters, including beer cans, debris from fish cleaning, etc. Complete results of the comprehensive survey of harbor sediment characteristics are given in Appendix B (p. 57-78)

2.12 Chemical Oceanography - Nutrient (nitrate and phosphate) levels within the harbor are related to the influx of groundwater and show high surface levels and low subsurface values. Surface nitrate and phosphate levels averaged 1.67 mg/l and 0.185 mg/l, respectively; and subsurface values were 0.042 mg/l and 0.024 mg/l, respectively. Nitrate and phosphate levels outside the harbor were 0.028 mg/l and 0.019 mg/l, respectively. Ammonium levels were low in all cases (ca. 0.010 mg/l) and showed no relationship to the groundwater intrusion. Thus the subsurface harbor waters appear to meet the nutrient specifications for A and perhaps AA waters, while the surface waters, due to natural hydrological processes, do not conform to Class B nutrient requirements. However, due to the high harbor flushing rates, these nutrients pass on to the ocean without causing adverse effects. This is confirmed by the 1975 field data on biological oceanography. The waters outside the harbor appear to satisfy the nutrient criteria for Class AA waters. Details of nutrient abundance and distribution are given in Appendix B (p 80-93). The pH and alkalinity of the harbor waters were similar to values recorded in the adjacent coastal waters (8.15 and 2.24 m-eq./l, respectively).

2.13 Biological Oceanography - Mean rates of primary productivity within the harbor range from 0.33-5.24 $mgC.m^{-3}.hr^{-1}$. These rates are low for harbors in general and compare favorably with values for open coastal environments. These low values are maintained largely by the harbor's rapid flushing capacity. Details of the vertical, spatial and temporal variations of primary production are given in Appendix B (p. 105-108).

Phytoplankton biomass within the harbor is also low and ranges from 0.06-0.70 mg chl $\underline{a}.m^{-3}$. This measure is a main component determining turbidity. The phytoplankton standing stock is maintained at these low levels, in the face of abundant plant nutrients, by the processes of flushing and grazing by zooplankton. Biomass is maximum in the 2.5-4.5 meter level, below which levels are similar to those of the adjacent coastal ocean. Vertical, spatial, temporal and seasonal variations of phytoplankton biomass are discussed in Appendix B (p. 98-105).

The biomass of zooplankton which are small animals, many of which feed directly upon the phytoplankton, are given by two measures: dry weight and individual density. Zooplankton biomass in the makai basin is $5.54\ mg \cdot m^{-3}$ or 501 individuals$\cdot m^{-3}$, and in the mauka basin levels are $32.63\ mg \cdot m^{-3}$ or 5744 individuals$\cdot m^{-3}$. Densities in the makai basin are similar to those found in the adjacent coastal ocean while levels in the mauka basin show a distinct increase over open coastal values. Details given in Appendix B (p. 108-114).

Coral communities show continued trends of increasing density, average size, diversity and zonation. The average coral density as of 1973 was 2.66 colonies/m^2, and the largest colonies showed maximum diameters of between 16-20 cm. Corals are most numerous on the harbor walls adjacent to the entrance channel. Details given in Appendix B (p. 129-136).

As of 1973, the makai basin had the greatest diversity (85 species) of mollusks (e.g. oysters) and echnoids (e.g. urchins). Sixty species of micromollusks were found in the outer basin sediments. Mean urchin density ranged from 10-24/m^2 and the micromollusk abundance in the sediment was about 2.1/cm^3. The channel assemblages resembled those of the outer basin but had fewer species. In the inner the mean urchin density was 21 m^2; there were few micromollusks in the sediment; and oyster cover on the walls ranged up to 100% cover. Details given in Appendix B (p. 122-125).

Upward trends of abundance and diversity of fish populations are apparent within the harbor. Fish recruitment in the outer harbor is by sub-adults and adults, and in the back harbor by juveniles primarily. In the outer basin 37 species of fish comprised of 337 individuals were recorded, and in the inner basin 25 species comprised of 142 individuals were recorded in the 1973 survey. Details are given in Appendix B (p. 125-129).

With respect to bacteriology, the harbor waters are far better than the required state standards for Class A waters, as shown by the total and fecal coliform data (Appendix B (p. 114-120). Two independent sets of total coliform results show harbor levels ranging from 0-553/100 ml; the majority of these values were below 70/100 ml. Fecal coliform densities ranged from 0-165/100 ml and 0-22.2/100 ml on the two surveys and in each case the high end of the range is due to a single sample. Mean fecal coliform levels were less than 5/100 ml. Bacterial levels tended to be higher in the brackish surface layer.

The discharge from the harbor restrooms is located near the basins, and this is apparent in the field measurements. Accordingly, there should be continued monitoring of harbor water quality.

3.0 Air - Although the Kailua-Kona area is subject to inversions, the air quality in the vicinity of the harbor is so close to pristine that there is no apparent reason for concern.

4.0 Noise - There are no unusual noise sources at or near the harbor and the distances to any proposed human activity make it unlikely that noise could be a significant environmental problem due to normal harbor activities.

5.0 Marine & Terrestial Biology - The Kaloko-Honokohau Park EIS (p. 38) has a comprehensive description of fauna and flora in the area, which includes plant cover of Christmas berry shrub, foxtail grass and a scattering of kiawe trees on the lands not actually barren. Waterfowl and shorebirds are present, particularly at Aimakapa and the other ponds to the north. In the adjacent shoreline areas and nearby ponds there is abundant marine life.

II.B LAND USE, INFRASTRUCTURE, AND RELATED PLANNING

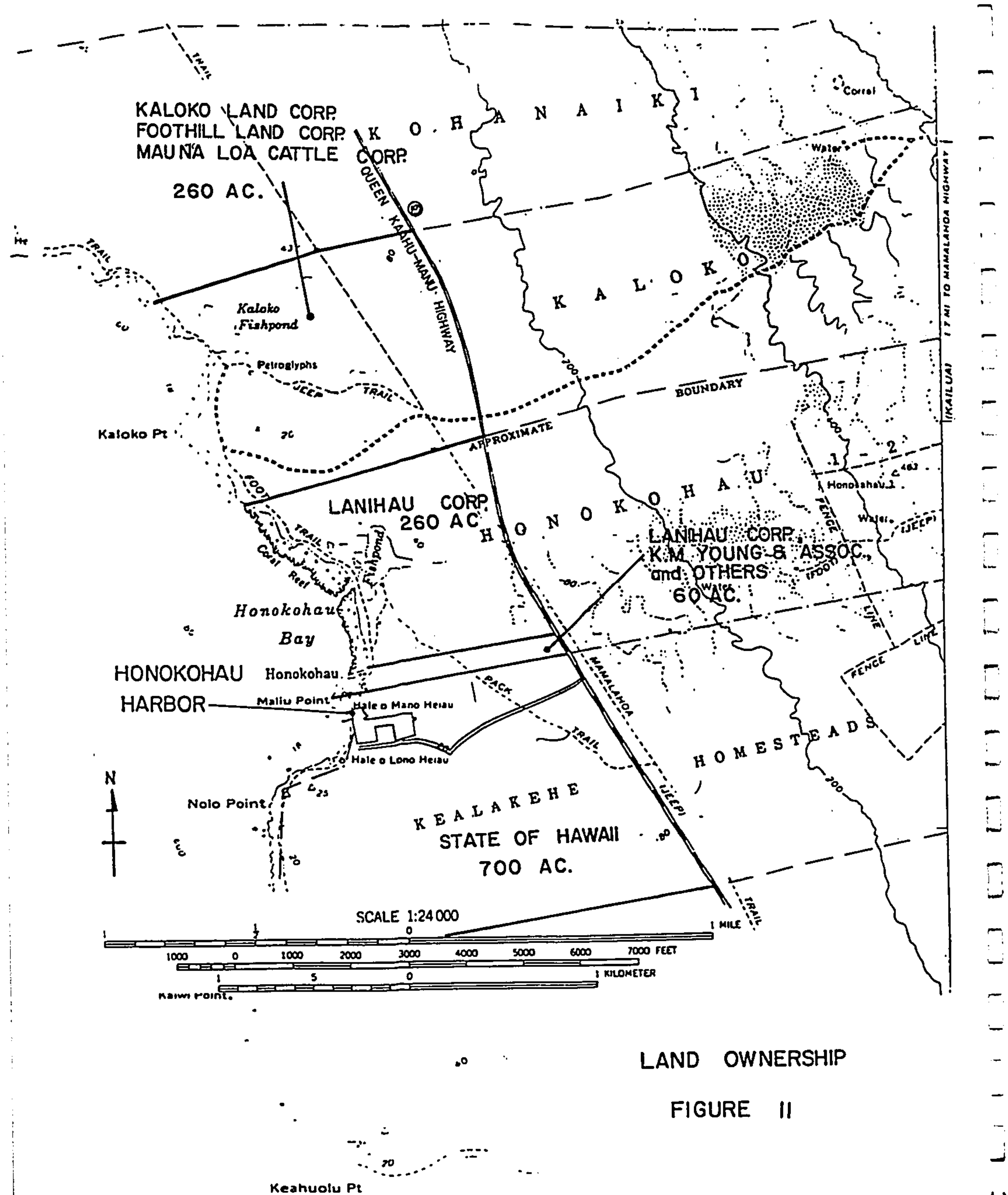
1. Land Use & Ownership

Except for harbor uses, the several thousand acres makai of Queen Kaahumanu Highway and 2 miles or more north and south of the harbor are virtually unused at present. The beautiful shoreline of the area gets occasional use by fishermen, hikers, campers, & sun-bathers. The existing harbor site of about 20 acres has about 50 moored boats, extensive use of the boat launch ramp facilities (weekend peaks of about 50 to 60/day currently), and a number of daily visitors. Figure 11 shows current land ownership in the area.

2. Infrastructure

Access, Traffic, Transportation

Queen Kaahumanu Highway, a 2 lane paved roadway about 1½ miles inland and more or less parallel to the shoreline is designed as a major traffic artery to link Kailua-Kona, the airport at Keahole, and the deep-water port at Kawaihaė. A paved 2 lane road leads from the highway to the harbor.



LAND OWNERSHIP

FIGURE II

The few other roads makai of the highway in this vicinity are but bulldozed paths through the lava, suitable for jeep travel.

Utilities

There is primary electrical transmission and telephone service along the highway from Kona to the airport, but no distribution makai of the highway has yet been developed in or near the harbor area. Temporary portable generators are being provided for lighting.

A 16 inch water main runs adjacent to Queen Kaahumanu highway, with an 8" connecting line to serve the harbor. Adequate supply will be available to meet harbor requirements of about 100,000 gals/day.

There are no sewer lines in the area at present. A septic tank and cesspool temporarily are accommodating the effluent from the harbor restrooms. A permanent sewage system for the harbor will be required. Hawaii County has plans for a future Kailua-Kona Sewerage System, which will include a waste water treatment plant about 1 mile due south of the harbor site. Harbor effluent of about 100,000 gal/day maximum can be accommodated. Disposal of treatment plant effluent by recycling on a proposed nearby golf course is part of the plan.

The nearest police and fire services and commercial services are in Kailua-Kona.

3. Related Planning

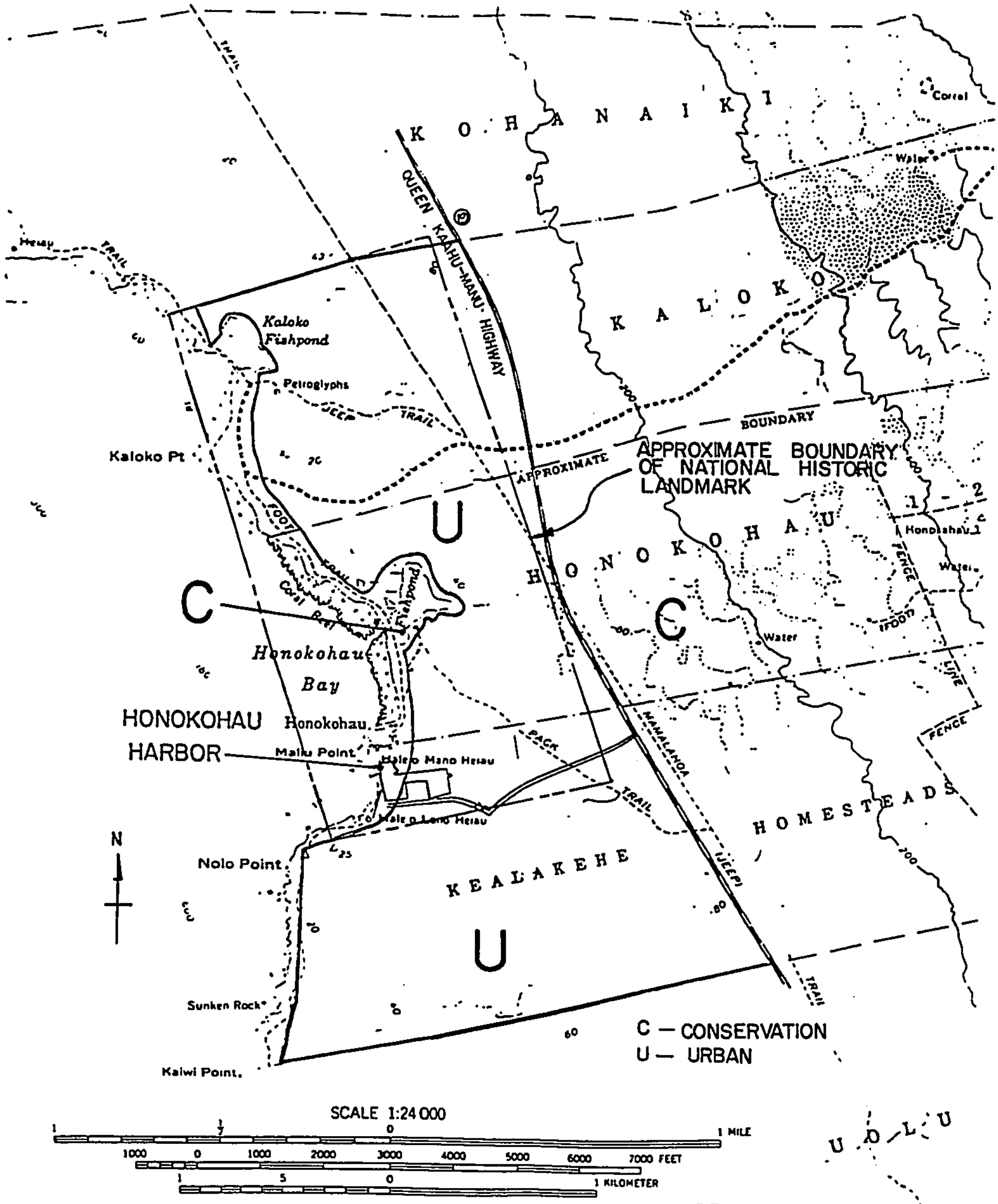
State Land Use Designations

Figure 12 shows the Urban (U) and Conservation (C) designations for lands in the area. The State of Hawaii has regulations which specifically limit the types of uses within lands having Conservation designation. The boat harbor is a permitted use.

National Historic Landmark

Figure 12 also shows the approximate area of the National Historic Landmark. This is a 'finders" rectangle enclosing the listed sites that make up the landmark. Precisely defined boundaries are the responsibility of the National Park Service, Department of Interior, but have not yet been set.

Any "undertaking" within a National Historic Landmark's "area of potential environmental impact" requires a determination of effect and a further determination of whether such effect is adverse, with review by the State Historic Preservation Officer and the National Advisory Council on Historic Preservation, before such undertaking can proceed.



STATE LAND USE DESIGNATION

FIGURE 12

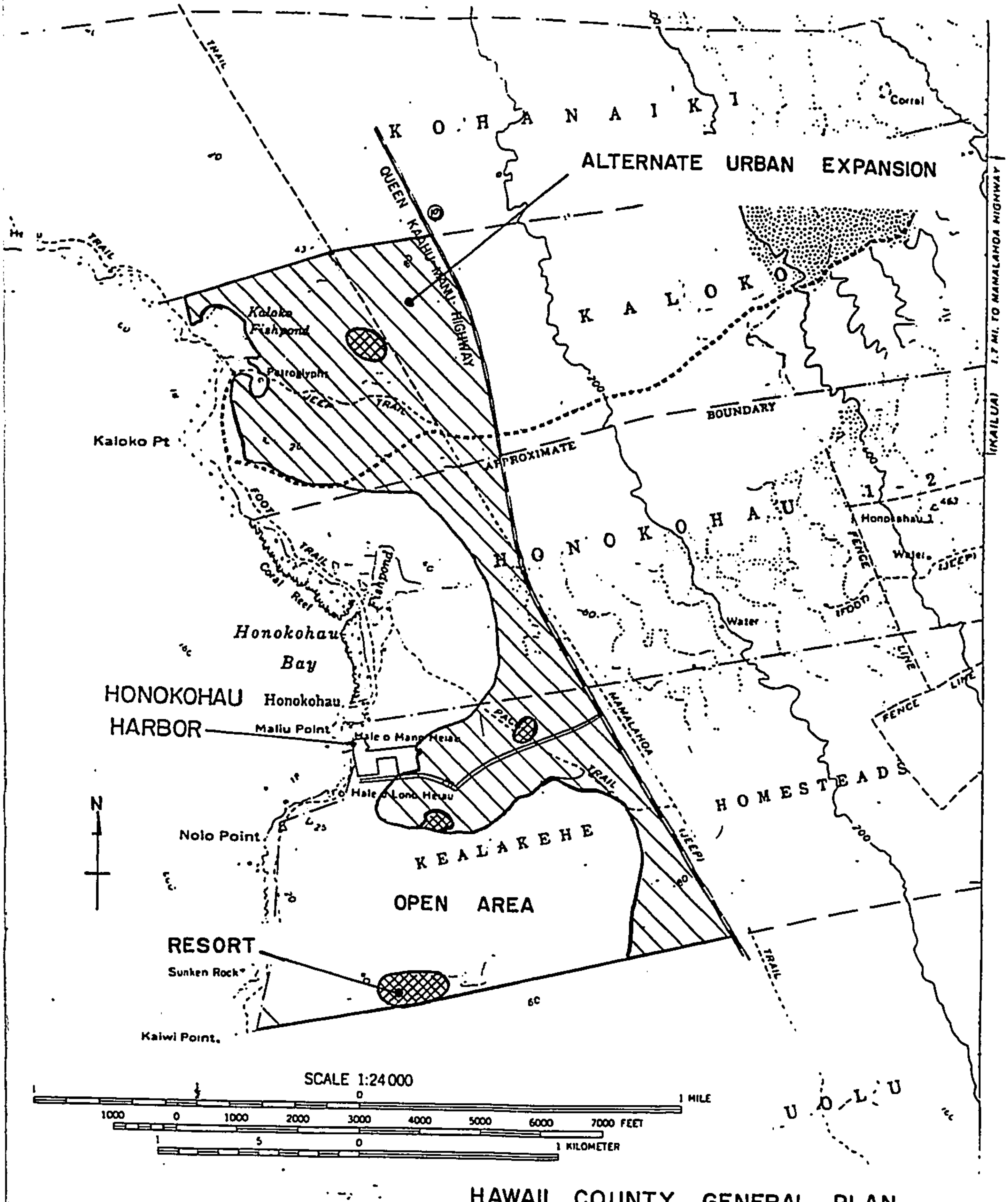
Hawaii County Plans & Zoning

The projected land-use policies of Hawaii County as expressed in the 1970 General Plan are depicted in Figure 13. Other policy statements in that General Plan (adopted Dec., 1971) indicate that resort development in the area shall be in balance with the social and physical goals as well as the economic desires of the residents of the district (North Kona) and that resort development in the area should not destroy the natural resources and historical significance of the area, and that the County should encourage ocean-based industries, such as aquaculture, in the area.

There are no presently announced plans of the State for use/development of the 700 acres of State-owned land around and south of the small boat harbor.

A Kona Community Development Plan, being prepared for Hawaii County is nearing completion. That document may be available prior to final action on this harbor EIS.

Present county zoning for the area is "open".



HAWAII COUNTY GENERAL PLAN
(LAND USE POLICIES — 1970)

FIGURE 13

Related Recreation Plans

The County of Hawaii Recreation Plan of 1974, is a sub-element of the County's General Plan. It recognizes that expanded facilities at Honokohau harbor will complement the Kona Coast fishing opportunities and thus cater to the tourist industry as the main economic source for the area. The Recreation Plan is responsive to current public demands, and looks forward to the establishment of shoreline reserves along the Kona Coast to be developed in conjunction with the Ala Kahakai (Trail by the Sea) concept outlined in the State's Na Ala Hele Report. The plan also indicates a high demand in the North Kona district for improving boat ramps, for provision of additional camping areas, and for historic preservation. A major purpose of the trail system is to reserve the shoreline for public use and preserve wildlife, scenic, natural, and historic areas. Service nodules for the trail system will include Kailua Park which is being improved, at the old Kona Airport site.

Proposed Kaloko-Honokohau Park Plan

A proposal for the establishment of a Kaloko-Honokohau National Cultural Park on lands adjacent to and north of the harbor has been made by the Honokohau Study Advisory Commission and endorsed by the National Advisory Council on Historic Preservation. The park proposal and an accompanying draft ENVIRONMENTAL IMPACT STATEMENT were published by the National Park Service in mid-March 1975. The development concept for such a park is depicted in Figure 14.

A letter of 6 February 1975 from the Office of the Secretary, Department of Interior has rejected endorsement of this scope of proposal for a National Park at this time because of lack of funds for land acquisition, but recommends further consideration of a "partnership which draws upon the combined resources of interested Federal, State, and local agencies" to develop a strategy to protect this significant Natural and Historic resource. The proposal awaits Congressional action at this time and/or further action detailed in the Department of Interior response of 8, May 1975. The Hawaii Senate, the County Council of Hawaii, the State Council of Hawaiian Civic Clubs, and numerous other Hawaiian organizations are on record supporting the National Park proposal.

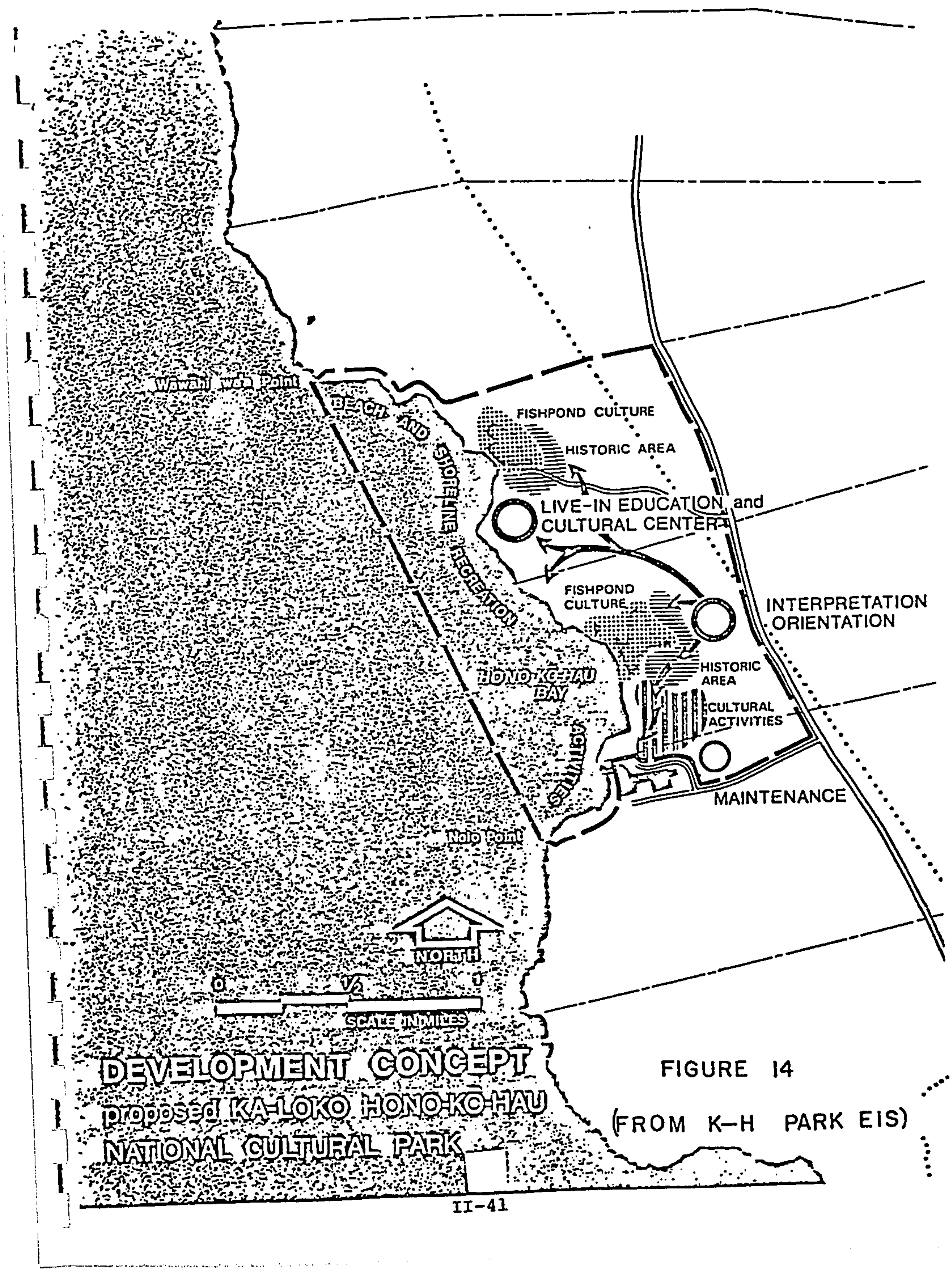


FIGURE 14

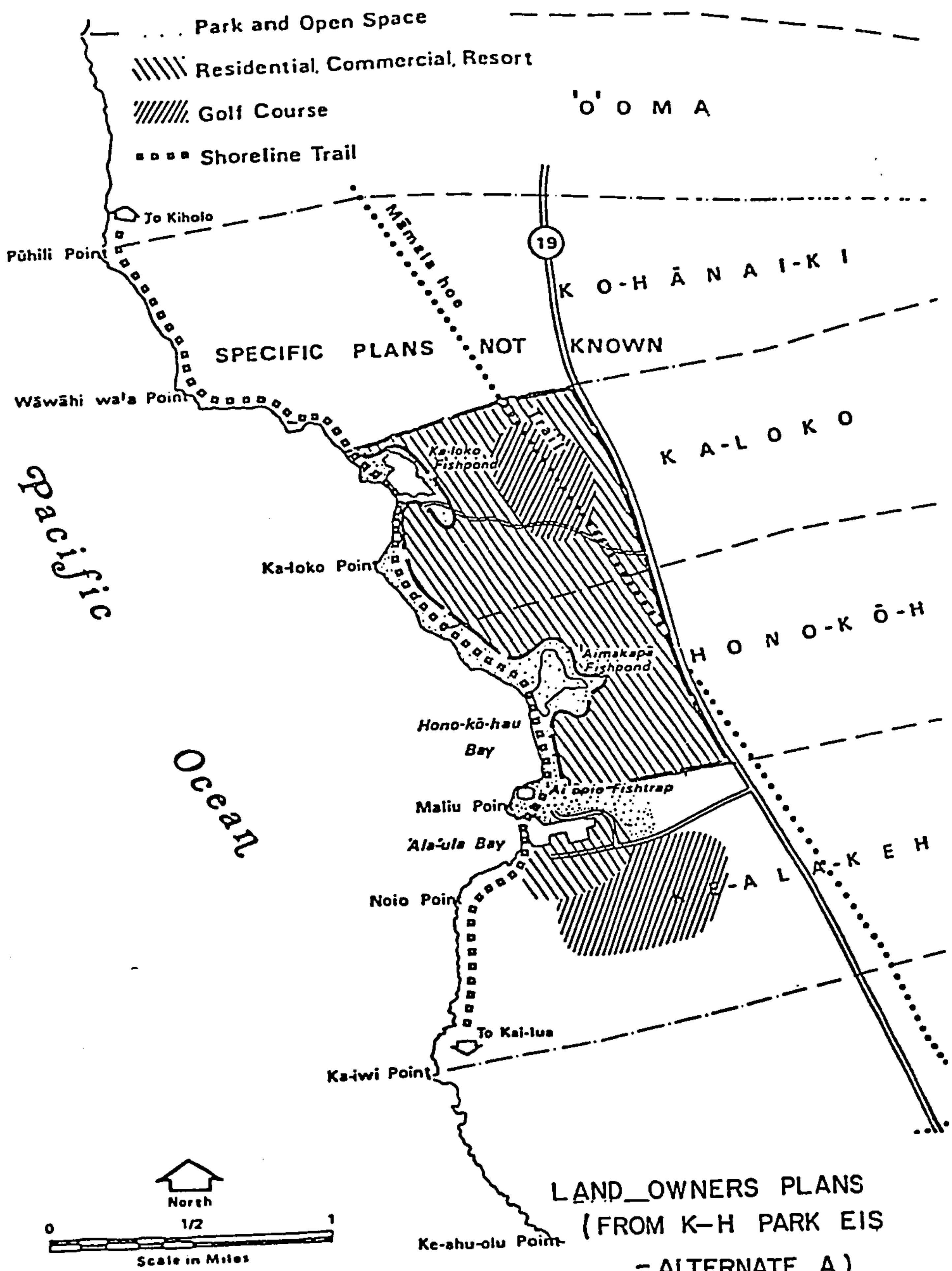
(FROM K-H PARK EIS)

Land Owners Plans

The plans of land owners in the area, as related to the Study Advisory Commission are given below (from park EIS), and are shown in Figure 15.

The bulk of the area (over 75% of the makai portions of the ahupua'a of Ka-loko and Hono-ko-hau) will be developed for commercial, resort, and residential use, or for open space directly related to those uses. Development would accommodate residents and tourists to a density of from 5 to 10 units per acre. No buildings over four stories would be built. Two fishponds--'Ai'makapa and "Ai'opio, would have a surrounding buffer zone of from 50 feet to about 200 feet wide. It should be noted, however, that the north end of "Ai'makapa, which is now a marshy area, is zoned for urban use and presumably would be filled to accommodate development. The major concentration of archeological sites on the Kai-lua side of 'Ai'makapa would be leased to the State of Hawai'i for park purposes. Precise plans for the state park have not been prepared yet.

The shoreline would be a public, parklike area, managed and developed by the State of Hawai'i and averaging about



LAND OWNERS PLANS
(FROM K-H PARK EIS
- ALTERNATE A)

FIGURE 15

100 to 200 feet in width except in the vicinity of the fishponds. The result would be a continuous unit of public land joining 'Ai'makapa and Ka-loko fishponds. It is expected that the entire park would be limited to day use only.

A major feature would be a shoreline trail passing through the Ka-loko, Hono-ko-hau area but extending from Kai-lua to Kiholo Bay.

At Ka-loko pond, two-thirds of the historic kuapa (seawall) would be removed and a small crescent beach formed on the Ke-ahole side of the pond to serve the resort complex there. A new wall would be built at the Kai-lua end of the historic pond, creating an enclosure about 30% as large (Kona Coast Company, 1973).

There would be a 50-foot open space buffer on the mauka and Ke-ahole sides of the pond. On the Kai-lua side, there would also be an 18 acre public park set aside to encompass part of the shoreline of the new pond and the adjacent complex of archeological sites. Several isolated historic sites would also be left undeveloped throughout the vicinity.

These would be small open spaces surrounded by residential, commercial or resort development. There are no details available on the areas to be set aside for these isolated sites, but it is expected that they would average about one acre each.

IIC. SOCIAL/ECONOMIC/CULTURAL SETTING

1. Social/Economic Factors

The "market area" used to study boating needs is shown in Figure 1 as comprising the North Kona & South Kona judicial districts. The market area may be somewhat larger now, since the March 1975 opening of the modern highway north Kailua-Kailua brings the Kawaihae area within less than 30 minutes of Honokohau, and some boaters of the Kohala districts are willing to drive to Honokohau if necessary. However, improvement of small boat facilities is planned for some future date at Kawaihae. Therefore, the long range prime tributary area for Honokohau harbor reasonably appears to be the North Kona & South Kona Districts.

Population of the North & South Kona Districts was 8,743 in 1960 and 10,400 in 1970. Projections used in planning the harbor were:

1980	--	14,000
1990	--	19,500
2000	--	25,000
2010	--	32,500

A Pacific Business News account of 21 April 1975 states that planning consultants currently studying the area forecast a 1990 resident population of 17,000 to 19,000, adding that recent growth has not been as rapid are earlier expected. Based on projection of current statistics from the State Department of Planning and Economic Development, a figure of about 22,000 appears to be a reasonable estimate of 2010 population for planning purposes. Agreement with such a forecast is far from unanimous, and there are those who forecast 2010 population several times higher than 23,000.

Current projections made available as part of data for Hawaii Water Resources Regional Study for Hawaii County at year 2010 vary from a low of 96,800 to a high of 185,000. Estimates of the Kona "share" of future population vary from 14% to 19% (i.e. from 13,500 to 35,000). The estimate of 23,000 is simply the result for combining a mid-range island population with a mid-range estimate of the Kona "share" of that population. State and County policies toward growth stimulation or moderation will play a large part in determining what the actual 2010 population becomes.

Factors such as potential support facilities for telescope/ scientific facilities on Mauna Kea, for research and development of ocean thermal energy near Keahole Point may combine with a growing tourism industry to create a growth rate in the upper range of present forecasts.

The ownership pattern of land in the Kona districts is characterized by a few owners holding vast parcels of land. Investor interest in the area has caused land prices to soar, especially in coastal areas.

The planning area over the past decade or so has seen a shift from agriculture to the visitor industry as its dominant economic base. Agricultural activities include coffee, ranching, fruit (bananas & avocadoes), macadamia nuts and vegetables. Minor industrial activities includes furniture making, carving, construction and printing.

Tourism has expanded tremendously in North Kona, particularly in Kailua village, and resorts nearby to the South.

Current projections for tourist accommodations are as follows:

Tourist Accommodations, North & South Kona
Projections

	Hotel Rooms	Transient Apts.	Total
1973	2698	311	3009
1980	3060	760	3820
1990	3640	1700	5340

The recently completed modern airport & the road link to a deep water port at Kawaihae will influence future development in the area.

Boating is a major supporting activity of tourism in Kona, and tourism is the basis of the economy of the area. The Kona Coast is a world famous big game fishing center, and the annual Kona Billfish Tournament attracts fishing clubs from many locations. The Kona coastline is also considered ideal by the skin and scuba diving community. Sightseeing boats and charter fishing boats constitute a special tourist attraction and income to the community from these sources is significant.

The harbor caters to essentially three categories of boaters in addition to casual visitors, namely:

1. Charter fishing boaters requiring moorings or berths
2. Power boaters (mostly part-time "skiff-troller" fishermen) requiring launch ramp facilities
3. Boaters with larger craft (over 24' length) requiring moorings or berths

A few transient boats from other islands are accommodated occasionally.

Each of the above groups makes expenditures which contribute to community income.

Present harbor facilities are inadequate for the growing needs of all three categories of recreation activity.

The first category of harbor use is related mostly to the tourist industry. At present there are 4 cruise boats, and 29 charter fishing boats. All these boats need the safe berthing afforded by Honokohau Harbor. In fact, boats cannot be insured unless such berthing is available. Although the cruise boats utilize Honokohau only during rough weather, the fishing charter boats are permanently moored at Honokohau harbor.

Gross revenue from the charter fishing fleet is estimated to be about $600,000 to $800,000 annually at present. This provides substantial "community" income from secondary turnovers of money. Substantial tax income, as well as direct fee revenue from berth rental also accrue to the State from these charter fishing fleet operations. It can be expected that charter fishing fleet operations will grow at a rate roughly proportional to the number of tourist rooms in North and South Kona.

Fishing by small boat operators, (mostly with power boats about 20' in length) is a district recreation activity enjoyed by an estimated 1,000 local families in North & South Kona. 180 of these are fulltime fishermen - the rest are part-time. Honokohau small boat harbor, being centrally located, and being a safe haven is the most active launching facility in the Kona districts serving these boaters. It is estimated that an average boat crew receives $6,000 annual revenue, spends about $2,000 per year for supplies, boat repairs, etc. Hoffman & Yamauchi (1972) estimated that in 1970, expenditures for recreational fishing totalled

$1,851,000 for the County of Hawaii, with $1,345,000 of this resulting in an increase in local income.

A third category of boating/fishing recreation activity is the operation of larger (over 24') power and sailing craft owned by individuals for use by themselves and friends. Community income is also generated by the expenditures of this group.

There are currently no commercial facilities available at the harbor area and none between Kailua-Kona and Keahole Point, but with expanded harbor facilities, commercial activities will likely include a restaurant, boating supplies, visitor center (multi-purpose building), boat fueling, boat repairs and boat storage. It is reasonable that the boat repair function be adjacent this largest concentration of boats on the island. Repair facilities at Keauhou are inadequate and are being phased out.

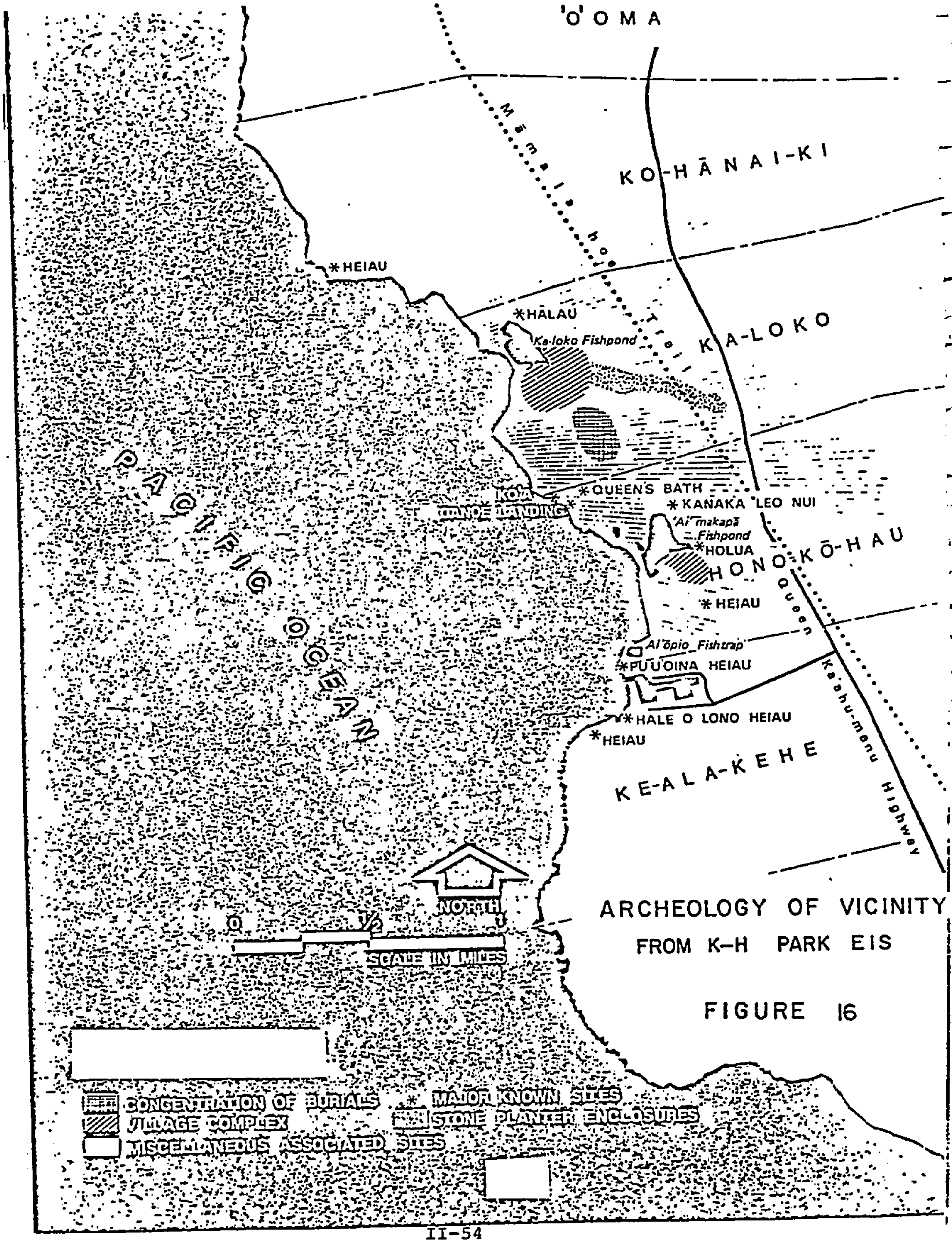
IIc2 Cultural Resources

The March 1975 draft environmental statement for the proposed Kalokȯ Honokohau National Cultural Park has an excellent description of tangible and intangible resources of the area, focussing primarily on the ahupua'a's of Kaloko and Honokohau and Kealakehe (the last being the location of Honokohau small boat harbor).

The wealth of present and potential historical/archeological sites in this area makes it one of (or perhaps the)most valuable areas in the state (K-H EIS p107) for the study and appreciation of Hawaiian history and culture.

Figure 16, from the K-H EIS presents a summary picture of archeology of the vicinity. Related maps and data are available that give details currently known concerning about 250 sites in the area.

The area immediately at and around the Honokohau small boat harbor site was surveyed in March 1975 for archeological items by Bishop Museum archeologists. Survey results are presented in Appendix A. In summary, the report recognizes the valuable nature of archeological sites on property adjacent to the harbor, (including the petroglyph field). The report concludes



ARCHEOLOGY OF VICINITY
FROM K-H PARK EIS

FIGURE 16

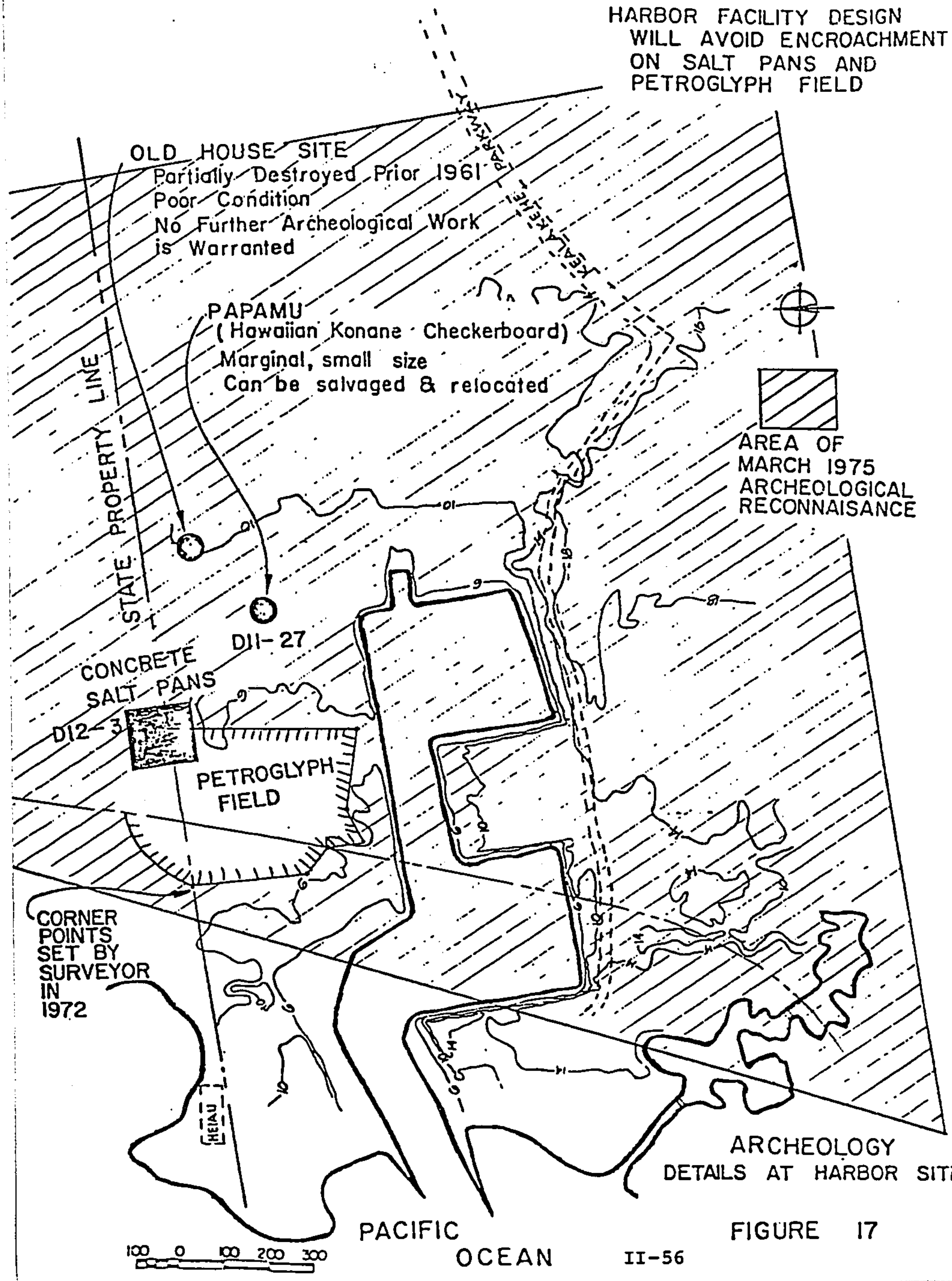
however, that there are no archeological items of significant value directly on the site of any proposed harbor construction --either water or shore facilities that would preclude completion of the harbor. Figure 17 shows the area of survey.

Recreation

Honokohau Bay provides opportunities for swimming, diving, surfing, picnicking and fishing. The present harbor provides a place of disembarkment for the diving community. Specific fishing opportunities of the area include not only the deep ocean waters reached by boat, but the inshore waters near the reef as well where local fishermen use surf casting, nets, and spears.

Safety Aspects of the Harbor

Honokohau small boat harbor is the central (but not sole) focus for boating recreation in the Kona districts. A prime asset of the harbor is that it provides a safe haven during storms. During heavy seas the 45 degree "dog-leg" entrance channel (designed to minimize rough water inside the harbor) requires expert navigation. Local boaters are aware of this and can cope with the problem (although at least one boat has been lost upon entrance). There is a minor safety problem posed by some crumbling of the rough sides of the berthing basins which have been blasted out of rock. Accordingly,



ARCHEOLOGY DETAILS AT HARBOR SITE

FIGURE 17

caution must be exercised in traversing the perimeter of the basins. However, for aesthetic reasons (as well as economy) retention of a rough (and natural appearing) wall surface may be preferable to massive vertical concrete surfaces for basin walls at this particular harbor.

Some local boaters have indicated that it would be desirable to have a short breakwater on the northside of the entrance channel.

A shallow shelf (about 6 to 8' depth) to the north just outside the entrance channel causes waves to break in the channel, creating a navigation hazard a few days each year. This shallow shelf also limits the effective width of the entrance channel, thus placing confines on navigation through the channel. Removal of part of this shelf in the future might be helpful. Although not a major problem, it deserves further investigation, particularly in view of the increased traffic resulting after enlargement of the harbor. Such action would also reduce the "surge" experienced in the outer berthing basin.

Boaters have also indicated the desirability of having a range light installed to replace the present light.

III. ENVIRONMENTAL IMPACT

Introduction

Valuable information on environmental impact of proposed activities and facilities in the area is documented in the draft environmental statement for Kaloko-Honokohau National Cultural Park (National Park Service March 1975) and the draft environmental statement for the Phase II increment of Honokohau Boat Harbor (State Dept. of Trans. Aug. 1972). The study leading to this present EIS for the harbor refers extensively to these earlier documents. The present study has provided an opportunity for substantial field data on water quality of the harbor in its existing state (Appendix B) which can serve two purposes:

1. This "base-line" data serves as a basis for predicting future water quality of the harbor and surrounding area.

2. This base-line data can serve as a basis for monitoring in future years. Any trends in water quality that may develop with increasing harbor usage can serve as a basis of judgement for imposition of any controls which may be necessary. Periodic water quality monitoring is recommended.

A. PHYSICAL IMPACTS

1. Land & Visual Impacts

Completion of the harbor to accommodate 450 berthed boats, and 350 launchings/day will enlarge the harbor (with its shore functions) from about 20 acres to about 65 acres.

About 600,000 cu. yards of volcanic rock will be excavated (with controlled blasting techniques) to provide the enlarged basins. The tentative location for excess excavated material will be a depressed area in the lava fields about 1,000 yards south of the harbor on state land which can accommodate it with minimum disruption of the scene one sees from adjacent areas. Usable land can be created. Part of the excavated material will be used for grading around the harbor site.

Shore facilities, plus parked boats on trailers, and the boat repair activities will create some visual impact on viewers from adjacent lands. This impact will be most evident from the vantage point of about 1 mile northeast of the site because there is higher ground - about elevation 75 ft. At such a distance, the impact particularly with landscaping, will not be significant. From the seashore trails to the north and south, (even as close as 100 yards), harbor facilities and activities can scarcely be detected.

2. Impacts on Water Quality & Life in the Harbor & Adjacent Areas

Much of the environmental impact of the completed small boat harbor on the present site and on the area around the site will be largely related to the number of people who visit and/or use the small boat harbor.

At present it is estimated that about 250 persons use/visit the harbor on a busy weekend.

For the 450 boat-slip harbor these numbers are estimated at 1700 persons per peak weekend day.

For a 350 boat-slip harbor the estimate would be roughly 1500 persons/day.

Additional boats and support facilities and additional visitors will tend to cause greater pollutant inputs in the harbor including nutrients, minor oil and gas slicks from motors, litter thrown by careless persons, and wastes from fish cleaning. There is presently a substantial amount of debris (beer cans, etc.) on the harbor bottom. However, based on observations of current low levels of oil and surface litter and based on the high continuing net water outflow from the harbor at all times, and with adequate monitoring, it appears reasonable to expect that water quality can be maintained to meet State Water Quality standards at all times.

The excellent flushing pattern and the observed dilution at the entrance indicate that there will be no significant impact on water quality of the waters and marine life outside the harbor, nor on adjacent ground water, ponds and marine life. There is no reason to suspect a major change in the flushing pattern upon harbor completion.

Water Quality Impact

The impact of an expanded basin on the harbor water quality depends heavily on the flushing effectiveness which can be attained with the additional basin volume. Higher flushing rates will result in less adverse impacts. The existing harbor is exceptionally clean, clear and contains no significant accumulation of pollutants; these features can be expected in the expanded harbor if similar flushing rates can be maintained. Our analysis indicates that suitable flushing rates can be achieved.

The diverse flora and fauna communities supported by the present harbor can be expected in a larger harbor if the water conditions which make the former suitable are not drastically altered. A major consideration here is changes in phytoplankton biomass (effecting turbidity) which would cause changes in the transmission of sunlight through the water and therefore many other environmental properties. Phytoplankton levels presently are maintained at low levels because: 1) most of the groundwater nutrients are confined to the thin surface layer and are thus unavailable to the vast majority of the phytoplankton, and because 2) these suspended plants are continuously removed through flushing and grazing. These two interdependent elements, nutrient availability and flushing, are the critical criteria to be considered in assessing the water quality impact of an expanded basin. We will first discuss nutrient availability in general terms because the same dynamics apply to all situations, and secondly we will deal with flushing in more specific detail for each of the alternatives.

By virtue of the high nutrient concentrations in the surface layer, Honokohau Harbor has the potential of being a highly turbid and eutrophic harbor. But because these nutrients pass through the harbor so rapidly, they do not become available to most of the phytoplankton in the lower layer. This is a consequence of the persistent outflow of the brackish surface layer. The density difference between the two layers augments the nutrient isolation. However, if the nutrient-rich surface layer were not flowing out rapidly, simple molecular diffusion into the subsurface waters would make significant quantities of these nutrients available to the phytoplankton population below. To give an idea of the nutrient quantities involved, calculations suggest that roughly one half of the nutrients in a one meter surface layer would diffuse into the subsurface oceanic layer in about one week. This would result in much higher phytoplankton and therefore turbidity levels.

Good flushing in an expanded harbor will depend on whether the present spring flow can remain uninterrupted by the new excavation and whether additional flows can be intercepted to produce bottom inflows in the inner part of the new harbor. Even if no further underground springs are encountered, harbor expansion to the east provides the most likely opportunity for continued good flushing and good water quality.

The basic behavior of the bottom layer (dominated by tides) will be the same whether harbor expansion is easterly or southerly. Removal times for a contaminant will be comparable (15 hours for half-removal of material originally dissolved in a thin band along the inner wall). However the behavior of the upper layer is dominated by the outward flow of groundwater. Mixing energy resulting from the high velocities of a relatively narrow access channel enhances flushing. At the actual water surface, wind has an influence on circulation. Harbor expansion to the east can minimize dead spots where floating debris as well as dissolved and suspended material at the top of the upper layer might collect and remain longer. Because the flushing effectiveness of a harbor expanded to the east closely approximates that of the existing harbor, we would expect only slight increases in phyto-plankton levels.

Because of the increased numbers of people who would use an expanded facility, enteric bacterial inputs are expected to increase. However, provided that adequate flushing is maintained no significant change in the water quality is expected.

Blasting Impacts

The blasting for excavation will cause some filling of marine life in the harbor, but based on the observations of marine life now, which has been established in the years since completion of the first increment, there is every reason to expect a reasonable degree of re-colonization. Blasting will create some new bottom sediments in the harbor to the same degree as in the first increment of harbor construction. However, no significant long term effects have been observed as a result of such sediments.

Contract specifications related to blasting will be detailed so as to preclude damage to adjacent heiaus.

Sediments

Final blasting opening the additional basin will produce the subsidiary impact of the production of some silt (several inches depth). This silt will constitute a large portion of the sediment load to be present in the expanded basin and will undoubtedly contribute to the sediments in other locations of the existing harbor. The absence of basaltic silt sediments outside the present harbor and the highly diverse coral, mollusc, echinoid and fish communities existing there suggest that the impact of the blasting-silt to outside regions would be confined to a discreet short term impact immediately following blasting, and that the adjacent areas would void themselves of this load via natural processes. Silt produced by additional blasting can be expected to have a generally short, one-time detrimental effect on the biota in all regions of the harbor. Data suggest that sediments (derived, in part, from the large urchin population which scrape the basaltic rocks during feeding) are presently affecting the growth, development, and distribution of the harbor coral community. Following the effects of blasting and siltation, recolonization of the various regions of the harbor can be expected to occur at the rates described in the Oceanic Institute report (1973) provided that residual silt thus produced is not prolific. Methods to minimize the extent of these effects are discussed under Mitigating Measures.

Colonization

The processes of blasting and excavation of additional basin volume will kill the sessile coral, molluscan and echinoid fauna on the walls of the present inner basin and the fishes swimming in the immediate area. However, the existing populations of these affected fauna are the lowest of anywhere within the harbor.

Previous studies have shown that the present harbor as a whole is a suitable environment for many species of marine flora and fauna. Harbor completion via excavation of additional basin volume will create additional habitats available for colonization by various forms of marine life. The rate and nature of this colonization involves speculation and will depend mainly upon two criteris: orientation of the additional basin relative to the coastal ocean, and the water quality characteristics which result in the newly created environment.

The expanded basin will have communication with the outside ocean -- the ultimate source of colonization forces such as coral planula, mollusk and echinoderm larvae and fish. It will have characteristics most nearly approaching those of the present inner basin. The colonization rates observed for the inner basin, which are lower than other harbor areas, give an indication of expected rates for the new basin. The sense of this comes from the fact that the greater distance from the coastal ocean decreases the "chance" factor of larval forms coming in contact with suitable substrates in the new inner basin. Accordingly colonization rates within the new basin will probably be lower than those for the present inner basin. A subsidiary element of the "chance factor" mechanism is the lower frequency of suitable substrates caused by the well-defined, cold, low-salinity, surface layer in the inner basin. The persistent outflow of water from the harbor, particularly the inner basin, augments this process by further decreasing the chance of larval forms, which float passively in the water, from coming into the inner basin.

A second factor which will influence colonization is the resulting water quality of the additional basin. This is somewhat more difficult to predict because it is heavily dependent on the amount of additional groundwater to be intercepted through expansion, which is an unknown. The groundwater presently influences the biotic system in three ways: it is the causative agent of the cold, low salinity surface layer; it contains high concentrations of nitrogen and phosphorous (which can affect turbidity by supporting phytoplankton growth); and, primarily, it is responsible for the excellent flushing characteristics of the present harbor.

The cold, low salinity surface layer is most pronounced in the mauka harbor region because most of the groundwater incursions originate in this area. The resulting inner basin environment exerts control over the composition and distribution of biota which can survive there. In contrast to oceanic assemblages present elsewhere in the harbor, the inner basin supports a brackish water assemblage of molluscs (dominantly Ostrea sandvicensis) and attenuate echinoid fauna (dominantly Echinothrix diadema). The lack of corals in the upper few feet of the walls reflects the unsuitability of this region for normal coral colonization. The relative frequency of Porites and Montipora verracossa in the present inner basin suggest that these corals have a greater tolerance to these conditions. The fishes of the inner basin contain a greater proportion of herbivores and are mostly juveniles; in other harbor vicinities sub-adults and adults are predominant. The aforementioned characteristics can be expected within the expanded basin because it will have groundwater features in common with the existing inner basin.

At present, the high nutrient levels of the groundwater exert a comparatively small effect on the harbor biota because the residence time of surface water within the harbor is low and most of the nutrients flow directly through the harbor. Thus, the existing harbor is unusually clear considering the ambient plant substrates in the water. Since the turbidity of the completed harbor will undoubtedly not decrease, the paucity of corals, molluscs and echnoids at the base of the walls and harbor floor will continue. Substantial increases in surface water residence time could result in the greater availability of these nutrients for plant growth, thus increasing turbidity. Significant increases in turbidity and subsequent reduced light penetration could retard the rapid, continuous or complete development of these communities.

The excellent flushing caused by the groundwater incursions presently serves to control turbidity at adequate levels and to "clean" the harbor by providing a constant outflow of surface water which entrains a significant amount of subsurface water. Continuation of this trend depends on the proportion of new flushing forces created (additional groundwater input) to the additional harbor volume to be flushed.

Overall, an enlarged inner basin is likely to have colonization suitability characteristics most like the present inner basin. Colonization rates and faunal diversity prevalent in the outer provinces of the harbor cannot be expected for the aforementioned reasons. Providing that water quality is not drastically altered, the additional basin will probably be colonized by species, and show faunal distributions now found in the inner basin; and the colonization rate would be similar to but probably slower than those seen in the existing inner basin.

Surge

There is some surge in the outer basin during periods of heavy seas outside. Harbor completion will not cause a major change in this surge. An expanded inner basin area will not have problems due to surge. Surge considerations are discussed under "Alternatives" and details of the analysis are given in Appendix C.

There will be no adverse effect on air quality as a result of harbor completion. The limited data available, plus visual observation, do indeed indicate present pristine air quality in the open space near Honokohau Harbor. In a recent uncompleted study of potential air quality along a major highway realignment being studied south of Kailua-Kona, no significant change in air quality is anticipated in 1978 and 1988. It is projected that there will be some decrease in CO and HC and minor increase in NO_x, while average daily traffic projections go up in that decade from about 8,000 vehicles to roughly 13,000. It is reasonable to conclude by comparison with these findings for the nearby Kaahumanu Highway that the air quality of the area will not be significantly affected by exhaust from: an additional 500 vehicles (estimate for peak-day harbor traffic), the boat motors, or a small diesel generator (which is temporary).

In view of the distances to other human activities there will be no adverse impact due to noise caused by harbor completion.

IIIB

1. Land Use

Completion of the small boat harbor will have an impact on adjacent land uses.

The harbor itself, as a significant visitor destination attraction of the Kailua-Kona resort area will provide a catalyst to hotel/residential development. Whether this impact is adverse will depend on the degree of control or encouragement given to resort development by State and County policies. At this time, these policies appear to favor "controlled-growth". These policies, rather than the harbor alone will influence scale, location and timing of resort development.

Harbor completion will provide opportunities for joint use of facilities such as parking lot, restrooms, and access to shoreline trails and beaches. Harbor completion is in consonance with State Land Use designations and County General Plan land use policies.

2. <u>Infrastructure</u>

Access, Traffic

As stated earlier, completion of the boat harbor will have an impact of increasing traffic on Queen Kaahumanu Highway due to the 1500 estimated visitor/users on a typical weekend day. This is on the same order of magnitude as the visitor estimate for the proposed Kaloko-Honokohau Cultural Park. The highway has been designed to accommodate the projected traffic of the park and harbor.

An estimate demand of 100,000 gals/day for domestic water at the harbor can be met from the 16" supply main along Kaahumanu Highway.

Sewage treatment facilities (aerated lagoon) to handle four mgd. at a site about one mile due south of the harbor are being planned by Hawaii County. Installation of the facilities may be expected in 5 to 10 years. Recycling of the treatment effluent by application on a nearby golf course is one method suggested for alternate disposal. The small boat harbor requirements for sewage disposal of 100,000 gal/day can be accommodated by the County's proposed waste water plant described above. Until that plant is built, the harbor restroom sewage will continue to be treated by the temporary cesspools and septic tanks, with chlorination of effluent. Harbors Division is planning up-grading of the temporary facilities with an aeration system (eg. Cavittette or equal). Harbor water quality should be periodically monitored to insure maintenance of best possible standards. Recent field tests have shown water quality within the harbor to be substantially better than minimums required by the State Dept. of Health. If monitoring should indicate trends toward bacteriological (or other) quality that doesn't meet standards, more sophisticated waste water treatment may be required even before the sewage treatment plant is built.

Sewage pumpout facilities for the boats should be included in an early phase of construction.

IIIC

1. Social/Economic Impact

The primary positive impact of harbor completion will be to provide recreational opportunities for 3 groups of users, i.e., those with:

a. trailered boats
b. charter boats requiring berthing
c. other recreation boats requiring berthing

Adequate facilities to be provided for all 3 types of use will promote maximum enjoyment of a unique and valuable natural resource, i.e., the Kona fishing grounds.

As stated earlier, on a typical high weekend day, over 1,000 persons of the above 3 categories (plus non-boating visitors) can enjoy the facilities.

The "a" group above has the greatest number of local residents who will benefit directly from provision of adequate boating facilities.

The "b" and "c" group include many local residents who will benefit directly, but it includes many more "visitor industry" patrons who enjoy the boating themselves, and bring indirect benefits to the community. Whether social/economic impacts on the local community due to this group are "adverse" or "favorable" must be judged in the light of the visitor industry advantages and disadvantages to the community, and whether or not visitor industry facility development is controlled wisely.

Charter boats alone bring a gross annual income of over $600,000 to the Kona community charter boat operators at present. There are varying opinions as to the number of times this money circulates in the community. Suffice it to say that a State investment in harbor facilities will have a significant impact on community income. The growth of charter boat activity may be roughly correlated with number of hotel units in the area, so that an estimate of at least $1,500,000 gross annual income from charter boat activities by year 2010 is reasonable.

There will be an increase in community income due to expenditures by fishermen (users of harbor launch facilities), and from sale of their catch. A similar increase in expenditures by other recreation boaters can also be expected.

In a sense, one impact of harbor completion will be in keeping with the State's policy to encourage decentralization of facilities (and therefore population) away from Oahu.

Harbor facilities will complement other proposals for attractions that will enhance Kona as a "visitor destination center". For example, the EIS for the proposed Kaloko-Honokohau National Cultural Park estimates that 500,000 persons/year (1,500 per day) might visit the park, with 50% remaining on the island at least 1/2 day longer because of the park....bringing a 10 million dollar increase annually to Hawaii County, mostly to North Kona. Such projections of income might also be applied to visitors drawn to Kona's boating and fishing. The above park numbers are higher than that for the harbor. However, if uncontrolled in scale and pace, the combined impact of too much and too fast encouragement for "visitor destination" facilities would be adverse and the advantage of increased employment, increased business opportunities, and increased recreation opportunities will be offset by threats to the life style of current residents.

As one infrastructure impact, some additional police and fire protection will be required for the full-scale harbor facilities.

2. Cultural Impacts

There are abundant and valuable historical/archeological sites in the vicinity. There is much current interest in their preservation, not only as individual objects with minimal buffer zones, but as a group of inter-related sites whose full potential value as a cultural resource can best be achieved if the present natural atmosphere and open space quality is maintained around the area which has a concentration of the sites (most of which are to the north of the harbor). -i.e. "area" preservation.

Accordingly, the primary cultural impact of completing the harbor involves the question of whether the harbor facilities, (size, configuration and architectural theme) can be compatible with the objectives in the paragraph above. All the above concerns subjective judgements on what should and should not be constructed within the area of impact of the National Historic Landmark.

Any harbor basins and facilities will have an architectural theme that differs somewhat from the theme to be emphasized for preservation of historic/archeological sites area. The harbor facilities, even with use of lava rock, etc., will connote activities of the "modern" era, whereas the theme in areas north of the harbor will emphasize historical/archeological aspects in the areas to be preserved. There are mitigating measures which can minimize any incompatibility. These are discussed in Section IV.

No known historic/archeological sites of value will be disturbed by the excavation of basins or construction of shore facilities in any of the harbor configurations under consideration (see Appendix A). Hence there will be no direct impact on such sites. Indirect impact is discussed in the paragraph above. The petroglyph field near the harbor entrance on its north side will be excluded from harbor development so that it may be preserved.

Another cultural impact of harbor completion will be a threat to the life style of some area residents if the scale and pace of harbor development is excessive.

IV. MITIGATING MEASURES

The following measures can and will be considered to minimize harbor impact.

A. Historical/Archeological Sites

1. The harbor will be designed so as not to intrude on the petroglyph field nor on the integrity of other National Historic Landmark features

2. Visual impact of the harbor facilities on adjacent property can and will be minimized by:

   a. An architectural theme that emphasizes "natural" materials of the region -- for the buildings and structures (and possibly even the basin walls if feasible) and perhaps even colored (dark) concrete

   b. Appropriate landscaping with due emphasis on native plants.

   c. Low rise buildings

   d. Roads of a "rural" type - i.e. without the formality of curbs and gutters

   e. Underground utilities from Kaahumanu Highway

   f. Consideration of topography in layout of buildings and facilities to help maintain a low profile.

g. Emphasis on multi-purpose buildings can minimize the number of buildings (e.g. meeting rooms for the boat clubs can be planned in conjunction with other facilities)

h. Some functions such as boat sales can be conducted at locations other than the harbor

i. Cooperation in developing a buffer or transition zone between the harbor area and historic/archeological sites ares. Even the existing kiawe trees in scme instances can be helpful in this regard.

3. Joint use of some facilities at the harbor (particularly roads, parking and restrooms) can facilitate access to enjoyment of adjacent historic/archeological sites and shoreline hiking trails. Joint use of an area for maintenance facilities may also be feasible.

B. <u>Water Quality</u>

Periodic monitoring of water quality in and adjacent to the harbor can provide information necessary for any actions that will insure that water quality standards are met. For instance, such monitoring might sometime show the need for more sophisticated treatment of the sewage from the harbor restroom -- or relocation of the temporary treatment facilities.

Honokohau Harbor in unique in that it is probably the only small boat harbor in the State which contains waters conforming to water quality standards for Class A waters. Only nutrient levels, which arise from natural hydrological phenomena, exceed Class A criteria. It is desirable to conserve, protect and maintain the existing degree of water quality to the maximum extent practical.

Because tie-in with the future Kailua-Kona sewage system is not anticipated for five to ten years, the existing septic tank and cesspool facility will have to serve temporarily the increased needs of the expanded harbor population. Harbor bacterial densities, though low overall, give indication that leaching is occuring from the present facility which exists on the peninsula separating the two berthing basins. This locations is one of the worst possible in that it provides near maximum surface area for interaction between the porous harbor walls and the seawater. Since increased use by additional harbor patrons can only amplify these inputs, it would be wise to minimize this impact by relocating this temporary facility if and when monitoring indicates any downard trend in quality. A southern location away from the harbor's edge would be a preferable location as a mitigating measure. This would decrease harbor contamination via leaching caused by seawater movements, and the southern location would likely not intercept groundwater intrusions (which might carry leachates into the harbor).

Harbor oceanographic considerations indicate that, to preserve the high water quality characteristics of the harbor and adjacent areas, the general direction of expansion should be to the east. Based on the location of harbor groundwater inputs and the distribution of terrestrial vegetation in the area, it appears this direction would give the best chance of intercepting maximum additional groundwater. If the extended harbor has bottom springs near its inner end, it will produce optimum flushing.

Minimum impact to the aquatic environment will result if the present, well-flushed harbor characteristics are maintained. In addition to groundwater considerations discussed above, the expansion should preserve and continue the present basin and channel type configuration. This has the advantage of causing tidal flows to speed up through the constrictions, creating a greater amount of mixing and eddy circulation within the basins.

As mitigating measures, launching ramps and boat repair facilities should be located adjacent to the best flushed portions of the harbor. Such facilities are sources of contaminants such as gasoline, oil, paint, fish entrails, etc.

Minimum impact can be achieved by placement of these facilities where such pollutants can be flushed from the harbor as quickly as possible. Oceanographic considerations indicate that placement along the northern side of the present inner channel would be best since the surface flow here is rapid and goes directly out toward the harbor entrance. The southern side of this channel would be the next best place.

C. Size and Configuration of Harbor Facilities

The size of the harbor could be reduced from that proposed in 1970 in concert with a policy of "controlled" growth. See Alternative B.

D. Blasting - Siltation

Because blasting which must be done in the water will kill fish in the area, efforts should be made to determine the periods of the year when fish movement into the area is minimal. If it is feasible, coordination with resource agencies, e.g., Bureau of Sport Fisheries and Wildlife and Hawaii Division of Fish and Game, should take place prior to blasting to determine the most appropriate time period for detonation.

Confining the duration of siltation to a minimal time will minimize the impact to the harbor and adjacent communities. Blasting and excavation of the basin in the dry will avoid the continuous generation of silts into the harbor over an extended time. Thus only the final blasting which will open the new basin to the harbor will generate sediments into the existing harbor.

To minimize the amounts of cans, garbage and debris in the harbor and along the shore, adequate numbers and types of waste receptacles must be provided, with regular and frequent pickup of the harbor trash. It is also suggested that the State communicate with and elicit support of the various boating organizations in appealing for kokua from their members in controlling litter and prohibiting the cleaning of fish within the harbor. Regular users of the site may have additional ideas along these lines. Rules for operations of the support facilities must be detailed and enforced so that debris, such as paint scrapings, oil, etc. do not enter the harbor.

Harbor Division's regulations for small boat harbors already prohibit litter and pollution of any form. At the time of harbor expansion additional attention will be devoted to enforcement by harbor attendants. In addition, appropriate supplies of absorbent materials will be stocked at the harbor for control of accidental oil spills.

V IRREVERSIBLE COMMITMENT OF RESOURCES

Initial construction of the harbor, in effect, committed the northwest corner of the Kealakehe ahupua'a to recreational uses related to boating. Completion of the harbor will strengthen that commitment. Because of the involved blasting and excavation, the change in land form and land use is irreversible.

The proposed action commits the state to expenditures for construction as well as future expenditures for operation and maintenance.

VI ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Harbor facilities present a different visual impact than that envisioned in National Historic Landmark land to the north if there is park development devoted to preservation of archeological sites having a featured theme of isolation and undisturbed natural scene. To the extent that this visual setting is "different" from that which might be developed in an adjacent park, it can be interpreted as an adverse impact which cannot be completely avoided by mitigating measures.

The very fact that more people will be using the harbor when completed introduces the potential of adverse effects from litter, other pollutants, traffic and noise that results at public facilities.

VII RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Long-term use of the environment here (i.e., the northwest corner of the Kealakahe ahupua'a) for boating activities can add to the enjoyment (quality of life) for those who enjoy fishing, boating, diving, etc.

Harbor completion will involve some short-term adverse impacts from blasting and other construction activities.

Harbor completion will bring direct long-term economic benefits to the community from boating, fishing, and diving activities. It will have some catalytic effect on construction of nearby resort and residential facilities. Whether or not this effect is adverse will depend on the control of the scale and pace of development.

VIII ALTERNATIVES

A. No Expansion

Present harbor facilities are inadequate even for today's boating needs. Although a few persons can enjoy use of the surrounding waters without use of the harbor, this alternative would minimize use and enjoyment of the Kona fishing grounds. Additional launch ramps could be installed within the existing basins, but the recreational and economic benefits to be gained from accommodating some additional boats at berths would not be realized. Even if a "no-growth" policy were adopted by the County and State, some harbor improvement and expansion would be necessary to meet the waiting list of area residents. There has already been a significant State and Federal investment in the initial increment of harbor construction. Failure to complete the harbor would minimize the benefits to be expected from that initial investment.

B. Partial Expansion

Averaging of population projections and analysis of planning factors indicates that the capacity of the complete harbor could be reduced by about 100 berths from that planned in 1970. Such an alternative would be in keeping with a "controlled growth" policy for the Kona area. It would provide water and land space for adequate facilities.

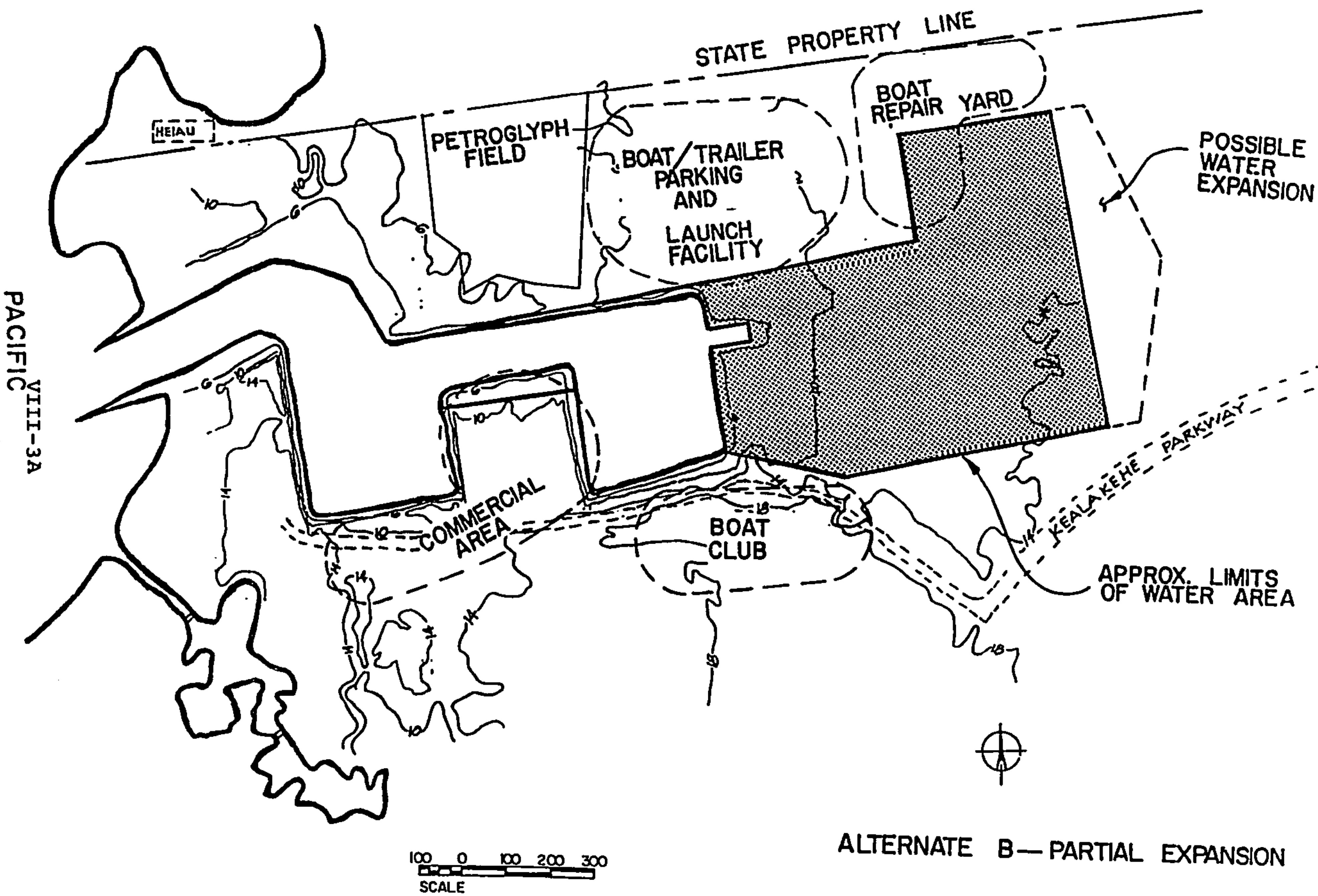
It would not over-commit current resources for the needs of future generations. Since the harbor will be developed in increments, an opportunity will exist to reassess the 2010 population planning base and planning factors before final harbor excavation. There will be time for orderly planning to accommodate necessary expansion, if in fact Keahole ocean energy activities, heavy usage from the Kohala districts and other factors result in further demands for berths at Honokohau Harbor.

Planning factors (e.g. boat berths required per 1000 population) are not precise numbers, and therefore there is some range of judgement to be applied in computing a requirement. On one hand, experience in Hawaii has shown that harbors have filled up more rapidly than expected, once constructed. On the other hand, computed requirements (450) in Table 9 of the 1970 Master Plan for Honokohau Harbor may be considered liberal in several categories so that the lower range of requirements might be considered closer to 400 than to 450. Furthermore, review of Table 12 of the 1970 Master Plan indicates a computed demand of 45 slips for boats 20' or less. Although less convenient, these boats could be trailered rather than berthed. The entrance channel itself, unless widened, serves to put some practical constraint on the ultimate practical size of the harbor.

In view of the above, a plan for a harbor with about 350 berths appears adequate under present circumstances. A prudent development plan will accommodate orderly expansion if and when it becomes necessary.

Figure 18 is a sketch of one suggestion for a partial expansion alternative. Figure 4 with the designation of berthing areas "H", "I", "N" and "O" as possible future expansion areas is another suggestion. Both alternatives provide for the functions and facilities desired by local boaters. They do not encroach on any valuable historical/archeological sites. Adequate space (at least 50 acres) could be available east of the harbor for park maintenance facilities if desired. No major changes in flushing, surge, water quality, etc., would result from the adoption of these alternatives. Details are discussed under the "Impacts" section.

Boat repair functions are suggested on the north side in Figure 18 to stay as close as possible to the deeper water of the access channel. An optional location for the boat repair facilities is to the east, and this might be acceptable. Another optional location for boat repair facilities would be on the south bank of the mauka basin. However, the elevation here is about 8 to 10 feet higher than the north side, and might provide a less desireable visual impact than if the repair facility were kept on low ground. Yet another option would be to



ALTERNATE B—PARTIAL EXPANSION

FIGURE 18

exchange the locations of boat launch ramps and boat repair facilities as depicted in Figure 18.

Launch facilities are suggested as close as possible to the access channel (as in the original Master Plan) to minimize interference with other boat traffic in the mauka basin and maximize benefits of flushing. The north side also provides a little more "turn-around" room for the launched boats.

There are several possible minor modifications which might be made to the actual shape of the basin yet to be excavated. For instance, a southward orientation of about 10° to 15° from east would follow the lowest contours to minimize excavation, and yet allow a little more room for boat repair activities if located on the north side.

Appropriate screen landscaping should be emphasized between the boat repair facilities and the northern boundary of the State property. This, and other details must await final planning/design. During this stage, plans can be set for maximum cooperation with those interested in historic/archeological site preservation on adjacent lands. There are opportunities for development of buffer and transition zones, joint use of roads as a secondary access to historical sites, restrooms, etc. (and perhaps even maintenance facilities) for mutual benefit.

The use of hoists can be considered in later years to provide additional launching capacity without increase in waterfront space.

In comparing the Partial Expansion, Alternate B (Figure 18) with the Modified Development Plan (Figure 4) it is noted that there are several options for configuration and for location of facilities As stated earlier, these details can and should be resolved during final planning/design of the harbor.

C. Southerly Expansion

Figures 19 and 20 are sketches of harbor configurations considered as alternatives. The former is a possible configuration if park boundaries (50 feet north and 400 feet mauka of the present harbor basins) were to be imposed as suggested in the Kaloko-Honokohau National Cultural Park proposal of 17 March 1975 (page 25). Figure 20 is a sketch of an alternate southerly expansion which would be preferable if the proposed park boundaries are not a constraint. Other variations, e.g orientation to the southeast are also possible alternates. These southerly configurations could be planned to adequately meet boating needs. Because the terrain is higher south of the present harbor, the additional cost of rock excavation/dredging has been estimated at $800,000 to $1,000,000; this is on the order of 10% of the total harbor costs, and a major percent of the next increment's cost.

Water Quality and Flushing

Because continued good water quality will be so dependent on good flushing special attention has been given to the relative flushing efficiencies of alternative configurations B, C1, and C2. The proposed southerly alternatives are discussed in order of increasing probable water quality. Results of the computer simulations of hypothetical pollutant spills and assumptions made in these assessments are also discussed.

Alternative C1. With respect to water quality this is the worst of the alternatives. The large inner basin is far removed from sources of mixing energy (high velocity channel flows and bottom springs), so that water motions will be quite sluggish.

In the new part of the harbor, the water would have a two-layered structure much the same as in the existing inner berthing basin; however, there would be little or no net circulating flow in these layers. Turbidity levels would be greatly increased.

The lower layer in the new basin would be dependent on tidal motions to exchange water with the outer harbor. Because this plan would remove the peninsula which now separates the existing basins, the velocity of flow and the amount of mixing energy at the outer end of the harbor extension would be reduced. Tidal flow in the lower layer in the neck leading to the enlarged basin would be 0.3 cm/sec. No large, circulating eddy would be produced in the basin, and water movements in the lower layer would approach zero near the inner walls.

A computer program was constructed to estimate the residence times of a hypothetical pollutant introduced into various places of the harbor extension. The largest part of the residence time of a substance in the lower layer is the time required for it to be dispersed locally. It would take about 6 1/2 days for half the original pollutant to leave the harbor extension.

Water in the surface layer would not be significantly mixed by tidal motions, and horizontal circulation would depend largely on the wind. Water in the surface layer at the inner end of the harbor extension could contain "dead spots" near the walls and corners where the prevailing winds would produce no circulation. Floating material could be trapped and might have an extremely long residence time (i.e., weeks - months). Dissolved material could escape by mixing down into the lower layer and thence outward. But since the vertical stratification is highly stable, the downward mixing would be slow; it might take one to two days to mix a significant fraction of the material down into the lower layer. Adding this to the time required to remove material from the inner end of the lower layer, we find that if some material were originally dissolved in the surface layer near the inner end of the harbor, about 8 1/2 days could elapse before half of it was removed from the harbor extension.

Alternative C2. This plan is second best of the three proposals with respect to water quality. It is very much better than C1 because of two factors. First, the existing interconnecting channel is left intact so that the high velocity flows in that channel provide a greater mixing energy at the seaward end of the new increment. Second, the increment is less extensive, so that its inner portions are closer to the source of mixing energy; this also increases the level of mixing in the interior. In addition, a pollutant must travel a shorter distance before being removed.

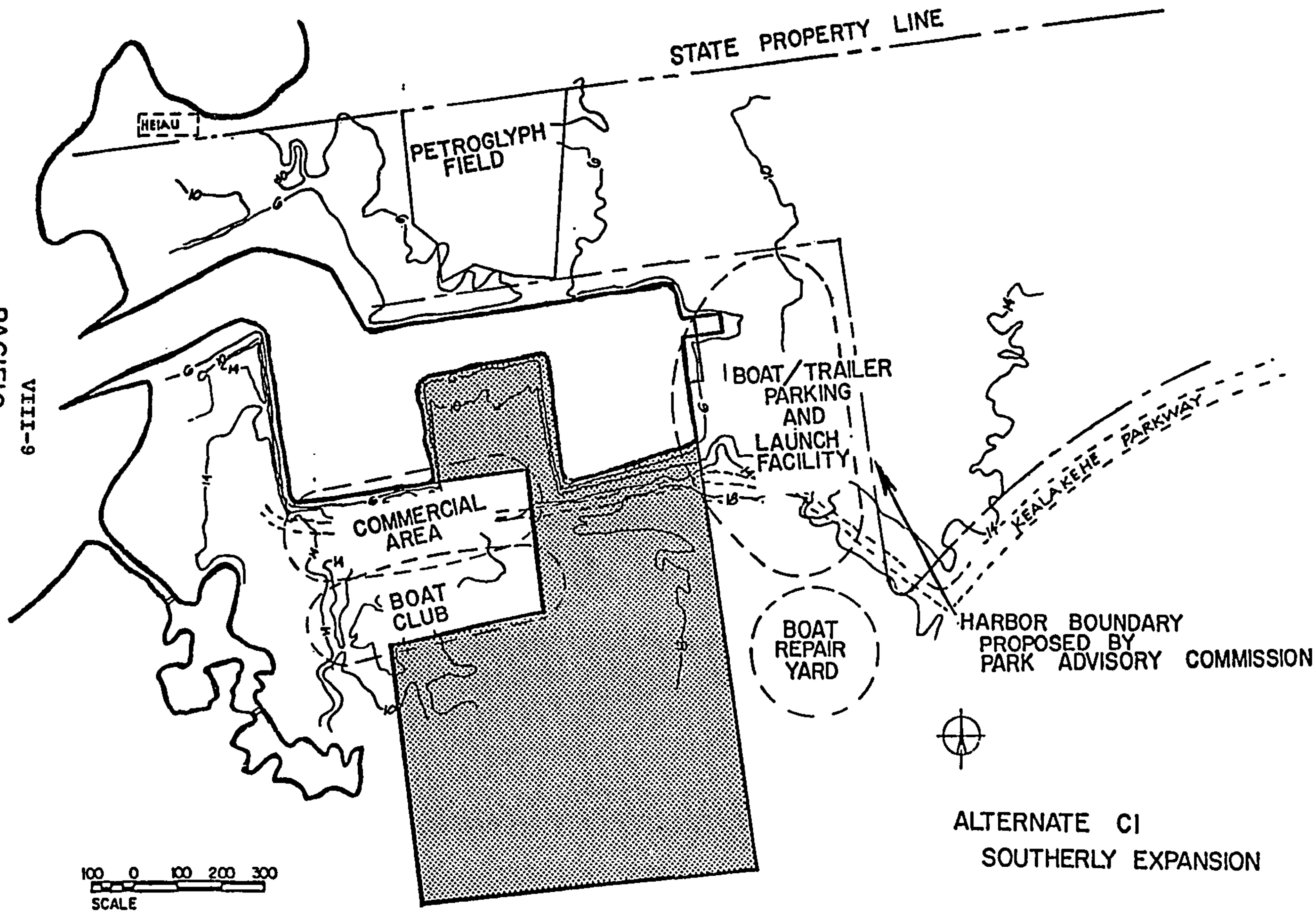
The overall physical behavior of extension C2 will be similar to that described for extension C1, except that the higher mixing energy and smaller dimensions combine to flush the lower layer much more rapidly. Half of a pollutant introduced in a thin band near the inner wall would be removed from the harbor extension in about 19 hours. This is about ten times faster than in plan C1. A dissolved contaminant at the inner end of the surface layer would be half removed in about three days. Again, floating material might be trapped from weeks to months.

Table 1 - HYPOTHETICAL POLLUTANT DISPERSAL

	Dissolved in 3m band in deep layer, along inner wall		Dissolved in 3m band in surface layer, along inner wall		Floating along inner wall	
Time to remove 1/2 of pollutant from original layer along inner wall	Alternate B	.3 hr.	Alternate B	~ hours	Alternate B	~hours
	Alternate C2	.4 hr.	Alternate C2	~2 days	Alternate C2	weeks-ms
	Alternate C1	3.4 hr.	Alternate C1	~2 days	Alternate C1	wks-mos
Time to remove 1/2 of original pollutant from inner half of harbor extension	Alternate B	12.3 hr.				
	Alternate C2	15.8 hr.				
	Alternate C1	134.8 hr.				
Time to remove 1/2 of original pollutant from entire harbor extension	Alternate B	14.8 hr.	Alternate B	~ 2.5 days	Alternate B	~1 day
	Alternate C2	18.9 hr.	Alternate C2	~2.5 days	Alternate C2	wks-mos
	Alternate C1	162.0 hr.	Alternate C1	~8.5 days	Alternate C1	wks-mos

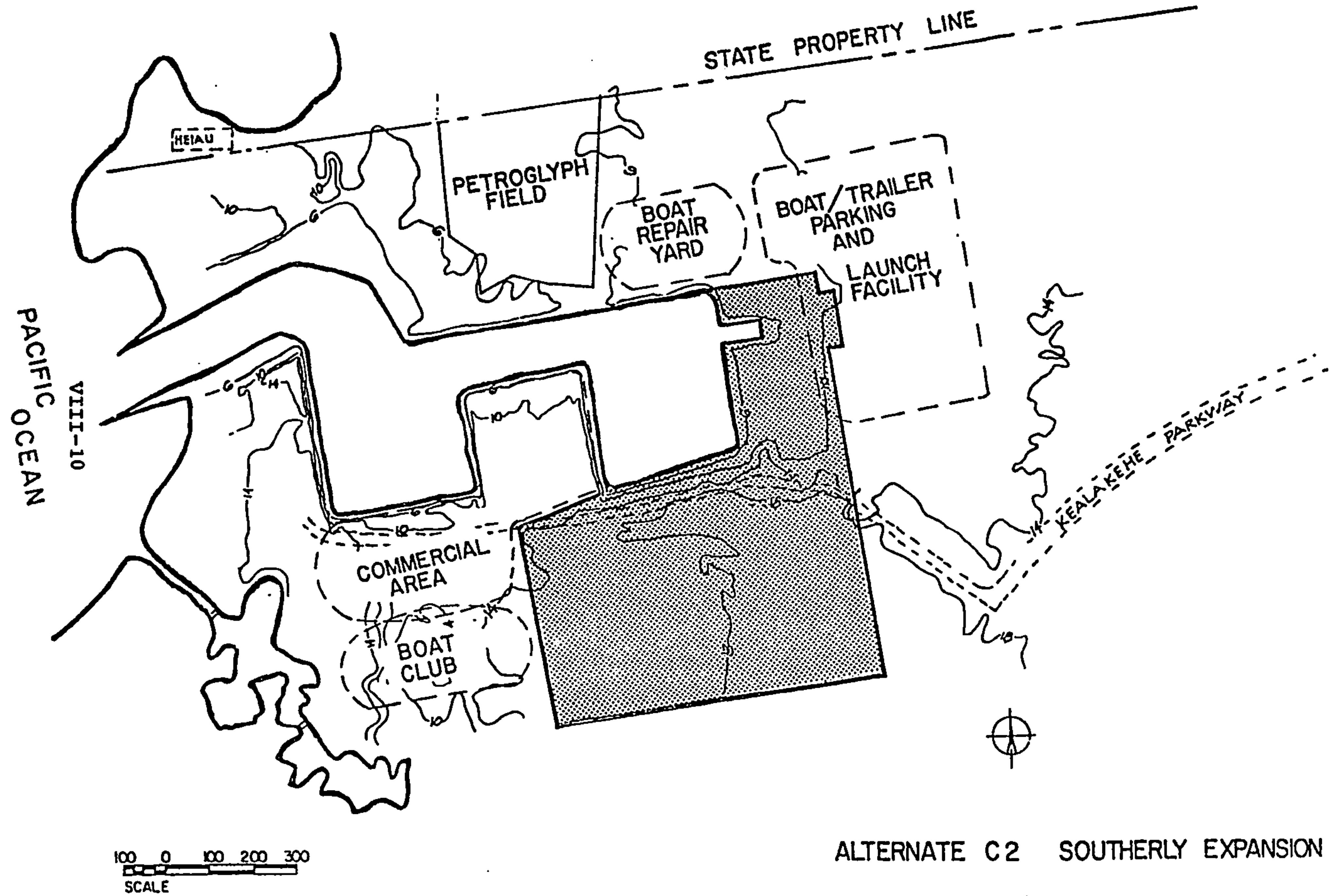
Table 1 shows the variation of half lives of hypothetical pollutant spills with proposed configurations B, C1 and C2.

Note: All numbers in this table are estimates. They show correct relative time periods and correct orders of magnitude, but no number should be regarded as exact.



ALTERNATE C1
SOUTHERLY EXPANSION

FIGURE 19



ALTERNATE C2 SOUTHERLY EXPANSION

FIGURE 20

Surge Considerations

Of the southerly expansion alternatives, the C2 concept in Figure 20 undoubtedly will provide quieter water than that in Figure 19 for berthing--based on observations of the excellent damping action of the present mole, which makes the inner basin substantially calmer than the outer basin.

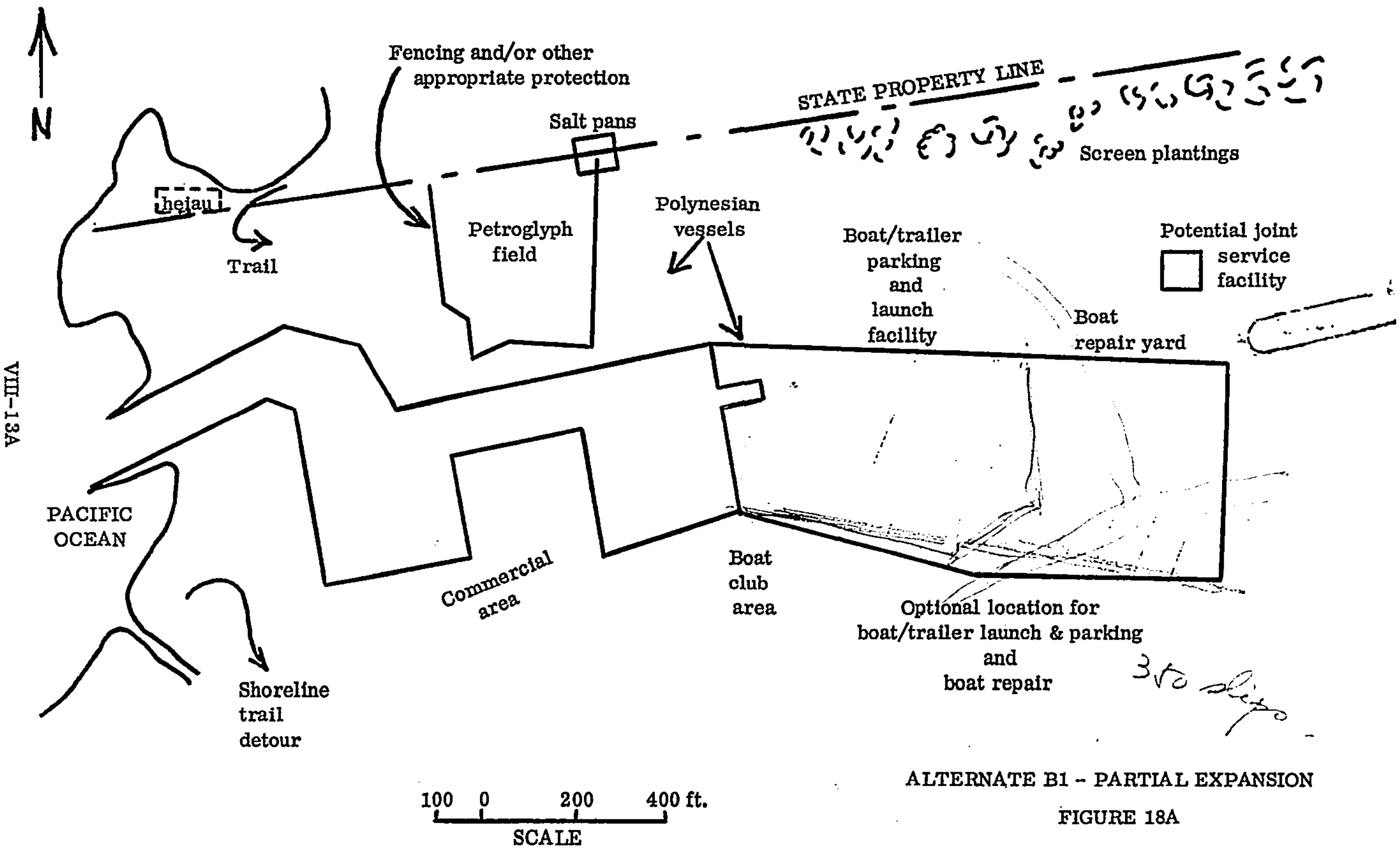
To determine whether any of the expansion alternatives would be much better in terms of expected surge (the seiching of water within a harbor) amplitude, Dr. Harold Loomis of the Joint Tsunami Research Effort (NOAA) was asked to apply computer programs he has developed for the analysis of seiching in irregularly-shaped basins. He was able to predict the various modes of oscillation that would occur in each of the proposed alternatives and the period of oscillation for each mode. Note: occasionally small remnants of ordinary surface waves which are not entirely damped out at the harbor entrance may enter and move through the harbor. Although boaters sometimes refer to this as surge, it is not the phenomena being discussed here.

Surge will occur in a harbor if it experiences any forcing or excitation having a period close to one of its natural seiching periods. In this case, the most likely sources of excitation are individual sets of high surf, or the long-period coastal waves (surf beat) that are generated during times of high surf. These excitations could have periods anywhere in the range from about 30 seconds to 10 minutes, and the results show that each proposed harbor has several natural modes of oscillation within this range (see Appendix C for Dr. Loomis' full analysis and report). Seiching has been observed in the existing harbor during periods of high surf and reportedly has an amplitude of about one foot with a period of near one minute, corresponding to excitation of the third mode of the present harbor. Since all of the proposed harbors have natural seiching periods in the range of possible excitation, all are equally likely to experience occasional surge.

Present analytical methods, such as those employed here, allow prediction of whether surge is likely to occur, but they do not permit reliable prediction of how big it will be. Our only guideline here is the fact that observed surge in the present harbor has an amplitude on the order of one foot. Although we cannot be sure, it seems unlikely that surging in an expanded harbor would have a much larger amplitude.

We note also that on June 10, 1975, an earthquake near Japan generated waves having 3-5 minute periods and it is known that some harbors reacted with violent surge. Honokohau Harbor will have oscillation with 3-5 minute periods and would therefore respond to such earthquake generated waves with rather large oscillation.

We conclude that none of the proposed alternatives vary significantly with respect to probable surge; the choice among the alternatives should therefore rest on other considerations.



ALTERNATE B1 - PARTIAL EXPANSION

FIGURE 18A

Figure 18A is an alternate harbor configuration developed in response to letter comments from the National Park Service State Director and others who expressed concern over expansion and/or activities to the north. This sketch is intended to serve as the basis for further discussion with state historical interests and national historic landmark interests concerning possible compromises and modifications to Figure 4, which is the configuration favored by the State Department of Transportation.

D. Other Locations for Harbor

GENERAL

Several sites were considered for development of a boat harbor before selection of the Honokohau site. Studies were made in the late 1950s by consultants to the State Harbors Division (then Board of Harbor Commissioners). Selection of the Honokohau site was made primarily because of:

1. Its favorable location
2. State ownership of the land
3. Its development could be tied to that of Ke-ahole Airport
4. Reasonable construction costs were projected
5. Favorable oceanographic conditions were predicted by model tests.

The following are some of the sites which were seriously considered as alternates to Honokohau.

KEAUHOU

Two sites were considered at Keauhou. The first is Keauhou Bay. This site is a less desirable alternate for the following reasons.

1. The bay is too small to allow berthing of the 350 plus boats requiring berths by the year 2010
2. Strong opposition has been voiced by local residents who are concerned about the impact of a harbor in the area on highways, utilities, etc.
3. The bay is subject to high waves and the breakwater would have to be located in deep water (about 20') - with resultant unreasonably high construction costs.
4. The surrounding topography makes it difficult to provide adequate parking and space for other shore facilities.

The second site is located about one mile south of the Kona Surf Hotel. Harbor development here would require excavation (blasting) similar to the Honokohau site. The site is owned by the Bishop Estate. Favorable aspects of this site include the following:

1. Land in this area is very low lying (about +6' to +10')
2. Deep water occurs just off the shoreline.
3. Existing infrastructure in the area is adequate for harbor development

Disadvantages of the site include the following:

1. It is adjacent to a historic battlefield (within a couple of hundred yards of the site)
2. Bishop Estate is not interested in selling the site
3. Cost of land acquisition would likely be very high. (It is estimated that land in this area is worth $200,000 per acre)

KAHALUU

This site is the location of an existing Hawaii County Beach Park. It is heavily used by both local residents and tourists. It is one of the few sandy swimming beaches in Kona. The site is also located on Alii Drive which is the heavily traveled roadway in Kona. For the above reasons, the site is not suitable for the development of a boat harbor.

KAILUA BAY

Early studies (circa 1960) by the State determined that development of a marina in Kaulua Bay was feasible. Local residents and hotel owners, however, voiced strong objections to construction of a harbor in this location because of:

1. Its visual impact
2. Its impact on the infrastructure

It should also be noted that if a harbor were to be constructed at this site, a very costly breakwater would be required because of the depth of the water.

Although Kailua Bay might have been a reasonable alternate 20 years ago it is not considered so today. Traffic and space requirements for harbor parking and shore facilities would pose problems whose solution would be disruptive to Kailua's current and planned development. Costs of solutions would be unreasonably high.

KALOKO

This site is located just north of the existing Honokohau Boat Harbor. Construction of a harbor here would necessitate destruction of a valuable Hawaiian fish pond, and therefore at this time Kaloko has not been given serious consideration as an alternate site.

KIHOLO

This site is located north of Kailua-Kona along the recently opened Kaahumanu Highway. The site has been chosen by the State Parks Division for development of a major state beach park. Development of the park will not occur for many years. It will require a costly access road. Utility lines must be extended from Ke-Ahole. A long expensive breakwater would be required for harbor development. Kiholo is a far less convenient location than Honokohau for a harbor site.

IX LIST OF NECESSARY APPROVALS (and status)

In addition to a ruling on acceptability of this Environmental Impact Statement, the following approvals will also be required:

A. Clearance under PL 92-346; 86 STFT. 457 (July 11, 1972)

This law was enacted to provide a study of the feasibility and desirability of establishing a national historic/cultural park at and near the Honokohau National Historic Landmark. The law prohibits any undertaking at or near this location during the study and until submission of the study report to the President and to the Congress until and unless approved by the Secretary of the Interior. A letter of 8 May 1975 from the Secretary to the Governor of the State of Hawaii advises that a review of this harbor EIS and recommendations of Congress will be necessary preludes to clearance under PL 92-346.

B. Clearance under National Historic Preservation Act of 1966

A permit from the US Army Corps of Engineers will be required for excavation/dredging of the harbor. The Harbors Division of the State Dept. of Transportation submitted an earlier permit request, but will submit a revised request for such a permit as soon as appropriate.

Before the Corps can act on such permit, consultation and correspondence with the State Historic Preservation Officer and the National Advisory Council on Historic Preservation will be required to assure compliance with the National Historic Preservation Act relative to an undertaking within the area of impact of a National Historic Landmark. The issues of interest to each of these groups are concurrently discussed in this EIS.

Note that both of the above clearances require review by the National Advisory Council on Historic Preservation. Action by the Advisory Council has heretofore been held in abeyance pending completion of the park proposal report and the harbor development EIS.

C. Structures proposed for commercial and administrative use at the harbor (where there is "Open" zoning) will require approval by the County Planning Department and the County Council.

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Daniel, Mann, Johnson & Mendenhall Dec. 1970 Master Plan of Boating Facilities for Honokohau Harbor

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National Park Service Draft EIS for proposed Kaloko, Honokohau National Cultural Park, Hawaii. March 1975.

Honokohau Study Advisory Commission, National Park Service, the Spirit of Kaloko Honokohau Proposal for establishment of a Kaloko Honokohau National Cultural Park. March 1975.

XI CONSULTATION & COORDINATION

1 Agency, Firm and Persons Preparing Statement

State Department of Transportation - Harbors Division

Prime Consultant - Oceanic Foundation

Paul Bienfang, leader of scientific team - assisted by:

Brent Gallagher - physical oceanographer

Wayne Mitter - environmental consultant

William E. Spencer - planning and engineering consultant

Aki Sinoto - Bishop Museum archeologist

2 Agencies, Organizations, Individuals Consulted

Department of Interior, National Park Service - Honolulu Office

U.S. Army Corps of Engineers

Department of Interior, Fish & Wildlife Service

State Department of Land & Natural Resources

State Department of Planning & Economic Development

State Department of Health

County - Planning Department

Hawaii Leeward Planning Conference - Mr. Wm. Thompson

State Historic Preservation Officer

2 Members of Honokohau Study Advisory Commission

David Roy - Executive Officer Honokohau Study Advisory Commission

Richard Kapolulu - Consultant to Honokohau Study Advisory Commission

Kona Mauka Trollers

Charter Skippers Association

Various boaters, including Sid Weinrich, George Parker, Phil Parker, Lewis Sterry, Kenny Young, Ken Nakamaru, Les Fujiwara, Roy Murioka

3 Summary of Views Opposing Harbor/with comments

a. There is some opposition to the harbor based on the belief that a no-growth policy would be good for the area, and that any harbor expansion or improvement would encourage growth.

b. There is fear by others that too much growth and too fast growth in the Kona area, partly encouraged by small boat harbor improvements could result in a "Miami" type community.

c. There is belief by some that any harbor expansion will inevitably bring pollution of the harbor water, and the outside coastal water, and even adjacent ground water so that adjacent swimming, diving, fishing, and even the proposed fishpond operations would be adversely affected.

d. There is much interest in preservation of a substantial integrated area of historic/archeological sites to the north of the harbor (not just preservation of small enclosures around individual sites with minimal buffers). There is a deep-seated belief that the full cultural/educational value of the sites can only be achieved by "area" preservation in a form such that open space and a natural atmosphere are preserved in and around the selected "area". The group with this interest is vitally concerned with minimizing any intrusion by the harbor facilities, visually or otherwise, on the sanctity of such an area.

e. There is a concern that insufficient attention is paid to the harbor facilities needed by "local" boaters - who are identified primarily as the owners of the trailered boats, needing launch ramps, and related facilities.

- Comment - Launch ramps, washdown facilities, fish weighing, trailer parking, etc., should be given priority consideration.

f. There is a concern that a substantial state expenditure for harbor enlarging and improvements will be primarily for the benefit of "non-local" people - and absentee owners and for those seeking tax-shelters (rather than primarily recreation).

- Comment - There can be some mitigation of the public funding concern by use of private funding for some facilities (i.e. through long-term lease). There are willing investors.

- Comment - Harbor benefits to "local" people must be made clear and understandable, if their support is to be requested.

- Comment - The present waiting list of 90 for berths at Honokohau shows:

boats 25' to 35'	-	48 persons
boats 35' to 45'	-	20 persons
boats 45 ' up	-	7 persons

(some applicants don't list length

Of the 90 now on list, 10 are from out of state, 12 from Honolulu and 1 from Lahaina. Less than 3 of the present boats in the harbor are held by what might be considered absentee owners.

- Comment - Potential tax write-off benefits have been made minimal compared to 5 years ago due to more stringent interpretations of tax laws.

g. A concern has been expressed that the main benefactors of harbor improvements will be those with vested interest in escalation of land values in the Kona districts. There is attendant fear of the problems of land speculation.

- Comment - Unquestionably, completion of the harbor will raise land values in the Kona area - particularly for property near the harbor, and this can lead to land speculation. On the other hand, this very increase in potential earnings makes it possible for private investment to bear part of the burden for desired facilities, without requiring further government expenditure. Limited government control can insure that the privately funded facilities are in keeping with community objectives. Zoning can afford some control on land speculation.

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S SAKAMOTO
CHARLES O SWANSON

IN REPLY REFER TO
HAR-ED 87

July 15, 1975

Fish and Wildlife Service
United States Department of the Interior
Division of River Basin Studies
821 Mililani Street
Honolulu, Hawaii 96813

Gentlemen:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

In reply to your letter of July 2, most of the topics of your concern are covered in the EIS. The following remarks are supplementary:

1. Flushing will be adequate to maintain water quality for fish and wildlife resources.

2. The analysis of groundwater flows indicates it is highly improbable that the harbor completion would affect either the water quality or water level of Aimakapa Pond.

3. The Harbors Division is planning to add aeration treatment of the sewage from the comfort station with the next phase of development.

   In addition, although liveaboards are not permitted at Honokohau Boat Harbor (except for transients), ship to shore "pump-out" facilities will be included in the next phase.

4. Regarding oil spills, the construction and operation of the fueling facility will have to comply with all applicable Federal, State and local regulations. The operator will be required to have an approved contingency plan including the equipment and materials for containment and removal of any oil spills.

5. There will be coordination with the Fish and Wildlife Service and the State of Hawaii Fish and Game service prior to blasting.

6. A dry storage facility will be considered during the design phase of this project.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

JUL 3 10 02 AM '75

HARBORS DIV.
DEPT. OF TRANSPORTATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Division of River Basin Studies
821 Mililani Street
Honolulu, Hawaii 96813

Reference: RB

July 2, 1975

Mr. Tom Fujikawa
State of Hawaii
Department of Transportation
Harbors Division
79 South Nimitz Highway
Honolulu, Hawaii 96813

Re: HAR-ED 3642

Dear Mr. Fujikawa:

This responds to your recent request to the Secretary of Interior, Rogers C.B. Morton, for comments on the proposed development of Honokohau Harbor, North Kona, Hawaii.

Your correspondence was directed to this office for a response relating to fish and wildlife interests. The following information is being provided on a technical assistance basis for your consideration in the preparation of an environmental impact statement regarding the possible impacts from the proposed expansion project on fish and wildlife resources.

We understand, from the information provided, that the additional water area required for the expanded harbor plan will be located inland from the existing harbor boundary. This design should consider whether or not the flushing action of the new harbor area will be adequate to maintain water quality for fish and wildlife resources, especially when the harbor becomes operative with slips for approximately 450 boats and 350 launchings/day at peak.

With the expansion of the harbor, undoubtedly, fresh water seeps will be uncovered. Ground water sources apparently originate from the uplands. We are concerned that the exposure of additional seeps during dredging operations could influence the water levels of the adjacent endangered waterbird ponds, located to the north of the harbor site. Aimakapa Fishpond is the largest of the ponds. Because of the high value of these ponds as endangered waterbird habitat, the proposed harbor study should evaluate the potential effects of dredging on the pond water supply or level.

With the development of restrooms in the area, adequate treatment and/or disposal of treated effluent should be considered. It is our opinion that at least secondary treatment should be undertaken with effluent discharge directed out of the harbor. In addition, if live-aboards will be allowed to utilize the harbor, we urge that ship-to-shore "hookups" for disposal of sanitary wastes be incorporated into the harbor design, or discussed in the impending statement. From our past experience, it appears that illegal shipboard discharge is almost impossible to enforce. The statement discussion should also indicate whether or not house boats will be allowed to utilize harbor facilities. Due to the overall and somewhat limited harbor areas in the State, we believe that the harbor should be utilized for bonafide boater activities and not specifically residential quarters.

The discussion on fueling dock operations should include a statement to cover potential oil spill problems. It should be indicated how problems of this type will be corrected, i.e., contingency plan, and what, if any, measures are being considered to prevent spills.

While excavating the harbor it is possible that explosives will be used. A statement should be included to indicate what control devices will be used to prevent excessive fish kills and/or minimize siltation and control turbidity.

In reference to boat berthing and launching activities, it is apparent that the demand for these facilities or uses of this type will increase in the future. Has the harbor plan considered onsite dry-land storage for small boats users? Supplemental dryland storage of smaller crafts would help alleviate a potential, future inwater berthing problem by providing this facility, thus allowing additional inwater berthing for larger vessels. It could also possibly result in less water area requirement for berthing. This method of storage should be considered in your preparation of the statement.

The statement will undoubtedly contain a list of the existing biota that utilize the area, and will address this Department's correspondence of November 29, 1972 to Mr. Matsuda regarding this project.

We appreciate this opportunity to comment. If we can be of any additional assistance, please let us know.

Sincerely yours,

Maurice H. Taylor

Maurice H. Taylor
Area Supervisor

cc: OEC, Washington, D.C.
RD,RB, Portland

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
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E. ALVEY WRIGHT
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CHARLES O. SWANSON

IN REPLY REFER TO

July 15, 1975

HAR-ED 88

Mr. James M. Greenwell, President
Lanihau Corporation
3210-E Koapaka Street
Honolulu, Hawaii 96819

Dear Mr. Greenwell:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

In response to your letter of June 27 concerning archaeological values, our Honokohau Harbor EIS relies on statements in the Draft EIS for the Proposed Kaloko-Honokohau National Cultural Park (p. 50) that there are 234 historic/archaeological sites within the National Historic Landmark and (p. 107) that Honokohau is one of ten potential historic park sites in the State. Among these 10 locations, Honokohau has a rating equivalent to Halawa, and is second in the State only to Honaunau in archaeological value.

I trust this satisfactorily explains the reason for our conclusion.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

LANIHAU CORPORATION

3210-E KOAPAKA STREET
HONOLULU, HAWAII 96819

June 27, 1975

Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

Attn: E. Alvey Wright, Director

RE: HAR - ED 3642

Gentlemen:

This letter shall acknowledge your communication of May 21, 1975 and thank you for extending to us an invitation to submit material germaine to the preparation of an Environmental Impact Statement looking to further development of the Small Boat Harbor at Kealakehe-Honokohau.

It is noted that your EIS Preparation Notice, Item (f), Major Impacts, alleges that historic/archaeological sites are abundant in the surrounding area. We suggest that while a heiau, certain petroglyphs and a few other items may exist within the Honokohau area and be worthy of preservation the term "abundant" is an exaggeration. To the best of our knowledge no fair and impartial evaluation has ever been made of evidences of early human habitation recorded by professional archaeologists within the area. We further submit that to continue to allege the presence of an abundancy of historic/archaelogical sites within the area serves to perpetuate an untruth which works to the detriment of many innocent taxpayers.

Yours very truly,

Lanihau Corporation

James M. Greenwell, President

JMG:sm
cc: GAH

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
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IN REPLY REFER TO

July 15, 1975

HAR-ED 89

Hawaii Leeward Planning Conference
P. O. Box 635
Kailua-Kona, Hawaii 96740

Gentlemen:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

In response to your letter of June 26, the Keauhou repair facilities will be phased out with the eventual development of the boat repair facilities at Honokohau Boat Harbor.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

2062

DIRECTOR

JUN 30

DEPT. OF TRANSPORTATION

HAWAII LEEWARD PLANNING CONFERENCE

June 26, 1975

E. Alvey Wright, Director
STATE OF HAWAII
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

SUBJECT: HONOKOHAU SMALL BOAT HARBOR PROJECT ENVIRONMENTAL IMPACT STATEMENT

Dear Admiral Wright:

We have reviewed the notice on the preparation of the E.I.S. for the Honokohau Boat Harbor Project and find it embraces the subject matters to be covered by said report adequately. While just a detail, we assume that the E.I.S. will also include a statement on the replacement of the limited existing ship repair facility at Keauhou Bay by the new and larger ship repair installation at the proposed Honokohau Boat Harbor project. This, of course, follows the concept of having the Honokohau Project serve as the principle boating center for Kona.

We look forward to the completion and circulation of the Honokohau Boat Harbor E.I.S. We are appreciative of the cooperation being provided by you and your staff and the Consultant to the recreational and commercial boat-owners of Kona.

Aloha,

Bill

W. Y. Thompson
Executive Secretary

WYT:ma

cc: Representative Minoru Inaba
Kona Mauka Trollers
Kona Charter Skippers Association

P.O. BOX 635 • KAILUA-KONA, HAWAII 96740 • PHONES 329-2334 • 329-1758

GEORGE R. ARIYOSHI
GOVERNOR

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CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU HAWAII 96813

IN REPLY REFER TO

July 16, 1975 HAR-ED 90

Advisory Council on Historic Preservation
1522 K Street, N. W., Suite 30
Washington, D. C. 20005

Attention Mr. Louis S. Wall

Gentlemen:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

In response to your letter of June 18, the following information is pertinent:

Inasmuch as the expansion of Honokohau Boat Harbor will take place within the boundaries of the Honokohau National Landmark, a National Register property, two Federal actions are necessary in order to proceed: (1) the Rivers and Harbors Act Permit to be issued by the U. S. Army Corps Engineers and (2) the approval of that Permit by the Secretary of Interior pursuant to P. L. 92-346. Both are governed by the provisions of Section 106 of the National Preservation Act of 1966.

Accordingly, a Section 106 consultation was held on February 2, 1973 with the subsequent request that a southerly expansion be considered. On August 16, 1973, the Department of Transportation, State of Hawaii, submitted information to the Secretary of Interior outlining the difficulties and relatively much higher costs involved with expansion towards the south. On September 24, 1973, the Secretary of Interior reported that approval of the harbor expansion will be held in abeyance pending completion of the Honokohau Study Advisory Commission's report.

The State Department of Transportation realizes the importance of preserving the remaining vestiges of our early Hawaiian culture and will continue close coordination with the Department of the Interior, the National Park Service (Hawaii Group), and the State Historic Preservation Office to insure that any adverse effect will be minimized and that satisfactory mitigating measures are adopted.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

P Jun 23 [illegible] AM '75

HARBORS DIV.
DEPT OF TRANSPORTATION

Advisory Council
On Historic Preservation
1522 K Street N.W. Suite 430
Washington D.C. 20005

June 18, 1975

Mr. Tom Fujikawa
Department of Transportation
Harbors Division
State of Hawaii
79 South Nimitz Highway
Honolulu, Hawaii 96813

Dear Mr. Fujikawa:

This is in response to Mr. E. Alvey Wright's request of May 21, 1975 for comments to assist in the preparation of an Environmental Impact Statement for the further development of Honokohau Boat Harbor, Kona, Hawaii. Pursuant to Section 106 of the National Historic Preservation Act of 1966 and Sections 1(3) and 2(b) of Executive Order 11593, "Protection and Enhancement of the Cultural Environment" of May 13, 1971, the Advisory Council is charged with the responsibility of providing Federal agencies with comments on their undertakings which affect cultural resources. Until the Council has been notified by a Federal agency that it has determined an undertaking will affect a property included in or eligible for inclusion in the National Register of Historic Places, the Council is unable to comment.

The Council on Environmental Quality's guidelines for compliance with the National Environmental Policy Act of 1969 directs Federal agencies to forward copies of environmental statements prepared for undertakings which will have an impact on historical resources to the Advisory Council for review and comment. Should a Federal agency become involved in the proposed development of the Honokohau Boat Harbor a copy of the environmental statement will be sent to the Advisory Council for review and comment because of the project's relationship to the Honokohau Settlement National Historic Landmark.

Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969, the Advisory Council will be unable to provide substantive comments on the environmental statement unless it contains evidence of the following:

I. Compliance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470[f]). The Council must have evidence that the most recent listing of the National Register of Historic Places has been consulted (see Federal Register, February 4, 1975 and monthly supplements each first Tuesday thereafter) and that either of the following conditions is satisfied:

A. If no National Register property is affected by the project, a section detailing this determination must appear in the environmental statement.

B. If a National Register property is affected by the project, the environmental statement must contain an account of steps taken in compliance with Section 106 and a comprehensive discussion of the contemplated effects on the National Register property. (36 C.F.R. Part 800 details compliance procedures.)

II. <u>Compliance with Executive Order 11593 "Protection and Enhancement of the Cultural Environment" of May 13, 1971.</u>

A. Under Section 2(a) of the Executive Order, Federal agencies are required to locate, inventory, and nominate eligible historic, architectural and archeological properties under their control or jurisdiction to the National Register of Historic Places. The results of this survey should be included in the environmental statement as evidence of compliance with Section 2(a).

B. Until the inventory required by Section 2(a) is complete, Federal agencies are required by Section 2(b) of the Order to submit proposals for the transfer, sale, demolition, or substantial alteration of federally owned properties eligible for inclusion in the National Register to the Council for review and comment. Federal agencies must continue to comply with Section 2(b) review requirements even after the initial inventory is complete, when they obtain jurisdiction or control over additional properties which are eligible for inclusion in the National Register or when properties under their jurisdiction or control are found to be eligible for inclusion in the National Register subsequent to the initial inventory.

The environmental statement should contain a determination as to whether or not the proposed undertaking will result in the transfer, sale, demolition or substantial alteration of eligible National Register properties under Federal jurisdiction. If such is the case, the nature of the effect should be clearly indicated as well as an account of the steps taken in compliance with Section 2(b). (36 C.F.R. Part 800 details compliance procedures.)

C. Under Section 1(3), Federal agencies are required to establish procedures regarding the preservation and enhancement of non-federally owned historic, architectural, and archeological properties in the execution of their plans and programs.

The environmental statement should contain a determination as to whether or not the proposed undertaking will contribute to the preservation and enhancement of non-federally owned districts, sites, buildings, structures and objects of historical, architectural or archeological significance.

III. <u>Contact with the State Historic Preservation Officer.</u>

The procedures for compliance with Section 106 of the National Historic Preservation Act of 1966 and the Executive Order 11593 require the Federal agency to consult with the appropriate State Historic Preservation Officer. The State Historic Preservation Officer for Hawaii is Christopher Cobb, Chairman, Department of Land and Natural Resources, P. O. Box 621, Honolulu, Hawaii 96809.

Should you have any questions or require any additional assistance, please contact me at P. O. Box 25085, Denver, Colorado 80225, telephone number (303) 234-4946.

Sincerely yours,

Louis S. Wall

Louis S. Wall
Assistant Director, Office of
Review and Compliance

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO

July 16, 1975 HAR-ED 91

Kona Conservation Group
RR1, Box 83
Captain Cook, Hawaii 96704

Gentlemen:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

This is in reply to the concerns in your letter of June 23:

1. Needs for projects, and for the several categories of boaters are discussed in the EIS.

   The EIS discusses the impacts of harbor completion as envisioned to meet needs to the planning year 2010. Inasmuch as State funds are involved, features of the harbor will be built in an order of priority to meet the needs of the people of Kona, people of the County of Hawaii, and people of the State of Hawaii.

2. Effects of the project.

   Harbor completion will be planned to insure maximum compatibility with State, County and private development plans for the area.

   a. Economic factors.

      (1) The State has no plans prepared at this time for leasing of adjacent areas.

      (2) The EIS section on alternatives discusses compatibility with a policy of controlled growth.

(3) Completion of the harbor is expected to have a positive effect on tourism. It is possible that officials of the Billfish Tournament might decide to hold activities at Honokohau Harbor, but no commitment has been requested.

(4) It can be expected that the boat harbor will encourage resort development.

b. Social factors – are discussed in the EIS.

There is no evidence of any possibility of depletion of fish species as a result of completing the harbor.

c. Historical sites – are discussed in the EIS.

This project is being coordinated with the State Preservation Officer and the National Park Service, Hawaii Office, to minimize any adverse effect so as not to violate in any way the integrity of the Honokohau National Historic Landmark.

d. Recreation, water quality and wildlife.

(1) Completion of the harbor will not itself degrade the quality of adjacent waters nor beaches. Improvement of access, as well as the proposed shoreline trail system will increase the number of persons on the limited beaches, as well as visitors to the harbor and this does increase the possibility of litter.

(2) Water quality standards and monitoring are discussed in the EIS.

Harbor completion will not create adverse water quality impacts at Aiopio fish trap nor at Aimakapa pond.

3. Design consideration.

Safety aspects are discussed in the EIS. The harbor entrance has wave problems several days a year. Possible solutions have been discussed which deserve further investigation. The problems are not considered major, nor do they require resolution prior to a decision on completion of the harbor.

4. Alternatives are discussed in the EIS.

5. A limited discussion of development costs and funding is provided in the EIS.

6. Rules and Regulations for harbor operation.

   Such rules are always subject to change to meet best needs of a community. However,

   a. There will probably be a minimum boat length for applications for permanent assignments to slips. At present, boats 24 feet and over can apply for berths. Smaller craft must be trailered and launched.

   b. There will probably be a continuation of prohibition on live-aboards except for short-term transients.

   c. Regardless of definition of marina or boat harbor, the likely facilities to be included are discussed in the EIS.

7. Supporting data is primarily included in the EIS or its appendices.

Thank you for submitting your comments.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

KONA CONSERVATION GROUP
CAPTAIN COOK, HAWAII 96704
RR1, Box 83

June 23, 1975

Department of Transportation
Harbors Division
79 South Nimitz Highway
Honolulu, Hawaii 96813
Attention: Mr. Tom Fujikawa

SUBJECT: Environmental Impact Statement of Honokohau Boat Harbor - Job H.C. 6047; Your Letter HAR-ED 3642

Dear Gentlemen:

We are happy to respond to your letter of May 21, 1975. We believe that the following questions and concerns need to be fully disclosed and discussed in the EIS in order to comply with the spirit and intent of the law.

1. Need for the project:

   A. What harbor facilities are needed by the various groups of people in Kona, i.e.

      (1) the local commercial fishermen
      (2) the local resident who fishes part-time for his family and for supplemental income
      (3) the charter boat fishermen
      (4) owners of luxury boats
      (5) other groups - specify

   B. What is the priority listing of these features and by which groups?

   C. What segment of the population of Kona do these groups represent?

   D. Who are the applicants for berths? Information should include date of application, place of residence, income group, purpose of boat (commercial, recreation, etc.).

   E. How was the assessment for #1A,B, and C above made?

   F. Will the EIS discuss only Phase 2 of the project, or Phase 2 and the total project? We believe that the latter is required for full disclosure, discussion, and evaluation of the project.

   G. Are the features being built in order of priority to meet the needs of the people of Kona?

2. Effects of this project:

   Is this project compatible with State, County, and private development plans for the surrounding area? Discussion should include, but not be limited to:

A. Economic factors:

(1) Is the State still planning to lease adjacent areas for resort development?

(2) How does the State Administration's slow growth policy tie in with this project?

(3) How will tourism in Kailua-Kona be affected by this project? For example, does construction of fish-weighing stations and tournament area mean that the Billfish Tournament activities will be held at Honokohau Boat Harbor instead of at Kailua Pier?

(4) Will the boat harbor expansion encourage resort development of the area?

B. Social factors:

If the boat harbor is completed to include 450 berths, boating club(s), resort, and commercial development, how will this affect:

(1) the neighboring Kealakehe housing project residents' lifestyles? Discussion should include population projection figures, traffic, congestion, etc.

(2) the residents to whom fishing is an integral part of their lifestyle? Discussion should include fish population and distribution information, possibility of depletion of fish, etc.

C. Historical sites:

In the light of a full discussion of the Honokohau Study Advisory Commission's findings and recommendations for the creation of a National Historical Park within this area, will this boat harbor project be compatible in terms of:

(1) maintainihg an atmosphere of appreciation for the early Hawaiian cultural and spiritual values? Or will it further violate the integrity of the National Landmark and thereby jeopardize its chances of remaining on the National Register?

(2) the visual effect of this project?

(3) factors of noise, smells, air pollution, traffic?

(4) the preservation of the petroglyphs and other historic sites in the area?

D. Recreation, water quality, and wildlife:

(1) What measures will be taken to preserve the sandy beaches on either side of the boat harbor for swimming

and surfing without degredation of water quality or "beach" quality (no oil slicks or leaks, debris, etc.)? Full disclosure and discussion is needed of the following:

(a) Kona has only 1.2 miles of sandy beaches.

(b) Honokohau Bay is a very good surfing site.

(2) What are the water quality standards in and around the boat harbor? How will they be maintained? What monitoring is planned? What corrective action is planned in case of pollution? Discussion is needed on:

(a) the plans for the National Historical Park which include the re-establishment of the Aiopio fish trap and the Aimakapa fish pond. .

(b) effects of known water-polluting activities in and around the boat harbor, e.g., paint-scraping, rust-removal, on the water quality and consequently on wildlife at Honokohau Pond, a wildlife sanctuary of national significance.

3. Design consideration:

Evaluation is needed on the present channel design and efficiency. Since one of the reasons given originally for the need of a boat harbor was the need for a refuge for boats in time of rough seas, is the entrance safe? Under what conditions is it safe and unsafe? Would expansion and increase in traffic compound the problem? What is needed to make the entrance channel safe, or safer, and at what cost?

4. Attetnatives:

We believe that alternative proposals would depend heavily on the full disclosure and discussion of the needs of the people of Kona - who needs what specific features and in what order of priority. Then, the alternatives listed below should be considered:

A. revision in scale of the total project (e.g., fewer berths, more ramps).
B. revision in direction of expansion (e.g., go south instead of east).
C. revision in list of specific features (additions or deletions).
D. reorder of priorities (e.g., if people need ramps most urgently, ramps should be built first).
E. dispersal of some facilities instead of centralizing (e.g., people may want small ramps at various locations along the Kona coast instead of several ramps at one location).
F. incorporate all priority features in Phase 2 and stop there.
G. no expansion (if needs of people are already met).

5. Funding: Included in a full discussion of the cost of the harbor features (separately and collectively) and the scheduling of construction should be a discussion of the funding process, and

in particular, the lapsing of funds. When do funds lapse and get lost? How can they be held over?

6. Rules and regulations regarding the operation of the boat harbor:

To the extent known about boat harbors in general, and Honokohau in particular, what rules and regulations will govern the operation of this boat harbor until completion and after completion of the total project? For example:

A. Will only boats of 20 feet or longer be permitted to moor in the harbor?

B. Will living on boats be permitted? What constitutes living on a boat?

C. Is the facility at Honokohau to remain a boat harbor or will it evolve into a marina? What features and/or operations define a boat harbor? a marina?

7. Supporting data:

We strongly believe that the adequacy of an EIS depends on the inclusion of supporting data to substantiate the conclusions and decisions. Therefore, all such studies, surveys, data, documents, etc., that are the source of information and basis of conclusions must be included in the EIS or in an appendix as an integral part of the EIS. Only then can each reviewer of the EIS analyze and evaluate the data himself, and then analyze and evaluate the conclusions and decisions based thereon. This, we believe, is required for meaningful discussion and evaluation.

8. Index:

We also believe that an index, however rudimentary, is needed for any EIS more than ten pages in length. A table of contents is not considered sufficient.

We hope that these comments, questions, and suggestions will be useful in the preparation of the preliminary draft EIS which is scheduled for completion around July 15, 1975. If, for any reason, any of these items cannot be incorporated in the EIS, please so inform us.

Yours truly,

Alan Tyler

ALAN TYLER
Chairman, Shoreline Committee
KONA CONSERVATION GROUP

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO

July 16, 1975

HAR-ED 92

Life of the Land
404 Piikoi Street
Honolulu, Hawaii 96814

Gentlemen:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

In response to your letter of June 20, your concerns in Items 1 and 2 are dealt with in the EIS.

State Health Department regulations designate a limited area of water next to the boat docking facilities as Class B. The remaining waters of the harbor and bay are Class A, and offshore ocean waters are Class AA. Harbor completion will not create an adverse impact on water quality.

With respect to your Item 3, the EIS discusses boating needs in three categories:

a. launch ramp users,

b. charter boats requiring slips,

c. other boats requiring slips.

Basic methods and calculations for computing demand for berths, ramps, parking, etc., are given in Sections IV and V of the 1970 Master Plan for Honokohau Harbor. The methods of computation are valid. The authors of the EIS have reviewed that market analysis, and based on boatownership experience in Hawaii, have made some refinements in projections.

Item 4--The EIS refers to other recreational facilities in the vicinity, but not to a relative needs study for all types of recreation. Because of the unique environmental resources of the Kona fishing grounds and weather conditions, boating facilities on a reasonable scale to permit enjoyment of these resources are considered desirable without being in direct competition with other forms of recreation.

Item 5--During the EIS preparation there was coordination with the County Planning Department, which coincidentally at this time is well along with a Community Development Plan for Kona. Consultation during preparation of the EIS as well as during earlier planning for the harbor has included a number of Kona residents.

Item 6--Consultation and coordination with the Honokohau Study Advisory Commission members and consultants has been a key element of the study leading to this EIS.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

LIFE OF THE LAND A GROUP FOR ECOLOGICAL RESEARCH AND ACTION

20 June 1975

Department of Transportation
Harbors Division
79 S. Nimitz Highway
Honolulu, Hawaii 96813

Attn.: Mr. Tom Fujikawa

Re: EIS for Honokohau Boat Harbor
Your letter #HAR-ED: 3642

Dear Sirs:

Thank you for your letter of 21 May 1975 on the above noted topic. We assume that you will continue to keep us informed as to all aspects of the EIS and construction plans preparation.

Please be advised that we moved our offices to 404 Piikoi Street, Honolulu, 96814, in mid-1972. Please correct your files in this regard.

Our concerns regarding the proposed expansion and development of the Honokohau Boat Harbor are many fold. Specific to your EIS preparation, we are especially concerned with the following:

(1) Backround items that should be covered in any EIS. Your EIS should include, minimally, the following:

(a) Full and clear maps of the subject area.

(b) Site plans and construction specifications.

(c) Full discussion (and maps) of state and county zoning at the site and surrounding areas. Discuss also the state and county designations of the off-shore waters.

(d) Full listing of governmental approvals that will be needed before the proposed project can proceed, and a discussion of the project's status vis-a-vis each. And:

(e) Full discussion of all appropriations that have been acquired for the project to date, and plans for further appropriation requests.

(2) Substanitive items that should be covered in any EIS. These include those discussed in the EQC's EIS regulation #1:42.

(3) Need for the proposed facility. Your EIS should tell us (objectively) why a facility such as this is needed in Kona. Your EIS should tell us who will use the facility and what it will cost them to use it. Your EIS should tell us, specifically, how your Department arrived at the conclusion that the facility is needed, and what evidence you used, as well as how you used it. Here, we warn you specifically that selective use or quotation of the State's SCORP will not be tolerated. Your references to SCORP must discuss the limitations of the SCORP as a planning document,

as well as all relevent tables and references in the document.

(4) Community Recreational Needs. Your EIS should discuss all projects for fulfilling community recreational needs that have been proposed for the entire Kona region. Discuss fully that status, both in planning and funding, of each. As part of your alternatives section in the EIS consider if community receratlonal needs would or would not be better met by transferring funds from your proposed project to other recreational projects.

(5) Community Participation in the Planning Process. The relationship of the entire Kona community to your planning should be discussed in depth.

(6) Honokohau Study Advisory Commission. (Reference: U. S. Congress, P. L. 92-346.) The nature and status of the work of this Commission should be fully discussed. The relation of the work of this Commission to your proposed project should be fully discussed. The possible impact of your proposed project on the successful implimentation of the plans proposed by the Commission should be fully discussed.

Should you have any questions on these preliminary comments, please free free to contact us.

Sincerely,

RW Gould

Robert W. Gould
Director, Research Staff
Life of the Land

cc: Life of the Land
Big Island Chapter
Ms. Jenny Parijs
Box 537
Pahoa, Hawaii 96778

Kona Conservation Group
c/o Lois and Slim Tyler
RR 1 Box 125
Captain Cook, Hawaii
96704

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU HAWAII 96813

IN REPLY REFER TO

July 16, 1975

HAR-ED 94

Mr. Raymond Suefuji, Director
Planning Department
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Suefuji:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

In response to your letter of June 24, 1975, the following are submitted:

1. An archaeological survey covering all areas of possible harbor expansion was conducted earlier this year by the Bishop Museum. The results of this survey are included in the EIS.

2. Permanent power and restroom facilities are discussed in the EIS.

3. State and County studies pertinent to the proposed harbor development have been reflected in the EIS.

Your comments are appreciated.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

PLANNING DEPARTMENT

25 AUPUNI STREET • HILO, HAWAII 96720

HERBERT T. MATAYOSHI
Mayor

RAYMOND H. SUEFUJI
Director

COUNTY OF
HAWAII

June 24, 1975

Mr. Tom Fujikawa
Dept. of Transportation, Harbor Division
79 South Nimitz Highway
Honolulu, Hawaii 96813

Re: Notice for Preparation
EIS for Development of Honokohau Boat Harbor
Job. H. C. 6047
HAR-ED 3642

We have reviewed your above notice. The following are our comments:

1. Although the harbor is proposed to be expanded in directions away from surveyed historic sites, the expansion area should also be surveyed to determine whether historic sites will be affected.

2. The harbor is currently serviced by a temporary source of electricity. Perhaps the EIS should address permanent alternatives as well as addressing permanent public facilities such as rest rooms and showers.

3. All studies conducted after 1970 should be included and cited.

We look forward to your draft EIS.

Sidney Fuke

Raymond Suefuji
Director

RN:lgv

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU HAWAII 96813

IN REPLY REFER TO

July 17, 1975

HAR-ED 505

Mr. Bruce M. Kilgore
Associate Regional Director
National Park Service
U. S. Department of the Interior
450 Golden Gate Avenue
Box 36063
San Francisco, California 94102

Dear Mr. Kilgore:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Job H. C. 6047

In response to your letter of July 2, 1975, all or most of your considerations are discussed within the subject EIS which will be filed shortly. Comments received from the State Preservation Officer, Advisory Council on Historic Preservation, and other interested agencies as well as individuals are being included with the statement.

We have been maintaining close coordination with the State Historic Preservation Officer, the National Park Service (Hawaii Group), and the U. S. Army Corps of Engineers in the preparation of the EIS and will continue to do so during the design and construction phases in order to minimize any adverse effects to the historic sites and to assure compliance with Section 106 of the National Historic Preservations Act.

Your comments and suggestions are appreciated.

Very truly yours,

E. Alvey Wright
E. ALVEY WRIGHT
Director

JUL 10 10 00 AM '75

HARBORS DIV.
DEPT OF TRANSPORTATION

United States Department of the Interior

NATIONAL PARK SERVICE
WESTERN REGION
450 GOLDEN GATE AVENUE, BOX 36063
SAN FRANCISCO, CALIFORNIA 94102

IN REPLY REFER TO:
L7619
(WR)PSE

July 2, 1975

Mr. Tom Fujikawa
Department of Transportation
Harbors Division
79 South Nimitz Highway
Honolulu, Hawaii 96813

Dear Mr. Fujikawa:

We have reviewed the informational material on the proposed development of Honokohau Harbor in North Kona, Hawaii. We have sent previous comments on an initial draft statement regarding further development of the Honokohau Harbor. These comments were included in our Department's response dated November 29, 1972. Recognizing that a new statement is being prepared, we will restrict these comments to the information and documentation that should be included in the statement and that relates to our specific field of jurisdiction. These comments are for technical assistance only as they do not constitute a formal response from the Department of the Interior.

COMMENTS ON THE PROPOSAL

Much of the land affected by the Honokohau Small Boat Harbor development project is currently within a National Park Service proposal for the establishment of Ka-loko, Hono-ko-hau National Cultural Park (refer to Draft Environmental Statement for Proposed Ka-loko, Hono-ko-hau National Cultural Park, DES 75-12 prepared by the National Park Service). Until a legislative decision has been made concerning this proposal, we recommend that no further action be taken toward the expansion of the Honokohau Small Boat Harbor.

COMMENTS ON THE ENVIRONMENTAL STATEMENT

The statement should completely discuss the effects of the project upon archeological and historical resources of the Honokohau area. As demonstrated by Emory and Soehrent, "Archeological and Historical

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Survey of the Honokohau Area, North Kona, Hawaii, 1971," these resources are extensive and significant. All viable alternative designs which may lessen the adverse impacts should be considered. The potential secondary effects which may result, such as increased vandalism of petroglyph sites, should also be considered.

The statement should include a full evaluation of the project's impact upon the Honokohau Settlement National Historic Landmark. A copy of comments received from the State Historic Preservation Officer regarding the project's effect upon potential (nominated or recently discovered, eligible and not yet nominated properties) and existing National Register properties (Honokohau Settlement National Historic Landmark) should be included in the statement. There should also be a copy of the correspondence carried out with the Advisory Council on Historic Preservation regarding the project's effect upon these properties.

The statement should discuss all mitigation measures that will be executed upon finding any adverse effects to National Register property and indicate all other measures taken to comply with Section 106 of the National Historic Preservation Act of 1966 and/or Executive Order 11593 in accordance with Title 36, CFR part 800.

We appreciate the opportunity to comment further on this environmental statement for the Honokohau Harbor project.

Sincerely yours,

John Hildam for

Bruce M. Kilgore
Associate Regional Director,
Professional Services

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO

July 17, 1975

HAR-ED 506

Ms. Jane L. Silverman
Historic Preservation Officer
Department of Land and Natural
Resources
State of Hawaii
P. O. Box 621
Honolulu, Hawaii 96809

Dear Ms. Silverman:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Job H. C. 6047

Thank you for your letter of July 15, 1975, regarding the subject impact statement.

Realizing the need for a detailed study of the historic sites, the Bishop Museum was engaged to conduct an archaeological survey of all areas of possible harbor expansion. Their report is being included as part of the EIS.

We appreciate your efforts in trying to have the exact boundaries of the Honokohau Landmark established.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

CHRISTOPHER COBB, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES

EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

DIVISIONS:
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

July 15, 1975

Department of Transportation
Harbors Division
79 South Nimitz Highway
Honolulu, Hawaii 96813
ATTN: Mr. Tom Fujikawa

Dear Mr. Fujikawa:

Subject: Request for Comments on Proposed Honokohau Boat Harbor Environmental Impact Statement

A necessary part of the final environmental impact statement for the Honokohau Boat Harbor will be a thorough survey of the petroglyph field adjacent to the present harbor by a qualified archaeologist. This survey should establish the boundaries of the petroglyph field. The most feasible approach to this would be to hire such an archaeologist on a contract basis. Attached is a list of the archaeologists in Hawaii doing contract work at this time.

The National Park Service is the agency which will determine the boundaries of the Honokohau National Landmark district. The location of those boundaries will be an important factor in determining possible effect on the landmark under provisions of the 1966 Historic Preservation Act (PL 89-665) and Executive Order 11593. We will ask the Park Service to expedite its decision on setting those boundaries.

We will look forward to the opportunity to review the pre-final draft of the Honokohau Boat Harbor EIS, and will assist in its preparation whenever possible.

Sincerely yours,

Jane L. Silverman

Jane L. Silverman
Historic Preservation Officer
State of Hawaii

GC:jsm

APRIL 9, 1975

RESEARCH ORGANIZATIONS THAT STAFF QUALIFIED ARCHAEOLOGISTS WHO HAVE INDICATED TO THE STATE HISTORIC PRESERVATION OFFICER THAT THEY ARE AVAILABLE FOR ARCHAEOLOGICAL CONSULTANT WORK IN THE STATE OF HAWAII

ARCHAEOLOGICAL RESEARCH CENTER HAWAII
P. O. BOX 285
LAWAI, KAUAI, HAWAII 96765 PHONE: 332-8521
Francis Ching, Jr., President

BISHOP MUSEUM, INC.
P. O. BOX 6037
HONOLULU, HAWAII 96818 PHONE: 847-3511
Dr. Yosihiko Sinoto, Ph.D., Chairman,
Department of Anthropology

CHINIAGO ENTERPRISES
47-395 HUI IWA STREET, # 2
KANEOHE, HAWAII 96744 PHONE: 239-7895
William Barrera, Jr.

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

July 17, 1975

IN REPLY REFER TO HAR-ED 507

Mr. Stanley D. Doremus
Deputy Assistant Secretary of
the Interior
United States Department of the
Interior
Office of the Secretary
Washington, D.C. 20240

Dear Mr. Doremus:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Job H. C. 6047

Thank you for your letter of June 18, 1975, responding to our EIS preparation notice for the subject project. We have also received comments from your Bureaus of Outdoor Recreation and Fish and Wildlife, Geological Survey and the National Park Service to which we are responding separately.

We are aware that the proposed expansion of Honokohau Boat Harbor will require a permit from the U. S. Army Corps of Engineers, and approval of the Secretary of the Interior in conformance with P.L. 92-346. The provisions of Section 106, P.L. 89-665, also apply. These requirements are discussed in the Environmental Impact Statement.

Regarding your suggestion of developing a joint Federal-State Environmental Statement, this matter was discussed with both the Corps of Engineers and the National Park Service, Hawaii Group. However, since we are on the verge of filing our impact statement, preparation of a joint statement will probably result in further delays.

Your comments and suggestion are appreciated.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

2017

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

JUN 18 1975

In reply refer to:
(ER-75/562)

Dear Mr. Wright:

Thank you for the letter of May 21, 1975 advising us of your intentions to prepare an environmental impact statement for the development of Honokohau Boat Harbor, North Kona, Hawaii.

As you may know, the Department of the Interior reviewed a draft environmental statement for a similar project proposal in 1972 and by letter of November 29, 1972 we furnished our comments to the Director, Hawaii Department of Transportation (copy enclosed).

We assume the impact statement now being prepared involves further consideration of the overall project proposal. Accordingly, we are providing a copy of your transmittal to Bureaus of this Department in the event they may be able to provide you further technical assistance for your environmental statement. However, since we have just received your letter, our Bureaus may not be able to respond to your request by the date set forth in your letter. Accordingly, we have requested our Bureaus to provide you with their comments by July 3, 1975. We trust this revised date for input will be satisfactory.

We are also enclosing three pieces of correspondence which may be of interest to your staff when they develop the proposed environmental statement. These communications are as follows: (1) a letter from our Acting Assistant Secretary of the Interior to the Chairman, Advisory Council on Historic Preservation dated November 22, 1972, (2) a Departmental letter to the Honorable Patsy T. Mink, House of Representatives, Washington, D.C. dated November 22, 1972 and (3) a letter from the Compliance Officer, Advisory Council on Historic Preservation to the Chairman, Hawaii Department of Land and National Resources dated February 13, 1973.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

In closing we wish to note that the proposed project may require certain Federal actions to be taken before it could be implemented. Federal involvement could arise if a Corps of Engineer permit is required in accordance with the provisions of Section 10 the Rivers and Harbors Act of 1899 and Section 404 of the Water Pollution Control Act of 1972. Also, the prior approval of the Secretary of the Interior may be required for compliance with Section 5 of Public Law 92-346, copy enclosed. Accordingly, you may wish to consider the prospect of developing a joint Federal-State environmental statement which complies with both Federal and State environmental legislation and thereby expedite the approval process at both levels of government. Should you wish to give further consideration to this idea, we would suggest that you consult with the responsible officials of those Federal agencies which you think will be involved in the action through Federal funding, licenses, permits or other approvals [Reference CEQ Guidelines; 40 CFR 1500.7(b)].

We trust the foregoing information will assist you in your plans to prepare an environmental impact statement for the Honokohau Boat Harbor. We will be pleased to review and comment on the statement when it is circulated later this year.

Sincerely yours,

Stanley D. Doremus

Deputy Assistant Secretary of the Interior

Mr. E. Alvey Wright, Director
Hawaii Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

Enclosures

92/1112

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

NOV 22 1972

Dr. S. K. Stevens
Chairman
Advisory Council on Historic Preservation
1522 K Street N. W., Room 430
Washington, D. C. 20005

Dear Dr. Stevens:

Public Law 92-346, approved July 11, 1972, establishes the Honokohau study area on the Island of Hawaii for purposes of a study to determine the most appropriate means of preserving the nationally significant natural and cultural values of this area. The study area defined in the law coincides generally with the Honokohau Settlement National Historic Landmark, a listing on the National Register of Historic Places.

Section 5 of Public Law 92-346 provides that during the study period no project shall be undertaken in the study area without the approval of the Secretary of the Interior, such approval being intended to preclude projects that might diminish the values of the area. Under this provision, the State of Hawaii has requested the approval of the Secretary of plans for the expansion of a small boat harbor located within the study area. A copy of this request, dated September 6, 1972, and signed by the Director of the State Department of Transportation, is enclosed.

Since the approval sought by the State would set in motion action that might affect the cultural values of the Honokohau Settlement National Historic Landmark, the provisions of Section 106 of the National Historic Preservation Act of 1966, Public Law 89-665, would appear to apply to the Department of the Interior's disposition of this request. We are therefore referring the State's request to the Council for comment as required by law.

We would appreciate your prompt review, with Council consideration at its February 1973 meeting, if possible. Please let us know what further information you will need.

Sincerely yours,

Curtis Bohlen

Acting Assistant Secretary of the Interior

Enclosure

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

NOV 22 1972

Hon. Patsy T. Mink
House of Representatives
Washington, D. C.

Dear Mrs. Mink:

This is in reply to your letter of October 16 urging the Secretary of the Interior to approve the plans of the State of Hawaii to expand a small boat harbor located at Honokohau on the Island of Hawaii. This approval is required by Section 5 of Public Law 92-346 establishing the Honokohau study area.

In the National Historic Preservation Act of 1966, Public Law 89-665, the Congress established a mechanism to evaluate adverse effect on cultural properties determined worthy of preservation. Section 106 of that act provides that no Federal undertaking having an effect on a property listed in the National Register of Historic Places shall proceed before review and comment by the Advisory Council on Historic Preservation. As a National Historic Landmark, the Honokohau study area is listed in the National Register.

Therefore, before giving the approval requested by the State of Hawaii, we are required by law to refer this matter to the Advisory Council for comment. In this referral we are urging the Council to consider the case at its next meeting, in February 1973. We shall keep you advised of progress.

Sincerely yours,

Curtis Bohlen

Acting Assistant Secretary of the Interior

FROM THE OFFICE OF
PATSY T. MINK
MEMBER OF CONGRESS
HAWAII

Public Law 92-346
92nd Congress, H. R. 11774
July 11, 1972

An Act

To authorize a study of the feasibility and desirability of establishing a unit of the national park system in order to preserve and interpret the site of Honokohau National Historical Landmark in the State of Hawaii, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Congress finds the site of Honokohau National Historical Landmark in the State of Hawaii encompasses unique and nationally significant cultural, historical, and archeological resources and believes that it may be in the national interest for the United States to preserve and interpret those resources for the education and inspiration of present and future generations. The Congress further believes that it is appropriate that the preservation and interpretation at that site be managed and performed by native Hawaiians, to the extent practical, and that training opportunities be provided such persons in management and interpretation of those cultural, historical, and archeological resources. Honokohau National Historical Landmark, Hawaii. Study.

SEC. 2. (a) The Secretary of the Interior (hereinafter referred to as the "Secretary") shall study the feasibility and desirability of establishing as a part of the national park system an area, not to exceed one thousand five hundred acres, comprising the site of Honokohau National Historic Landmark and adjacent waters.

(b) As a part of such study other interested Federal agencies, and State and local bodies and officials shall be consulted, and the study shall be coordinated with other applicable planning activities.

SEC. 3. The Secretary shall submit to the President and the Congress within one year after the effective date of this Act, a report of the findings resulting from the study. The report of the Secretary shall contain, but not be limited to, findings with respect to the historic, cultural, archeological, scenic, and natural values of the resources involved and recommendations for preservation and interpretation of those resources, including the role of native Hawaiians relative to the management and performance of that preservation and interpretation and the providing to them of training opportunities in such management and performance. Report to President and Congress.

86 STAT. 457
86 STAT. 458

SEC. 4. (a) There is hereby established a Honokohau Study Advisory Commission. The Commission shall cease to exist at the time of submission of the Secretary's report to the President and the Congress. Honokohau Study Advisory Commission, establishment.

(b) The Commission shall be composed of fifteen members, at least ten of whom shall be native Hawaiians, appointed by the Secretary, as follows:

(1) Two members, one of whom will be appointed from recommendations made by each of the United States Senators representing the State of Hawaii, respectively;

(2) Two members, one of whom will be appointed from recommendations made by each of the United States Representatives for the State of Hawaii, respectively;

(3) Five public members, who shall have knowledge and experience in one or more fields as they pertain to Hawaii, of history, ethnology, anthropology, culture, and folklore and including representatives of the Bishop Museum, the University of Hawaii, and organizations active in the State of Hawaii in the conservation of resources, to be appointed from recommendations made by the Governor of the State of Hawaii;

(4) Five members to be appointed from recommendations made by local organizations representing the native Hawaiian people; and

(5) One member to be appointed from recommendations made by the mayor of the county of Hawaii.

(c) The Secretary shall designate one member to be Chairman. Any vacancy in the Commission shall be filled in the same manner in which the original appointment was made.

Compensation.

(d) A member of the Commission shall serve without compensation as such. The Secretary is authorized to pay the expenses reasonably incurred by the Commission in carrying out its responsibilities under this Act on vouchers signed by the Chairman.

(e) The Secretary or his designee shall consult with the Commission with respect to matters relating to the making of the study.

Other projects restriction.

SEC. 5. During the period commencing with enactment of this Act and ending with submission of the Secretary's report to the President and the Congress and any necessary completion of congressional consideration of recommendations included in that report (1) no department or agency of the United States shall, without prior approval of the Secretary, assist by loan, grant, license, or otherwise in the implementation of any project which, in the determination of the Secretary, would unreasonably diminish the value of cultural, historical, archeological, scenic, or natural resources relating to lands or waters having potential to comprise the area referred to in section 2(a) of this Act and (2) the Chief of Engineers, Department of the Army, shall not, without prior approval of the Secretary, undertake or assist by license or otherwise the implementation of any project which, in the determination of the Secretary, would diminish the value of natural resources located within one-quarter mile of the lands and waters having potential to comprise that area.

"Native Hawaiian."

SEC. 6. The term "native Hawaiian", as used in this Act, means any descendant of not less than one-half part of the blood of the races inhabiting the Hawaiian Islands previous to the year 1778.

Appropriation.

SEC. 7. There are authorized to be appropriated not to exceed $50,000 to carry out the provisions of this Act.

Approved July 11, 1972.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 92-985 (Comm. on Interior and Insular Affairs).
SENATE REPORT No. 92-944 (Comm. on Interior and Insular Affairs).
CONGRESSIONAL RECORD, Vol. 118 (1972):
Apr. 17, considered and passed House.
June 30, considered and passed Senate.

GPO 83-139

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER-72/1112

NOV 29 1972

Dear Mr. Matsuda:

This is in reply to your letter of September 6, 1972, requesting the views and comments of the Secretary of the Interior on a proposed small boat harbor expansion program and a draft environmental statement for a project located in Honokohau, Hawaii.

Approval of plans for this facility by the Secretary of the Interior is required by Section 5 of Public Law 92-346 which established the Honokohau study area. The Secretary's action on this request, however, falls within the purview of Section 106 of the National Historic Preservation Act of 1966, Public Law 89-665, which provides that no Federal undertaking having an effect on a property listed in the National Register of Historic Places shall proceed before review and comment by the Advisory Council on Historic Preservation.

An environmental impact statement should be an impartial and complete laying-out of all environmental consequences, both primary and secondary, short-term and cumulative, that will result from the construction of a proposed project. The Honokohau Harbor Draft Environmental Statement fails this initial overriding test. The statement can best be described as a project support document designed to facilitate the approval of the project.

The environmental statement completely lacks a framework for evaluating environmental impacts of the proposed project. This deficiency can be corrected by adding a section describing the existing environment. The description needs to be in as great a detail as existing data and knowledge permits. It should include history, archaeology, geology and natural resources of the area. Without this frame of reference of backup data, there is no basis for evaluating the project's environmental impact. For example, the introduction, page 1, third paragraph, states ". . . this study merely describes these major relationships in theoretical form without the empirically verified relationships of data analysis." We concur that the subject statement does not include ". . . information and technical data adequate to permit a careful assessment of environmental impact by commenting agencies," as stated in the CEQ Guidelines, 6(i) (Federal Register 36 No. 79). Without the benefit of data analysis, which the statement admittedly lacks, the "conclusions" reached throughout the statement appear to be largely based on conjecture.

As a National Historic Landmark, the Honokohau study area is listed in the National Register. Secretarial approval of plans for expansion of the small boat area would constitute a Federal undertaking within the meaning of Section 106.

We are taking immediate action to refer this undertaking to the Advisory Council and are urging that its comment be made as soon as possible. We shall keep you advised of progress.

We have completed our review of your draft environmental statement in support of this project. Referral to the Advisory Council does not preclude our comment on the impact statement. We have assessed it in the same manner that would be accorded a Federal draft statement for a similar project and we submit the following comments.

Page 14, under II - Impact of Project, C. Environment, Section 2. Recreation and Parks - This section states that blasting will kill some of the marine life in the harbor, but does not mention that any coordinating efforts will be made with natural resources agencies to minimize the known adverse effects of blasting on fish and wildlife resources. Fish movement into the area is heavy during certain periods of the year. The section should include a statement that coordination with resource agencies including the Bureau of Sport Fisheries and Wildlife and the Hawaii Division of Fish and Game will take place prior to blasting within the harbor to determine the most appropriate time period for detonation.

This section also states that siltation will occur with blasting and that silt produced at the time of the previous construction has since remained on the harbor floor. Page 22 concerning this condition indicated that silt accumulations vary from two to eight inches. In both instances it is indicated that the existing siltation and future anticipated siltation is not expected to be a problem. We disagree with these statements as siltation, whether two or eight inches deep, does smother or prevent development of benthic organisms. In addition, if sedimentation of organic debris is also occurring, an adverse water quality condition now exists or will exist upon completion of the harbor. Reference to siltation not being a problem should be removed and undoubtedly studies to determine the effects of this siltation should be conducted.

Page 15 refers to the previously discussed ecological survey of Honokohau and water current measurements. It states, "Tests were limited and inconclusive; however, it was felt that circulation of the harbor would be satisfactory." We do not feel that the limited and inconclusive current measurements made during a preconstruction period provide any assurance that flushing is adequate or will be adequate after completion of the project. The creation of a harbor approximately 2400 feet long with the existing design would also indicate an impeded water circulation condition. We believe these conditions should be stated in the text and the reference to water circulation being satisfactory should be removed. Additional evidence should be provided to indicate adequate flushing of the harbor will occur.

Further water problems could occur through the effect of the proposed harbor development upon the existing groundwater regimen in the immediate vicinity of the harbor. Ground water does not occur under artesian conditions in or near the harbor as indicated on pages 15 and 25 of the statement, but rather as a free watertable body that is part of a fresh-to-brackish water lens present in the region. Fresh water from inland areas of recharge move seaward within the lens and discharge naturally at or near median tide level along the shore. Excavation of the harbor displaces the natural discharge points landward to the perimeter of the excavation and, to the extent of excavation, moves salt water farther inland. The normal tidal fluctuation can be expected to cause a small increase in salinity of ground water in the immediate vicinity of the harbor.

Page 23, b. Sewage, under Part 4. Noise, Air and Water Pollution - This section indicates that the present master plan calls for temporary sewage disposal by use of cesspools and septic tanks. It also indicates that an aerated treatment unit will be added to this system and eventually a permanent treatment plant will be provided. We do not consider septic tank and cesspool treatment adequate because of the extremely high gross permeability of the lavas in this vicinity. Water movement into and out of the walls of the excavation is free, and the relatively fresh effluents from sewage may be expected to move freely and rapidly through the rocks into the harbor. In addition, no mention of specific time periods for upgrading the treatment facilities in relation to population numbers was mentioned. Improving the treatment systems in pace with population increases and use has, in most all other instances of similar projects, been lagging and inadequate to maintain fish and wildlife resources. A more definite assurance should be provided to indicate that treatment will be improved when the population numbers reach a specific use level. In all instances, treatment of sewage should be at least secondary treatment.

This section also refers to the anticipated violations of boaters who, it is expected, will violate existing regulations regarding the discharge of untreated sewage into the harbor. We are also aware that similar conditions have been experienced elsewhere as indicated on page 24, but do not feel as it was stated that "It has not been a major problem." On the contrary, discharging of raw sewage into a semi-enclosed body of water such as this has caused major problems for fish and wildlife resources. Numerous cases of this type are on record as evidence. We believe that plans to control the anticipated problem should be set forth prior to expansion of the harbor. Such plans would include ship-to-shore sanitary hookups, holding tanks, vigorous enforcement of existing regulations, or restrictions against living aboard. In any case, the condition should be corrected, and the statement indicating that "It has not been a major problem" should be removed.

Page 24, Part C Emissions - This section refers to emissions from boat motors, gas, and oil spills as being a source of pollution and states that these factors are not expected to cause any noticeable effects or to be significant. We believe the statements are unrealistic and should be removed from the text. Petrochemical spills as indicated in the third paragraph of this section point out this fact.

This section also states, "Every precaution will be taken to prevent oil and gasoline spills from occurring." No mention or details of the methods for prevention was made. Also, no information with reference to a plan or program to clean up any accidental spills was observed. A plan to prevent and clean up any accidental spill should be made or reference to such a plan should be included in the draft.

Page 31, III. Adverse Environmental Effects - This section should include a statement indicating blasting will kill some of the marine life in the harbor.

Appendix G indicates improvements for Phase II. Section AA in the lower half of the diagram indicates a cross-section of the area to be dredged. There is no location relationship between the cross-section and the General Plan diagram. The various dredging depths should be indicated on the overall General Plan sketch. Spoil quantities and deposition locations should also be indicated on this diagram.

Page 32, item IV, Alternatives, does not adequately reflect the intent of this section as proposed by the CEQ Guidelines that state, ". . a rigorous exploration and objective evaluation of alternative actions that might avoid some or all of the adverse environmental effects is essential. Sufficient analysis of such alternatives and their costs and impact on the environment should accompany the proposed action through the agency review process . ." We believe the alternative section should discuss alternative designs for expanding the harbor to the south and assess the full range of environmental effects which would take place in order that the petroglyphs found on the north edge of the harbor would not be disturbed.

In addition to the above examples of topics within the draft environmental statement that need substantial improvement, there is also a number of important topics that have been overlooked. The statement should include a full discussion of the environmental impact of the new residential and commercial development that the harbor project is designed to attract. In addition, the project construction will obviously have some impact on the values of the Honokohau Settlement National Historic Landmark, a property listed on the National Registry of Historic Places. The impact statement should provide a full and unbiased evaluation of the impact of the project on this property and provide a discussion of the mitigation measures which will be employed to minimize the impact of the project on this landmark.

The foregoing comments are not intended to be an exhaustive analysis of the draft environmental impact statement. They are, instead, an attempt to provide a direction that a revision effort could take in order to meet those objectives contained within the National Environmental Policy Act.

Sincerely yours,

Deputy Assistant Secretary of the Interior

Mr. Fujio Matsuda
Director
State of Hawaii
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO

June 17, 1975

HAR-ED 517

United States Department of the Interior
Geological Survey
Reston, Virginia 22092

Gentlemen:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

In response to your letter of July 9, 1975 most of your concerns are discussed in the subject Statement.

The Statement includes an extensive discussion of the ground water flow in and around the harbor and the physical, chemical and biological impact of this flow. Tidal patterns and flushing actions are also discussed.

With regard to water supply and sewage disposal, present and planned facilities are discussed. Drainage is not a problem due to the high permeability of the existing ground.

The EIS includes the approximate locations of ground water inputs observed at the harbor. Flow is directly out to sea.

A pump-out facility for ship wastes is planned for the next phase of development. Any substantial storage and dispensing of petroleum products, as in the case of a planned fueling facility, will be constructed and operated strictly in accordance with all applicable Federal and local regulations. In addition, the operator of the facility will be required to have a contingency plan for oil spillage and the necessary equipment and material for collection and disposal.

Thank you for your suggestions.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

JUL 16 10 36 AM '75
HARBORS DIV.
DEPT. OF TRANSPORTATION

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

OFFICE OF THE DIRECTOR

ER-75/562

JUL 9 1975

Department of Transportation, Harbors Division
Attention: Mr. Tom Fujikawa
79 South Nimitz Highway
Honolulu, Hawaii 96813

Dear Mr. Fujikawa:

We have received your request for technical information on the proposed development of Honokohau Harbor and we offer the following suggestions.

The evaluation of possible environmental impacts from the proposed project should include such aspects as the following:

(1) Description of ground-water occurrence in the vicinity of the harbor, including aquifer properties and hydrologic characteristics, rate and direction(s) of movement of ground-water, water-table configuration, and salt or brackish/fresh water relationships.

(2) Tidal patterns and flushing actions affecting either surface or ground water.

(3) Details of water-supply, sewerage facilities, and drainage plans. If septic tanks or cesspools are to be used, appropriate laboratory and/or field tests of rock materials and soils involved should be included.

(4) Map showing locations of adjacent wells and springs and, if feasible, the trends of any known lava tubes nearby that might be affected by the project (that is, transmit pollutants from it). It would also be useful to know the principal emplacement flow directions of the lavas that will be affected, because this influences the orientation of lava tubes.

(5) Storage and disposal facilities for boat-transported sanitary wastes, and for oil, grease and other petroleum products involved in the development or construction and operation of the proposed harbor.

We thank you for the opportunity to provide these suggestions.

Sincerely yours,

Henry W. Coulter

Acting Director

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU HAWAII 96813

IN REPLY REFER TO
HAR-ED 521

July 18, 1975

Honorable Hideto Kono, Director
Department of Planning and
Economic Development
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Kono:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

This is in response to your letter of July 10, 1975 regarding the subject EIS.

Your concerns regarding the effects of blasting and the impact of the development on historical/archaeological sites are discussed in the impact statement. Regarding boat displacements during construction, arrangements will be made to provide temporary moorings within the harbor for displaced boats.

The impact statement has been completed and will be available for public review shortly.

Your comments are appreciated.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

DEPARTMENT OF PLANNING
AND ECONOMIC DEVELOPMENT

GEORGE R. ARIYOSHI
Governor

HIDETO KONO
Director

FRANK SKRIVANEK
Deputy Director

Kamamalu Building, 250 South King St., Honolulu, Hawaii • Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Ref. No. 4684

July 10, 1975

Mr. Wayne Mitter
Environmental Consulting
Room 704
1136 Union Mall
Honolulu, Hawaii 96813

Dear Mr. Mitter:

Subject: Preliminary Draft Environmental Impact Statement for the Honokohau Harbor

We have reviewed the above preliminary draft and wish to offer the following comments at this time.

It is felt that documentation of the effects of blasting for excavation should be provided. We also suggest that you contact the Division of Fish and Game, Department of Land and Natural Resources, regarding the impact upon various marine ecosystem existing in this area.

The EIS should indicate provisions for accommodating boat displacements during the harbor construction phase.

Measures for minimizing the impact on the historical/archaeological sites located north of the harbor should be coordinated with the Department of Land and Natural Resources. Since this agency is responsible for preserving and maintaining historic sites in the State, it is vitally concerned with any development proposed within the immediate vicinity of such sites.

We trust that the missing sections on Irreversible Commitment of Resources (Section V), Adverse Environmental Effects Which Can't Be Avoided (Section VI), and The Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity (Section VII) will be addressed and available for comment prior to the final report submittal.

Thank you for the opportunity to review this preliminary report.

Sincerely,

HIDETO KONO

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO

July 28, 1975

HAR-ED 93

Kona Civic Club
P. O. Box 127
Kailua-Kona, Hawaii 96740

Gentlemen:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

This is in reply to your concern about an appropriate population base for planning completion of the harbor. The Department of Planning and Economic Development (DPED) has in April 1975, provided a projection of Hawaii County population for year 2000 at 98,000. This is in contrast to the island projection of 132,000 for that same year in Table 1, page 12, of the 1970 Honokohau Master Plan.

Subsequent population studies for use in the Hawaii Water Resources Regional Study show year 2010 projections that range from a low of 97,000 to a high of 185,000. The estimates of Kona's share of that population also vary. Using mid-range factors leads us to propose that a planning base of 23,000 is appropriate at this time for year 2010. Inasmuch as current funds are inadequate for dredging of the complete basin anyway, there will be another opportunity to reassess this and other planning factors prior to harbor completion.

It is recognized that population forecasting 35 years into the future in Hawaii is very speculative, and different statistic approaches could indeed result in an estimate such as yours of as high as 92,000 for North and South Kona in the year 2010. More important than specific numbers, however, is our feeling that State and County policies are beginning to reflect a concern for rate of growth. We also recognize that boating "needs" are to some degree a function of facilities available and that a harbor planned for 35 years growth may, in fact, fill up in half that time or less.

In view of the above, the following has been included in the EIS:

"Since the Harbor will be developed in increments, an opportunity will exist to reassess the 2010 population planning base and planning factors before final harbor excavation. There will be time for orderly planning to accommodate necessary expansion, if in fact Keahole Ocean activities, heavy usage from the Kohala districts and other factors result in further demands for berths at Honokohau Harbor."

We hope this satisfactorily answers your concerns.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

JUN 23 10 12 AM '

HARBORS DIV
DEPT. OF TRANSPORTAT

KONA CIVIC CLUB

P. O. Box 127
Kailua-Kona, Hawaii 96740

June 2, 1975

State of Hawaii
Harbors Division
Dept. of Transportation
79 South Nimitz Highway
Honolulu, Hawaii 96813

Subject: Population Forecast for North & South Kona, and its Relation to the Need for the Expansion of the Honokohau Boat Harbor

Attention: Melvin Lepine
Chief of Harbors Division

Dear Mel:

In an evening meeting at the Kona Hotel on May 5, 1975, consisting of interested boating groups, Dept. of Transportation official, E.I.S. representatives, etc., Mr. William Spencer, (E. I.S. Study for Honokohau Harbor), related figures, projection, etc., prepared by DPED, which show that the population in Kona was growing at a very slow pace, and that the forecast of this growth to year 2010 would continue at a slow pace. DPED's estimate of the total North & South Kona population, year 2010, was 22,000 which he said was 2/3 of DMJM estimate of 32,500.

However, I obtained from the County their latest population figures and growth forecasts "R & D DATA BOOK, 1974, Dept. of Research & Development, County of Hawaii". This shows a much different forecast. I enclose a xerox copy of page 4, showing a population forecast for 1990, total of North & South Kona, totaling 28,600 (use averages of their low and high). They do not show the forecast beyond this date, but assuming the population will grow at the same percentage rate from 1990 - 2010 as it did from the same 20 year period of time 1970 - 1990, which was an increase of 224%, the population in 2010 would be 92,664 (the 1970 population figure totaling 8,836 was taken from the same report page 1; see copy enclosed). This forecasted population of 92,664 as mentioned above, is over 4 times the E.I.S. study figure of 22,000!

Furthermore, with our new road connecting the Honokohau Boat Harbor and South Kohala area, South Kohala's population should be largely included in this forecast. Residents there will use our harbor if there are berths available.

In addition to the above, in a public hearing held by the Dept. of Transportation on Wednesday, May 7th at the Kona Hilton, Admiral Alvey E. Wright "predicted a nearly ten-fold increase in population on the West Hawaii Coast". (Quoted from West Hawaii Today, 5/8/75). This increase is the result of the new road connecting Kona with Kawaihae, the two new proposed ferry systems, and the ability of DC-10's to land at Keahole Airport with full loads now.

Attached is an article which appeared in Pacific Business News, May 26, 1975, which summarizes the Island wide urgent need for small boat harbors. One of the statements in this article regarding the "waiting list" points out that a lot of people who would like to get a boat don't even bother to apply because of the very long waiting list. Honokohau Harbor, which presently has 52 slips, has 101 additional applications and no vacancies!

I feel that it is very important that the above information be included in the E.I.S. report!

Very truly yours,

KONA CIVIC CLUB

Sidney J. Weinrich

Sidney J. Weinrich
Vice President

SJW/bp
Encl. 2

Ron Burla
Vice Comm.
Kona Yacht Club

President
Kona Sellers

MGR. Kona Activities Center

MGR. Kona Charter Skippers Assoc.

cc: Hawaii Leeward Planning Conference
Kona Chamber of Commerce

Tom Fujikawa 6/26/75

TABLE 4: POPULATION PROJECTIONS, HAWAII COUNTY

by Districts, 1975 - 1990

JUDICIAL DISTRICT	1973[1/]	1975	1980	1990
HAWAII COUNTY	70,200	70,000 - 78,000	84,000 - 99,000	115,000 - 137,000
Puna	6,188	5,200 - 5,300	5,300 - 5,500	5,900 - 8,400
South Hilo	38,469	35,700 - 40,000	39,300 - 47,100	48,700 - 55,100
North Hilo	1,534	1,700 - 1,800	1,600 - 1,700	1,500 - 1,600
Hamakua	4,549	4,700 - 4,900	5,100 - 5,500	5,900 - 7,300
North Kohala	3,045	3,400 - 3,500	3,300 - 3,500	3,300 - 3,500
South Kohala	2,820	3,700 - 5,300	8,000 - 11,700	13,900 - 22,200
North Kona	6,520	7,200 - 8,000	11,900 - 13,500	21,700 - 23,000
South Kona	3,597	4,100 - 4,200	4,400 - 4,900	5,700 - 6,800
Ka'u	3,478	4,300 - 5,100	5,100 - 5,700	8,400 - 9,200

[1/] As of July 1st.

Source: State Department of Planning & Economic Development, 1974; County Department of Research & Development, July 1971.

Water, water everywhere — but there's little solace for would-be boaters here

By ROBERT NEFF

More than one person undoubtedly has moved to Hawaii with plans to buy a boat, figuring the island state would naturally be a boater's paradise. More than one person undoubtedly has been disappointed.

Simply put, Hawaii does not have nearly enough mooring facilities to serve those who own, or want to own, recreational boats. And a solution that will satisfy boaters, bureaucrats, environmentalists, and legislators looks increasingly elusive.

Statistics bear out the problem:

1 — In December 1974, the latest date for which complete figures are available, the State had 1,549 applications on file for mooring space, and 180 vacancies, many of which were unsuitable for most of the boats on the waiting list. The State's 22 small-boat harbors can accommodate 1,817 vessels.

2 — At Ala Wai Boat Harbor, the State's largest and most popular marina with 711 slips, there were 967 applications on file in December, and no vacancies. Average waiting time for a slip: three to four years.

3 — The Big Island's 52-slip Honokohau Boat Harbor had 101 applications and no vacancies.

4 — Lahaina Boat Harbor, with 92 spaces, had 172 applications and two vacancies.

"We don't have anywhere near enough moorings. Everybody is crying about the long waiting lists," says Thomas Stratton, boating administrator for the State Department of Transportation's Harbors Division. "A lot of people who'd like to get a boat don't even bother to apply."

Stratton says three main factors account for the shortage: a lack of protected waterways, environmentalists' objections to harbor construction, and the absence of private development of harbors.

He seems to think environmentalists are the major obstacle. "You can't get anything built without going to court anymore," he says.

The State, he says, has been ready for more than two years to complete Honokohau Harbor in Kona but hasn't been able to surmount objections that petroglyphs and visual qualities would be ruined. And he says similar interests have stymied a new harbor in Lahaina.

Stratton says that nationally, mooring fees pay for an average of 15 per cent of harbor costs. The balance is financed by hotels, restaurants, condominiums, fuel stations, and other commercial enterprises that either develop the harbors themselves or lease from the state for the privilege of locating near the boating facilities.

"But mention that around here," he says, "and you'll get a big explosion."

Stratton seems convinced that revenues must be generated from some source other than mooring fees, which are designed here to cover the costs of docking facilities.

He says the least that could be done is renting harbor-side space to such businesses as boat dealers, as is done on a limited basis at the Ala Wai marina.

But he says that harbors eventually should be viewed as "packages" which include a variety of private concerns contributing to development costs.

The choice appears to come down to Stratton's proposal or drastically higher mooring fees, which boaters already complain are too high. State legislators appear to have little interest in supporting boating facilities with public funds

"Boaters must realize that they've been getting a free ride. They've been subsidized by the rest of the public," says Rep Benjamin Cayetano chairman of the House Energy/Transportation Committee. Cayetano's committee handles recreational boating matters in the House.

"We've told the (State) Administration that rates are unreasonably low and should be raised. If boaters want facilities, they should be ready to pay for them. They don't think about who built the facilities. The facilities may be inadequate, but the boaters are getting their money's worth."

Stratton says "we're not collecting enough" to meet costs and that rate hikes are being contemplated. The Department of Transportation has the power to set mooring fees.

Until 1971, Cayetano says, most harbor improvements were financed by the State's General Fund. Since then, there's been a move to pay for the facilities on "the user principle," he says. He says the State should continue to pay for major capital expenditures in developing harbors, such as dredging, but that boaters should pay for docks and walkways.

About 12,000 small boats are registered in Hawaii. Officials say there would be many more with adequate mooring facilities.

Cayetano, who represents voters in Central Oahu, also contends that boating funds have been disbursed disproportionately. Leeward Oahu, he says, had more than three times as many launchings as Hawaii Kai in 1972 but had only two launching ramps to Hawaii Kai's seven.

Louis Valier, president of the Hawaii Boaters Association, says boaters are not getting their money's worth. He points to two rate increases in one recent year.

"Hawaii is not the paradise for boaters that it could be," he says.

Valier is particularly critical of the State's attitude toward dormant vessels — those which virtually never leave port and are used as permanent homes. He says that if removed, they would provide spaces for "proper" recreational boats.

Transportation Department officials have testified before the legislature that about 350 boats in Ala Wai and Keehi boat harbors are used as "floating homes." The officials have recommended elimination of such arrangements.

The officials also are considering adoption of a requirement that all boats go to sea for at least two hours twice a quarter. The Department can adopt such regulations itself.

The House of Representatives passed a bill outlawing live-aboards during the last legislative session but the Senate postponed action pending completion of an audit of the Harbors Division.

Valier says that because an audit has never been done on the division and because it doesn't release its expenditures to the public, there is no way to know whether claims for rate increases are justified. "They have no incentive to be efficient," he adds.

Valier agrees that boaters should pay their reasonable share for harbor development costs, but says many of the facilities, such as parking, sidewalks, and beach houses, are used by the general public and thus should be paid for from public funds.

Plans are underway for expansion of small boat facilities throughout the State, and the legislature has allocated funds for many of the projects.

Those projects include about 300 moorings at Waianae, a separate recreational boat facility at Nawiliwili, a new boat harbor at Heeia-Kea, expansion of Haleiwa Boat Harbor, construction of a new harbor at Maunalua, a new Lahaina boat harbor, additional facilities at Maalaea, and completion of Honokohau boat harbor.

But Stratton reiterates that funding and plans are not enough. Somehow, he says, environmentalists' concerns must be overcome

HERBERT T. MATAYOSHI
MAYOR

EDWARD K. HARADA
CHIEF ENGINEER

BUREAUS AND DIVISIONS:
AUTOMOTIVE EQUIPMENT & MOTOR POOL
BUILDING CONSTRUCTION AND INSPECTION
PLANS AND SURVEYS
ROAD CONSTRUCTION AND MAINTENANCE
SEWERS AND SANITATION
TRAFFIC SAFETY AND CONTROL

COUNTY OF HAWAII
DEPARTMENT OF PUBLIC WORKS
25 AUPUNI STREET
HILO, HAWAII 96720

June 3, 1975

Department of Transportation
Harbors Division
79 South Nimitz Highway
Honolulu, Hawaii 96813

ATTENTION: Mr. Tom Fujikawa

SUBJECT: Environmental Impact Statement for Development of Honokohau Boat Harbor
Job H.C. 6047
Re: HAR-ED 3642

In response to your May 21, 1975 letter, the Department of Public Works, County of Hawaii, has reviewed your project description for the subject project and have no comments to offer in regards to its environmental impact statement.

Edward Harada

EDWARD HARADA
Chief Engineer

cc: Mayor
Planning Department

No response necessary.

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

DIRECTOR'S OFFICE
JUN 10 7 56 AM '75
DEPT. OF TRANSPORTATION

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. Box 3378
HONOLULU, HAWAII 96801

GEORGE A. L. YUEN
DIRECTOR OF HEALTH
Audrey W. Mertz, M.D., M.P.H.
Deputy Director of Health
Henry N. Thompson, M.A.
Deputy Director of Health
James S. Kumagai, Ph.D., P.E
Deputy Director of Health

In reply, please refer to:
File: EPHS - SS

June 6, 1975

MEMORANDUM

To: Mr. E. Alvey Wright, Director
Department of Transportation

From: Deputy Director for Environmental Health

Subject: Comments for the Proposed Draft Environmental Impact Statement (EIS) for Development of Honokohau Boat Harbor - Job H.C. 6047

Thank you for allowing us to submit comments for the subject EIS. We have no comments at this time.

We will submit comments when the draft EIS is made available. We also reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

for JAMES S. KUMAGAI, Ph.D.

cc: DHO, Hawaii

No response necessary.

JUN 16 10 47 AM '75

HARBORS DIV.
DEPT OF TRANSPORTATION

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAII
P. O. BOX 1820 • HILO, HAWAII 96720 • 25 AUPUNI STREET

June 13, 1975

Mr. Tom Fujikawa
Department of Transportation
Harbors Division
79 South Nimitz Highway
Honolulu, HI 96813

Re: Development of Honokohau Boat Harbor - Job H. C. 6047

Inasmuch as this is a long-range plan for the development of Honokohau Boat Harbor, we have no adverse reactions at this time.

We shall appreciate reviewing the environmental impact statement when it has been completed.

Akira Fujimoto
Manager

GK

No response necessary.

JUN 20 1 01 PM '75

HARBORS DIV.
DEPT. OF TRANSPORTATION

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
PACIFIC SOUTHWEST REGIONAL OFFICE
BOX 36062
450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94102

IN REPLY REFER TO:

M2253

June 18, 1975

Mr. Tom Fujikawa
Harbors Division
Department of Transportation
State of Hawaii
79 South Nimitz Highway
Honolulu, Hawaii 96813

Dear Mr. Fujikawa:

Mr. Watt asked this office to respond to your request for comments on the proposed environmental impact statement for development of Honokohau Boat Harbor dated May 21, 1975.

Your proposed development will not conflict with or impact any programs of the Bureau of Outdoor Recreation. We have no information to provide at this time but will be pleased to review the completed draft environmental statement.

Sincerely yours,

Frank E. Sylvester
Regional Director

No response necessary.

XII. COMMENTS AND RESPONSES TO EIS

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO:

September 23, 1975

HAR-ED 1220

Mr. Yasushi Kurisu
Box 365
Hakalau, Hawaii 96710

Dear Mr. Kurisu:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

In response to your letter of August 22, 1975, your suggestions on landscaping and sewage disposal at the boat harbor are discussed in subject impact statement.

On the matter of harbor fees, loss of property and cleanliness, these are covered by Rules and Regulations Governing Small Boat Harbors of the Department of Transportation.

In regard to the boaters' desire for a range light, this matter was brought out at a recent meeting with boaters and will be investigated further.

Your comments and suggestions are appreciated.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

J. Tsurisu
Box 365
Hakalau, Hi.

Hakalau, Hawaii
August 22, 1975

Dear Ann,

Thank you very much for the Environmental Impact Statement of the Honokohau Harbor.

My comments of the Honokohau Harbor:

State land is situated around the Honokohau Harbor, so the project could be an ideal model of planned unit development of future growth.

I would like to see some planting and growing of "quality greens" at the Honokohau Harbor area, for scenic and environmental reasons.

Harbor dues and fees may be charged, for pilferage and cleanliness of the Harbor must be enforced.

I really like the idea of the boaters desire of a range light to replace the present light.

A location should be designated for a sewage treatment plant to "accommodate future growth". Otherwise, sewage may be seepaged into the harbor on low sea tide, due to the lava formation.

Sincerely,
[illegible]
Masaichi Tsurisu

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO:

October 17, 1975

HAR-ED 1404

Honorable Christopher Cobb
Chairman of the Board
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Cobb:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Comments in your letters of September 10 and 19 are appreciated.

Provision for detour of the shoreline trail "Ala Kahakai" around the harbor will be made. As indicated in paragraph IV A-3, page IV-2, joint use of access, parking, and restrooms can also benefit trail users.

Proximity of the petroglyph field is shown in Figure 18, page VIII-3A. The extent of the petroglyph field was precisely determined by a licensed surveyor of the Harbors Division in 1972, working under the direction of Dr. Stell Newman, State Archaeologist. Figure 17, page II-56, indicates the corner points of that survey.

An archaeological reconnaissance of any proposed dredge spoil area will be conducted prior to construction.

It is true that no firm commitment has yet been made to the details of mitigating measures in Section IV of the EIS. The National Park Service comment letter of September 18, 1975, on the EIS also makes that point. A sketch (Figure 18A) is being added to the Revised EIS which incorporates elements of mitigating measures and responds to several comments made in the course of the EIS review. It is the intent of the State Department of Transportation to work as soon as feasible with the State Historic Preservation Officer, National Park Service (Hawaii Group), Corps of Engineers, National Advisory Council on Historic Preservation to reach agreement on the details of mitigating measures.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute
Jane Silverman, State Historic Preservation Officer

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

CHRISTOPHER COBB, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES

EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

DIVISIONS:
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

OCT 11 10 35 AM '75

HARBORS DIV.
DEPT. OF TRANSPORTATION

September 10, 1975

Harbors Division
Department of Transportation
79 So. Nimitz Highway
Honolulu, Hawaii 96813

Gentlemen:

We have reviewed the EIS for Honokohau Harbor.

We note that no provision has been made for the proposed shoreline trail "Ala Kahakai" either as a channel crossing or as a detour around the harbor.

Very truly yours,

Edgar A. Hamasu
for CHRISTOPHER COBB
Chairman of the Board

HARBORS DIVISION
From:
Date SEP 17 1975
To:
☐ HAR
☐ HAR-S
☐ HAR-FS
☐ HAR-FSR
☐ HAR-FMN
☐ HAR-OTC
☐ HAR-B
☐ HAR-E
☐ HAR-EP
☐ HAR-ED
☐ HAR-EC
☐ HAR-EM
☐ HAR-O
☐ HAR-H
☐ HAR-M
☐ HAR-K
☐
☐
FOR:
☐ Info & ☐ Return
☐ Com & Recom
☐ App Att
☐
☐ File
☐
See File

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF STATE PARKS
P. O. BOX 621
HONOLULU, HAWAII 96809

DIVISIONS:
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

FILE NO. ____________

September 19,1975

Office of Environmental
Quality Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Gentlemen:

Subject: Honokohau Boat Harbor: Environmental Impact Statement.

After reviewing the above document, dated July 14, 1975, we have the following concerns:

1. Figure 4 (Page I-6A), shows a modification of the 1970 plan which was made in order to protect the petroglyph field that is the immediate area of the undertaking. However, the proximity of the petroglyph field is not shown in this illustration.

2. Page III-19, Paragraph 2: This paragraph says that judgements regarding area preservation were "subjective." These judgements were made on the basis of professional evaluations by qualified specialists in Hawaiian archaeology.

3. Page IV-I: The measures outlined on this and the next page would to a large extent mitigate certain of the adverse effects of the undertaking on the National Landmark property. However, there is no firm commitment to these mitigating measures. This is especially true as no decision has been made on which alternative will be selected.

4. Figure 18 (Alternate B), Page VIII-3A: This alternative may have adverse effects on the petroglyph field due to what appears to be close proximity of the boat/trailer parking and launch facility. Construction in the commercial area could pose an adverse visual effect to the National Landmark property.

5. Figure 19 (Alternate C1), Page VIII-9: No additional intrusion on the petroglyph field is evident here, but the possibility of adverse visual effects on the Landmark property from construction in the commercial area still seems to exist.

6. Figure 20 (Alternate C2), Page VIII-10: The boat repair yard seems in close proximity to the petroglyph field and may pose an adverse effect. Construction in the commercial area again could cause an adverse visual effect on the Landmark property.

7. We understand from the archaeological report and from personal conversations with the archaeologist who did the work, that the boundaries of the petroglyph field have not been delineated. This must be done before decisions on undertakings in that area can be made.

8. An archaeological survey must be done of the area where spoil material will be dumped to ensure that no archaeological resources will be lost as a result.

Sincerely Yours,

Jane L. Silverman

Jane L. Silverman
Historic Preservation Officer,
State of Hawaii

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO:

October 17, 1975

HAR-ED 1405

Mr. Frank E. Sylvester
Regional Director
U. S. Department of the Interior
Bureau of Outdoor Recreation
P. O. Box 36062
San Francisco, California 94102

Dear Mr. Sylvester:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Your comments on the EIS contained in your letter of September 18, 1975, are appreciated.

Harbor completion will not have any significant direct impact on recreation other than boating, fishing, and diving.

Inasmuch as the harbor will be a catalyst to some hotel/residential development, it is recognized that a secondary impact of harbor completion will be a requirement for other forms of recreation. These issues are dealt with in the Kona Community Development Plan, the County Recreation Plan, and the State Comprehensive Outdoor Recreation Plan, and there appears to be no need to condition the harbor completion on implementation of these other recreation plans.

Water quality will be somewhat degraded within the harbor with higher use rates, but flushing is excellent inside the harbor, and attenuation outside the harbor is so great that impacts on adjacent beaches will be negligible.

Harbors Division is planning to upgrade the sewage treatment system in the next construction phase.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
PACIFIC SOUTHWEST REGIONAL OFFICE
BOX 36062
450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94102

HARBORS DIV.
DEPT. OF TRANSPORTATION

IN REPLY REFER TO:
E3053

September 18, 1975

Mr. Melvin E. Lepine
Chief, Harbors Division
Department of Transportation
79 So. Nimitz Hwy.
Honolulu, Hawaii 96813

Dear Mr. Lepine:

In response to your letter of August 21, 1975 we have reviewed the July 14, 1975 environmental impact statement on Honokohau Harbor and submit the following comments for your consideration. These comments are provided as assistance in preparing your statement and do not reflect the position of the Department of the Interior on this project.

The beach areas adjacent to the harbor are extremely valuable recreation resources. As stated in the latest Hawaii State Comprehensive Outdoor Recreation Plan (expected to be approved in November of 1975), the Kona area contains a majority of the island's usable sandy beaches. The impact of the proposed project on the beach areas should be an important consideration in land-use decisions for this area. Therefore the environmental statement should include a section describing the impacts the project may have on recreation.

The environmental statement says that the harbor itself will be a significant visitor destination and that it will also be a catalyst to hotel/residential development. This will result in an increase in demand for beach-related recreation. Will this added pressure exceed the capacity of nearby beaches to accomodate it? Should the expansion of the harbor be conditioned on the development of additional recreation facilities to accomodate this demand? Is additional land acquisition necessary to meet the demand?

Since there is some uncertainty as to what impact the proposal will have on water quality in the area, there should be some discussion of what impacts water quality degradation could have on nearby recreation resources. The environmental statement indicates that if it is discovered that present onshore sewage treatment facilities are inadequate or that management procedures are ineffective in curbing the dumping of onship sewage into the harbor, then action will be taken to halt further degradation of water quality. But such corrective actions may prove to be too late to prevent irreversible damage to the harbor and nearby beach ecosystems. Including the upgrading of the existing sewage treatment facilities and the provision of ship-to-shore "hookups" for disposal of sanitary wastes in the initial phase of the project would appear to be a mitigating measure worthy of discussion.

We appreciate the opportunity to review your environmental statement and hope our comments will prove helpful.

Sincerely yours,

Frank E. Sylvester
Regional Director

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO:

HAR-ED 1406

October 17, 1975

Dr. James S. Kumagai
Deputy Director of Health
Department of Health
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Kumagai:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H.C. 6047

Comments in your letter of September 17, 1975, are appreciated.

Harbors Division plans to include the suggested sewage treatment facilities in the next construction phase.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. Box 3378
HONOLULU, HAWAII 96801

GEORGE A. L. YUEN
DIRECTOR OF HEALTH

Audrey W. Mertz, M.D., M.P.H.
Deputy Director of Health

Henry N. Thompson, M.A.
Deputy Director of Health

James S. Kumagai, Ph D., P.E.
Deputy Director of Health

September 17, 1975

In reply, please refer to:
File: EPHS - SS

MEMORANDUM

To: Dr. Richard E. Marland, Director
Office of Environmental Quality Control

From: Deputy Director for Environmental Health

Subject: Draft Environmental Impact Statement (EIS) for Honokohau Harbor

Thank you for allowing us to review and comment on the subject EIS. Please be informed that we have no objections to this project.

Staff comments are as follows: Serious consideration should be given to the addition of the aerobic sewage treatment with disinfection in the initial construction phase. Since leaching from the present facilities into the harbor is evident (page IV-3), the new facility should be located where it will have a minimum effect on the harbor's water quality.

We realize that the statements are general in nature due to preliminary plans being the sole source of discussion. We, therefore, reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

JAMES S. KUMAGAI, Ph.D.

cc: DHO Hawaii

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO.
HAR-ED 1407

October 17, 1975

Mr. Raymond Suefuji, Director
Planning Department
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Suefuji:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Comments in your letter of September 8, 1975, are appreciated.

Section X will be revised per your suggestion.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

HARBORS DIV.
DEPT. OF TRANSPORTATION

PLANNING DEPARTMENT

25 AUPUNI STREET • HILO, HAWAII 96720

COUNTY OF HAWAII

HERBERT T. MATAYOSHI
Mayor

RAYMOND H. SUEFUJI
Director

September 8, 1975

Dr. Albert Q. Y. Tom, Chairman
Environmental Quality Commission
550 Halekauwila Street
Honolulu, HI 96813

Re: EIS for Honokahau Harbor

Thank you for the opportunity to review the above.

The present County zoning designation for the expansion area(s) is Open. As such, the expansion is compatible with the zoning. However, the ultimate harbor development proposes administrative offices and meeting rooms as well for commercial facilities. These latter uses are not permitted in the Open zone. Perhaps the County Council should be listed in Section X, List of Necessary Approvals.

Once the appropriate County zone is obtained, the structures proposed for commercial and administrative purposes would have to undergo "Plan Approval" by the Planning Department. Perhaps this approval process should also be included in Section X.

RAYMOND SUEFUJI
Director

RN:rfd

cc: Mayor
DOT
DPW

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO:

October 17, 1975

HAR-ED 1408

Mr. W. Y. Thompson
Executive Secretary
Hawaii Leeward Planning Conference
P. O. Box 635
Kailua-Kona, Hawaii 96740

Dear Mr. Thompson:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Comments in your letter of September 16, 1975, are appreciated.

With respect to your notes on fencing near the northern boundary, there will be further coordination with the State Department of Land and Natural Resources and the State Historic Preservation Officer prior to construction. Details with respect to the sensitive historic area, as well as access to the Ala Kahakai shoreline trail, will be developed at that time.

All mitigating measures, including essential features of Alternate B, Figure 18, page VIII-3A, will be considered prior to facilities design.

A repair area for boats will be included, as suggested in your letter of June 26, 1975, so that some modification of the concept depicted in Figure 4, page I-6A, will be required. A concept which emphasizes compatibility with the aesthetic objectives for development of adjacent property to the north will be emphasized.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

HAWAII LEEWARD PLANNING CONFERENCE

September 16, 1975

Office of Environmental Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96814

SUBJECT: HONOKOHAU HARBOR E.I.S.

Gentlemen:

The development of a safe small boat harbor for Kona has been of deep concern to the commercial and recreational fishermen. Further, a top attraction for our visitor industry, deep sea fishing, has been hampered by the delay in the construction of such a facility. It took years to locate a suitable site. Such a site was found at Honokohau (on the State lands of Kealekehe). Plans were drawn and after initial dredging, the project came to a halt.

The details in the Honokohau Harbor impact statement are accurate on the history of this project. Yet, it cannot express fully the vast amount of studies, frustrations, and anxieties that surrounded this project. During the past twenty years, the development and expansion of the water system and a safe small boat harbor were the priority items for Kona. This is still true today. Fortunately, the development and expansion of the water system has progressed steadily, and people can count on a first-rate water system very shortly. However, the small boat harbor has fared poorly.

The present E.I.S. for the completion of the harbor adequately presents the case. It emphasizes the engineering superiority of the original harbor design of the former consultants: Daniel, Mann, Johnson and Mendenhall. The size is appropriate for the design period. The configuration takes advantage of the flushing action of the seaward flow of the basal water.

The modification to the original plan is based on historical preservation considerations. The petroglyph field area is eliminated from the harbor boundary. Further, a buffer area is provided which, should those who will assume historical preservation responsibilities over the area choose, could

P.O. BOX 635 • KAILUA-KONA, HAWAII 96740 • PHONES 329-2334 • 329-1758

become the parking area and entry point into the coastal zone which contains the prized items of historical and archaelogical significance. We approve the fencing of the proposed north boundary of the harbor. This fence will exclude vehicles into the sensitive historical area until management procedures are worked out.

The efficient ocean harvest from the bountiful leeward side of the island; the enjoyment of recreational boating by our resident population; the service to our number one industry, tourism - all have been hampered by the present incomplete Honokohau Harbor. The importance of providing attractions to support our visitor industry has been hammered home, time and again. Even the most recent County plan for Kona, the Community Development Plan, stresses this point.

The present delay in completing the Honokohau Harbor can be attributed to a reassessment for insuring the preservation of historical items. Without belaboring the point, the archaeological study included in this E.I.S. covers this subject adequately and concludes: "Since our one-day survey produced no new archaeological or historic sites, and because of the paucity and low calibre of previously known sites within the immediate project boundaries, we have concluded that the situation permits the planned expansion of the harbor." We urge that the mitigating measures described on pages IV-1 and IV-2 be a condition for approval.

We, the Hawaii Leeward Planning Conference, earnestly recommend acceptance of the Honokohau Harbor E.I.S. and urge approval of the modified development plan as proposed by the State Department of Transportation, Harbors Division, and shown on page I-6A, Figure 4. A long-sought dream - more than that, a long hoped for necessity for those who enjoy the sea and for those whose livelihood depend on the sea - is a safe and efficient harbor. Honokohau Harbor is the answer.

Respectfully submitted,

HAWAII LEEWARD PLANNING CONFERENCE

W. Y. Thompson

W. Y. Thompson
Executive Secretary

WYT:ma

cc: E. Alvey Wright
Harbors Division

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO

HAR-ED 1409

October 17, 1975

Honorable Andrew I. T. Chang, Director
Department of Social Services and Housing
P. O. Box 339
Honolulu, Hawaii 96809

Dear Mr. Chang:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Comment in your letter of September 10, 1975, is appreciated.

Requirements for public or subsidized housing for residents engaged in tourist and service occupations in the Kailua-Kona area are an appropriate concern of the County and State. This subject will undoubtedly be investigated during implementation of the Kona Community Development Plan which proposes general housing policies. Employee housing requirements directly related to the harbor are considered minimal and need not be discussed in the EIS.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

GEORGE R. ARIYOSHI
GOVERNOR

ANDREW I. T. CHANG
DIRECTOR OF SOCIAL SERVICES & HOUSING

STATE OF HAWAII
DEPARTMENT OF SOCIAL SERVICES AND HOUSING
P. O. Box 339
Honolulu, Hawaii 96809

September 10, 1975

Environmental Quality Commission
Office of Environmental Quality Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Gentlemen:

Construction of the Honokohau Small Boat Harbor can be thought to be a catalyst to resort and residential development. We think the EIS should have some mention of housing implications. Considering the high cost of property in the harbor area, we wonder if some public or subsidized housing would be needed for residents engaged in tourist and service occupations.

Sincerely,

Andrew I. T. Chang
Director

cc: Department of Transportation
Harbors Division

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO:

October 17, 1975

HAR-ED 1410

Mr. Kisuk Cheung
Chief, Engineering Division
U. S. Army Engineer District, Honolulu
Building 230, Ft. Shafter
APO San Francisco 96558

Dear Mr. Cheung:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Comments on the EIS contained in your letter of September 17, 1975, are appreciated. Our notes are as follows:

a. Depths and fairway widths and configuration will be checked for adequacy during the detailed planning/design stage. In general, depths and widths will be similar to those depicted in the 1970 harbor master plan.

b. Liaison will be maintained to insure that necessary permit requirements are met.

c. Reference will be made in the Revised EIS to present and planned maintenance and operations regulations and enforcement.

d,e,f. Appropriate changes will be made in the Revised EIS.

g. Revision will indicate resident population.

h. The basis for judgment on air quality will be included on pages II-30 and/or III-13.

i. Construction specifications related to blasting will be detailed so as to preclude damage to adjacent heiaus. Notation will be added to page III-7 of the EIS.

j. The highway has been designed to accommodate projected traffic loads of both the harbor and proposed cultural/historic park.

k. Correction noted.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BLDG. 230, FT. SHAFTER
APO SAN FRANCISCO 96558

PODED-P

17 September 1975

Dr. Richard E. Marland, Director
Office of Environmental Quality Control
State of Hawaii
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Dr. Marland:

We have reviewed the environmental impact statement for Honokohau Harbor and find it to be comprehensive and well-documented. The following specific comments are offered for consideration:

a. The proposed modified development plan is generally consistent with the project plan described in the Federal project authorizing document and the U.S. Army Corps of Engineers' General Design Memorandum report. The proposed plan is in compliance with the local cooperation requirements of the Federal project and should have no impact on the Federally maintained general navigation features, such as the entrance channel, service channel, main access channel, wave absorbers, and wave trap. The information provided on the proposed new slips and fairways was not sufficient to evaluate their adequacy for navigation.

b. Processing of the application for a Department of the Army permit for expansion of the harbor is being held in abeyance pending Congressional action on the Honokohau Study Committee Report. The Harbors Division's intent to file a revised permit application (p. X-1) has been noted. Issuance of the permit will be subject to fulfillment of the requirements for the National Environmental Policy Act of 1969 and compliance with the applicable historic preservation regulations outlined in the 18 June 1975 letter from the Advisory Council on Historic Preservation.

c. The operations and maintenance aspects of the completed harbor should be addressed in more detail. Although the existing water quality and flushing are excellent, harbor use and pollution potential levels are also very low. With ultimate development, the 8- to 9-fold increase in boats berthed and the 6- to 7-fold increase in launchings point to the need for an effective program of harbor operation and maintenance. Such a program will require more than "kokua" from boaters (p. IV-6). Reference should be made to applicable boat harbor regulations relating to harbor trash, spills, and boat maintenance operations and to the enforcement of these regulations.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

PODED-P
Dr. Richard E. Marland

17 September 1975

d. Figure 1 on page I-2 should reflect that Queens Highway between Kailua and Kawaihae is now completed.

e. The discrepancies in completion date of the harbor (p. I-9 and II-5) should be noted, and the month of completion should be indicated.

f. The reference for information on tsunami height (p. II-10) should be given.

g. In the discussion of social/economic factors, pages II-46 to II-49, the population figures should be clarified as to whether they represent resident or de facto population.

h. The basis for the conclusions on air quality, page 30, should be provided.

i. The possibility of damage to the adjacent heiaus caused by blasting should be addressed.

j. With reference to page III-14, will the highway be adequate to accommodate combined traffic loads to both the boat harbor and to the proposed cultural/historic park?

k. The spelling of Montipora verrucosa, page III-11, should be corrected.

Thank you for the opportunity to review the statement.

Sincerely yours,

KISUK CHEUNG
Chief, Engineering Division

Copy furnished:
Chief, Harbors Division
Department of Transportation
State of Hawaii
79 S. Nimitz Highway
Honolulu, Hawaii 96813

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO:

October 22, 1975

HAR-ED 1435

Dr. Richard E. Marland, Director
Office of Environmental Quality
Control
State of Hawaii
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Dr. Marland:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Your comments on the EIS contained in your letter of September 22, 1973, have been helpful. Our responses, following your format, are as follows:

MASTER PLAN FOR HONOKOHAU

There is no master plan for the ahupua'a of Honokohau nor for the adjacent ahupua'a of Kealakehe which contains Honokohau Harbor. Figure 3 on page I-4 of the EIS is taken from the document entitled Master Plan of Boating Facilities for Honokohau Harbor prepared for the State Department of Transportation in 1970. Other pertinent documents include a July 1975 preliminary draft of the Kona Community Development Plan being prepared under the direction of the Hawaii County Planning Director, a National Park Service document entitled The Spirit of Kaloko-Honokohau of May 1974, a proposal for a cultural park on property adjacent to and north of the harbor, and a March 1975 EIS for the proposed cultural park. Appropriate discussions from all the above documents have been included in the EIS.

PREVIOUS EIS

The previous EIS of July 1972 is listed under References, page XI-4. It was intended primarily to evaluate only the effects of the then-imminent next phase of construction. Processing of the EIS was discontinued when it became evident that a lengthy delay, and perhaps changed circumstances, would result from the comprehensive study of adjacent property by the Honokohau Study Advisory Commission.

The 1975 EIS for Honokohau Harbor does discuss desirable modifications of former (1970) planning (page I-6).

The proposed modifications are summarized under Partial Expansion, pages VIII-1 through 5. Section IV, Mitigating Measures, also includes several modifications to the plans of 1970.

DESCRIPTION

Figure 3 and page I-5 of the EIS refer to space for commercial facilities which might approximate 1 to 2 acres. No specific design or commitment has been made at this time on these details, but it is conceived that a restaurant, store for marine and fishing supplies, and offices for charter boat operators would be located here, to be operated as concessionaires under the jurisdiction of the State Department of Transportation.

SURROUNDING AREA

Land ownership essentials are given in Figure 11 on page II-32.

TIMETABLES

Timing of the next increment of harbor construction is given on page I-7. Subsequent increments are expected as demand develops and funds become available between 1977 and 2010. The best current estimate for completion of the Kailua-Kona sewage treatment plant and tie-in to the harbor sewer system is about 5 to 10 years (see pages II-33 and IV-3).

AIR QUALITY

The statement on air quality should probably have been phrased differently. It was intended to disclose that because of inversions in the Kailua-Kona area, air pollution potential cannot be ignored. The limited data available, plus visual observation, do indeed indicate present pristine air quality in the open space near Honokohau Harbor. In a recent uncompleted study of potential air quality along a major highway realignment being studied south of Kailua-Kona, it was indicated that no significant change in air quality is anticipated in 1978 and

1988. It is projected that there will be some decrease in CO and HC and minor increase in NO_x, while average daily traffic projections go up in that decade from about 8,000 vehicles to roughly 13,000. It is reasonable to conclude by comparison with these findings for the nearby Kaahumanu Highway that the air quality of the area will not be significantly affected by exhaust from an additional 500 vehicles (estimate for peak-day harbor traffic), the boat motors, and a small diesel generator (which is temporary). It is considered that the summary impact statement on page III-13, i.e., "There will be no adverse effect on air quality as a result of harbor completion", is adequate and appropriate in the circumstances. In accordance with your suggestion, the above explanatory material will be included in the Revised EIS. Power lines from the Kaahumanu Highway will be run underground.

PROPOSED KALOKO-HONOKOHAU NATIONAL CULTURAL PARK - EIS

Please see attached copy of summary of the EIS for the proposed park.

FLUSHING

Flushing analysis indicates (pages II-18-22) that average residence time of present harbor waters is about 12 hours. This is exceptionally good flushing, and about 6-10 times better than if the unique groundwater flow were not occurring.

The completed harbor's volume will be approximately double the present volume, and discussion of flushing in the proposed expansion is detailed on pages III-6-7 and on pages VIII-5-10 in the "Alternatives" section. The flushing discussion was placed in this section because the flushing capacities of the proposed configurations are significant environmental criteria in evaluating the alternative plans. The flushing dynamics of the alternatives are assessed by description of the half-lives of hypothetical pollutant spills. This method of assessment and reporting was chosen in preference to "residence time" values because of its enhanced applicability. For example, with a spot spill, most of the time involved with its removal is the time for uniform dispersal within the basin to occur. This internal mixing time is affected, to a large degree, by the internal circulation, which is configuration-dependent. These times, presented on page VIII-8, vary considerably among the proposed alternatives. This type of half-life data can be related to "residence times", but such a condition would assume an initially uniform distribution of the substance within the given area, i.e., that the values for any column in Table 1 were equal for all configurations. Because this is clearly not true, the true predictiveness of such values is limited. The given flushing analysis of the alternative configurations assumed the worst-case condition that no additional groundwater was encountered via the expansion.

DREDGING

Completion of the harbor will entail blasting and excavating (dredging) roughly 600,000 cubic yards ultimately of volcanic rock (page III-2). Because the harbor is to be excavated from rock and there is little erodible soil near the harbor, no maintenance dredging is anticipated over the life of the project.

EFFECT FROM INCREASED HARBOR CAPACITY

The proposed harbor completion will increase boat launchings on a peak day from about 50 to 350. Berthed boats would increase from about 50 to 450 (or 350 - Alternate B).

Current projections for North and South Kona to year 2010 (page II-47) indicate that population will more than double over the 35 years from 10,000 to 22,000. The harbor will be a factor (but certainly not a major factor) in that population growth. There will indeed be some increased urbanization related to that growth, but adverse effects of urbanization will be minimized if the State's current policy of "controlled growth" is implemented by State and County actions so that rates of growth are not excessive. (Incidentally, because of the lava terrain of most Kona areas, siltation and sedimentation are not major urbanization problems here.)

While both the proposed harbor completion and proposed cultural park would cause some growth stimulation, it is considered that neither, at its respective scale (or jointly), would be incompatible with the State's controlled growth plan, and neither would cause unacceptable secondary impacts due to growth rates.

PERMITS REQUIRED

It is expected that the Honokohau Harbor project will be subject to County review under the Shoreline Protection Act.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

Enclosure

cc: Oceanic Institute

SUMMARY

(x) Draft ( ) Final Environmental Statement
Department of the Interior, National Park Service, Western Region

1. Type of Action: ( ) Administrative (x) Legislative

2. Description of Action: The Department of the Interior proposes to establish a Ka-loko, Hono-kō-hau National Cultural Park in the State of Hawai'i on the North Kona coast of the County of Hawai'i. The Park will consist of approximately 750 acres of land and 550 acres of adjacent offshore water area. The area will be managed and interpreted to the greatest extent possible by persons of Hawaiian descent. The major purpose will be to help preserve the fabric of Hawaiian culture through: stabilization and restoration of historic sites; educational and training programs for Hawaiians; cultural demonstrations; and an accentuation of the land-sea ethic, a dominant force in Hawaiian attitudes and feelings. Parking areas, roads, trails, orientation structures and management facilities will be built only to the extent that they are in conformance with the purpose of the park.

3. Summary of Environmental Impact and Adverse Environmental Effects: The proposed action will provide an opportunity for Hawaiians to participate in preserving their own culture and in presenting, to visitors, this important element of American culture. The land-sea ethic is particularly significant at this location as it has ramifications relating to current problems of food production, conservation of energy, and preservation of habitat for species of rare and endangered Hawaiian birds.

As a result, the Hawaiian will regain cultural pride and have an opportunity to learn about his heritage from other Hawaiians. For the visitor, there will be an opportunity to view and appreciate many aspects of Hawaiian culture and attitudes. There will be a high cost to the Federal Government for land acquisition. There will also be an impact on the current land-owners, in that plans for a resort-recreation complex will not be realized. Dominant impact on the land itself will come from construction of parking, orientation, and research facilities, and from visitor use.

4. Alternatives to the Proposed Action: A. No action (development plans now proposed by the state, county, and current landowners); B. Proposed cultural park with a minimum acreage; C. Proposed cultural park with greater land and less water acreage; D. Cultural park proposal at a site other than Hono-kō-hau; E. Locate park orientation center adjacent to south boundary; and F. Management limited to persons with 50% or more Hawaiian ancestry.

5. Comments have been Requested.

6. Date Statement made available to CEQ and the public:

Draft Statement: March 14, 1975

GEORGE R. ARIYOSHI
GOVERNOR

RICHARD E. MARLAND, PH D.
DIRECTOR

TELEPHONE NO.
548-6915

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
OFFICE OF THE GOVERNOR
550 HALEKAUWILA ST
ROOM 301
HONOLULU, HAWAII 96813

September 22, 1975

MEMORANDUM

TO: E. Alvey Wright, Director
Department of Transportation

FROM: for Richard E. Marland, Director

SUBJECT: Environmental Impact Statement for Honokohau Harbor, North Kona, Hawaii

As of this date, this Office has received thirteen comments on the above subject. As attached sheet lists ten responding agencies and organizations.

In our evaluation of the environmental impact statement (EIS), we find several areas in which the document should expand discussion. We offer the following comments:

MASTER PLAN FOR HONOKOHAU

The master plan for the above subject should be discussed in the EIS to include the harbor and the surrounding areas.

PREVIOUS EIS

Our files show that we have a draft EIS for Honokohau Harbor, Phase II dated July 1972. However, the present EIS does not indicate previous EIS being written. Why was the former draft EIS discontinued? Are there any changes in design or plans from the former EIS to the present one? A discussion is recommended.

DESCRIPTION

In figure 3 and on page I-5, commercial operations have been cited. However, the commercial operations should be described as to what type and whose jurisdiction for that area will be.

SURROUNDING AREA

Who are the landowners surrounding the harbor and the Honokohau National Historic Landmark area?

TIME TABLES

What are the time tables for the completion of the project? When is the sewer system expected?

AIR QUALITY

This Office is quite concerned about the statement on page II-30, "Although the Kailua-Kona area is subject to inversions, the air quality in the vicinity of the harbor is so close to pristine that there is no apparent reason for concern." In the described condition of the air, we feel that it is important to realize that preserving the existing air quality should be emphasized, not disregarded until a problem develops. In other words, action should be taken before it happens, not after.

On page II-33, the EIS indicates that a generator will provide the electricity, until the utility is installed. We recommend a discussion of the air emissions from the generator. Will air pollution increase if the population increases? When are power lines proposed to be installed? Will it be overhead or underground lines?

How will the increase of vehicles and water crafts caused by the expansion of the harbor affect the air quality as a whole?

KALOKO-HONOKOHAU NATIONAL CULTURAL PARK

Throughout the EIS, reference has been made to a federal document, namely the EIS for the Kaloko-Honokohau National Cultural Park. It would be helpful to the reviewer if a summary of what the document contains is given.

FLUSHING

The flushing data seem to be based on the present harbor conditions. Is the mode of oscillation also applicable to flushing for the proposed expansion? How much effect on the flushing quality will the 650% increase in harbor space be?

DREDGING

How much material is expected to be dredged? With what frequency will dredging occur?

EFFECT FROM AN INCREASED HARBOR CAPACITY

Since the proposed project will increase the use of the harbor by 900%, various primary and secondary impacts will be associated with the project. Thus, there are a few impacts that should be considered in long-term effects and in the total environment.

1. The proposed expansion along with the plans by other agencies to develop this area into a cultural center will have a positive direction to growth. If growth is stimulated, adverse affects from urbanization such as siltation and sedimentation will increase.

2. Controlled preservation of the historical sites will be needed. Positive growth will affect the historical sites along with fishponds and wildlife.

3. Secondary impacts such as traffic, increase air, water, and noise pollution, population growth, use of public facilities and utilities, and etc, will exist.

PERMITS REQUIRED

Will your project be affected by the County of Hawaii's guidelines to the Shoreline Protection Bill when it becomes effective December 1, 1975?

RECOMMENDATIONS

For fairness and brevity, this Office did not attempt to summarize other reviewer's comments. Instead, the EIS Regulations require that your agency respond "point by point discussion of the validity, significance, and relevance of comments;" ...and discuss " ...how each comment was evaluated and considered in planning the proposed action."

The EIS Regulations further state that responses should be made by fourteen days after the review process. However, the Governor or his authorized representative has the discretion to consider late responses. This Office will consider late responses because of the controversial nature and our extensive comments on the proposed action.

We trust that these comments will be helpful to you. Thank you for the opportunity to comment on this EIS.

Attachments

LIST OF RESPONDING AGENCIES

FEDERAL

*Department of the Army	September 4, 1975
*Department of the Army-Tripler	September 4, 1975
Fish and Wildlife Service	September 12, 1975
Soil Conservation Service	September 16, 1975
Corps of Engineers	September 17, 1975

STATE

Department of the Agriculture	August 25, 1975
Department of Social Services and Housing	September 10, 1975

COUNTY OF HAWAII

*Planning Department	September 8, 1975
Department of Public Works	September 12, 1975

UNIVERSITY OF HAWAII

Environmental Center	September 19, 1975

ORGANIZATIONS

*Yasushi Kurisu	August 22, 1975
Mokuaikaua Church	September 15, 1975
Kamehameha Development Corp.	September 18, 1975

*Previously sent by correspondence of 9/10/75

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU HAWAII 96813

IN REPLY REFER TO.

October 22, 1975

HAR-ED 1436

Mr. Fred Cachola
Director of Extension Education Division
The Kamehameha Schools
Honolulu, Hawaii 96817

Dear Mr. Cachola:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Your comments on the EIS contained in your letter of September 19, 1975, are appreciated. The specific suggestion relative to provisions for Polynesian vessels is particularly helpful in providing a theme of transition and compatibility with the adjacent petroglyph area.

Construction specifications on blasting will be detailed so as to preclude damage to adjacent heiaus.

Your concerns will be considered during preparation of the construction plans.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

September 19, 1975

Office of Environmental Quality Control
550 Halekauwila Street
Room 301
Honolulu, Hawaii 96813

Gentlemen:

The following commendations and recommendations are my personal reactions to the EIS for Honokohau Harbor. My interest in the harbor development stems from my past and present involvement as a member of the Department of Interior Honokohau-Kaloko Advisory Study Commission.

I. Commendations

A. Section IV. Good thoughts have gone into this section. I urge that the mitigating measures discussed for historical/archeological sites become required conditions for expansion activity. The joint use of some facilities, particularly parking, access trails, restrooms, service utilities should be planned to accommodate the visitors who are primarily interested in the historical sites in the immediate vicinity.

B. Section II, Page 40. This is an accurate reflection of the current national status of the National Park proposal. However, your EIS should include, for the record, that the State Senate, the County Council County of Hawaii, the State Council of Hawaiian Civic Clubs, and numerous other Hawaiian organizations have also supported the National Park proposal. (See attached documents.) The feasibility of a park development is more likely, in view of the strong public sentiment expressed. Therefore, the expansion of the harbor should include compatible planning concepts which will have reciprocal benefits for a harbor-park development.

II. Recommendations

A. Provisions for canoes and traditional Polynesian vessels.

The area close to the petroglyph fields should include a launch ramp and berthing facilities specifically designated for Polynesian vessels. The increasing canoeing activity in the Kona area, and the traditional aquatic activity of the National Park proposal will benefit from these considerations. Your demonstrated sensitivity for serving a large spectrum of culturally-related aquatic activity will enhance support for harbor expansion and create a better balance among contemporary and traditional commercial-recreation needs.

The current harbor design is limited only for contemporary vessels. In the midst of this valuable cultural-historic area, your harbor design should include accommodations for Hawaiian vessels ranging from 14' fishing canoes, 40' racing canoes, 40' inter-island double canoes, to 60' voyaging canoes.

(See attached sketch of proposed area.)

C. Blasting consequences.

Both heiaus in the immediate vicinity should be temporarily shored-reinforced to absorb any shock and possible damage due to prolonged blasting.

There are other ideas and considerations which I would like to discuss with you. However, I just received a copy of your EIS today and deadline requirements for responses limit what can be said in this written response.

Sincerely,

Fred Cachola
Member
Honokohau-Kaloko Advisory Study Commission

ROBERT M. YAMADA
Chairman & Presiding Officer

TOMIO FUJII
Vice Chairman

COUNTY COUNCIL
County of Hawaii
Hawaii County Building
Hilo, Hawaii 96720

DANTE K. CARPENTER
FRANK DE LUZ, III
IKUO HISAOKA
WILLIAM S. KAWAHARA
MERLE K. LAI
ANDREW C. LEVIN
JOSEPHINE R. YADAO
Council Members

April 16, 1975

The Honorable Patsy T. Mink
House of Representatives
301 Cannon House Office Building
Washington, D. C. 20515

Dear Representative Mink: Patsy

The enclosed Resolution 373 regarding the Kaloko-Honokohau "Historical" Park is self-explanatory.

Please be advised that in the discussion prior to adoption, I pointed out our discussion and the potential availability of funding from Federal Congressional appropriations. I hope the Resolution is adequate in terms of support from Hawaii County.

As you are aware, Hawaii County presently holds the area in question in "open" zoning, therefore, County zoning would have to be granted in order for the developments to be realized. It is my understanding that Senate Concurrent Resolution 141 which is supportive of this idea was adopted by the Senate only.

I did have an opportunity to discuss our conversation with Senator John Ushijima and Representative Minoru Inaba regarding the above.

I hope this aids in the cause and can bring about, if not the total envisionment, at least a compromise between the Advisory Council and the property owners.

Sincerely yours,

Dante K. Carpenter
COUNCILMAN

Encl.

STATE ASSOCIATION OF HAWAIIAN CIVIC CLUBS
16TH ANNUAL CONVENTION

February 7-9, 1974
Honolulu, Hawaii

RESOLUTION 12

A RESOLUTION TO SUPPORT AND ENCOURAGE THE ESTABLISHMENT OF A HAWAIIAN CULTURAL PARK AS A UNIT OF THE NATIONAL PARK SYSTEMS AT HONOKOHAU NATIONAL HISTORIC LANDMARK AND TO INCLUDE THE ESTABLISHMENT OF THE PARK AS A BONA-FIDE ACTIVITY OF THE 1976 BICENTENNIAL CELEBRATION

WHEREAS, the 92nd Congress of the United States enacted Public Law 92-346, "To authorize a study of the feasibility and desirability of establishing a unit of the National Park System in order to preserve and interpret the site of the Honokohau National Historic Landmark in the State of Hawaii, and for other purposes,"; and

WHEREAS, the Congress of the United States, " . . . finds the site of Honokohau National Historic Landmark in the State of Hawaii encompasses unique and nationally significant cultural, historical, and archaeological resources and believes that it may be in the national interest for the United States to preserve and interpret those resources for the education and inspiration of present and future generations,"; and

WHEREAS, the Congress of the United States, " . . . further believes that it is appropriate that the preservation and interpretation at that site be managed and performed by native Hawaiians to the extent practical and that training opportunities be provided such persons in management and interpretation of those cultural, historical, and archaeological resources,"; and

WHEREAS, the Hawaiian population has indicated overwhelming and positive support in concurrence with the objectives and proposals set forth through a series of eight (8) lengthy and intensive Public Hearings held on the islands of Hawaii, Maui, Molokai, Oahu, and Kauai; and

WHEREAS, Public Law 92-346 mandated that the Honokohau Study Advisory Commission be established, " . . . composed of fifteen (15) members, at least ten (10) of whom shall be native Hawaiians, appointed by the Secretary of the Interior,"; and

WHEREAS, the Honokohau Study Advisory Commission, duly appointed by the Secretary of the Interior, is comprised of fifteen (15) knowledgeable citizens of the State of Hawaii, including thirteen (13) Hawaiians and part-Hawaiians and an outstanding authority on Hawaiian anthropology and archaeology; and

WHEREAS, the conclusions of the Honokohau Advisory Commission drawn from the expressions of the Hawaiian population and others in the State of Hawaii at the aforementioned Public Hearings and elsewhere, indicate that it is in the best interests of the citizens of the County of Hawaii, the State of Hawaii, and the United State of America that these qualities of cultural, historical, and archaeological significance be preserved and interpreted for the education, enjoyment, and inspiration of present and future generations; and

WHEREAS, the first draft of the proposals presented to the Director and Staff of the National Park Service, and the Secretary of the Interior has received their full support and encouragement; and

WHEREAS, the National Bicentennial Administration in Washington, D.C. is considering the establishment of Honokohau National Cultural Park as a bonafide activity of the 1976 Bicentennial celebration; and

WHEREAS, the establishment of this Cultural Park is consistent with the aims and objectives regarding the preservation and perpetuation of the Hawaiian Culture as set forth in the provisions of the Constitution and By-Laws of the Hawaiian Civic Clubs Association; and

WHEREAS, the proposals and objectives of the Honokohau Study were presented and well received by representatives of Hawaiian Civic Clubs Historic Site Committees at a conference at Kamehameha Schools January 19, 1974;

NOW, THEREFORE, BE IT RESOLVED that the State Association of Hawaiian Civic Clubs at convention, February 7, 8, 9, 1974 formally supports and encourages the establishment of a Hawaiian Cultural Park as a unit of the National Park Systems at the site of the Honokohau National Historic Landmark and respectfully requests the County of Hawaii, State of Hawaii, National Park Service, and the Department of the Interior to assist and implement the necessary steps to create and establish as a unit of the National Park Service, the Honokohau Cultural Park as proposed by the Honokohau Study Advisory Commission.

BE IT FURTHER RESOLVED that copies of this resolution be transmitted to the Governor of Hawaii; President of the Hawaii State Senate; Speaker of the Hawaii State House of Representatives; the Hawaii State Senate Minority Leader; the Department of Land and Natural Resources; Mayor and members of the County Council, County of Hawaii; the University of Hawaii Department of Anthropology; the Hawaiian Foundation of Culture and the Arts; the Bishop Museum; the United States Department of the Interior; the Hawaii State Congressional Delegation; the Coalition of Hawaiian Organizations; and all other individuals and organizations interested and concerned in Hawaiian Cultural perpetuation.

SUBMITTED BY:	The Hawaii Council
REFERRED TO:	Historic Sites Committee
ACTION:	ADOPTED - See attached signature page

ASSOCIATION OF HAWAIIAN CIVIC CLUBS

Representatives attending Historic Sites Committee Meeting who unanimously adopted Resolution #12 pertaining to the Establishment of a Hawaiian Cultural Park as a Unit of the National Park Systems at Honokohau National Historic Landmark as a Bonafide Activity of the 1976 Bi-Centennial Celebration are as follows:

CLUB NAME	REPRESENTATIVE
ALII PAUAHI	[illegible]
EWA	Carmen Ewa Oliveira
HONOLULU	Julia Toomey
KAILUA	Blanche M. Keahi
KALIHI-PALAMA	[illegible]
KING KAMEHAMEHA	Ellen Moa
KOOLAULOA	Nona O. Hill - for Tina
KOOLAUPOKO	Jeanette L. Gay
MAKAKILO	Marian L. Makuna
NANAIKAPONO	John Loke Joseph Kekuna
PEARL HARBOR	
PRINCE KUHIO	Jeanelle K. Choy
PUULOA	Amber K. Smith
QUEEN EMMA	Juliet - Director
WAIALUA	Lani - Sec.
WAIANAE	Mercy Garcia - Historian
WAHIAWA	Hiram Diamond
WAIKIKI	Adele K. Haili Historian
WAIMANALO	Kuulei Aila
HILO	Kenneth Makuakane
PRINCE DAVE KAWANANAKOA	Mary Ann Leilani Uno - Director
NORTH HILO	Kani Viveiros
HAMAKUA	Elaine L. Mill
WAIMEA	Mabel Tolentino

KOHALA

KONA

HO'OPULOA

KA'U

CENTRAL MAUI

LAHAINA

HOOLEHUA

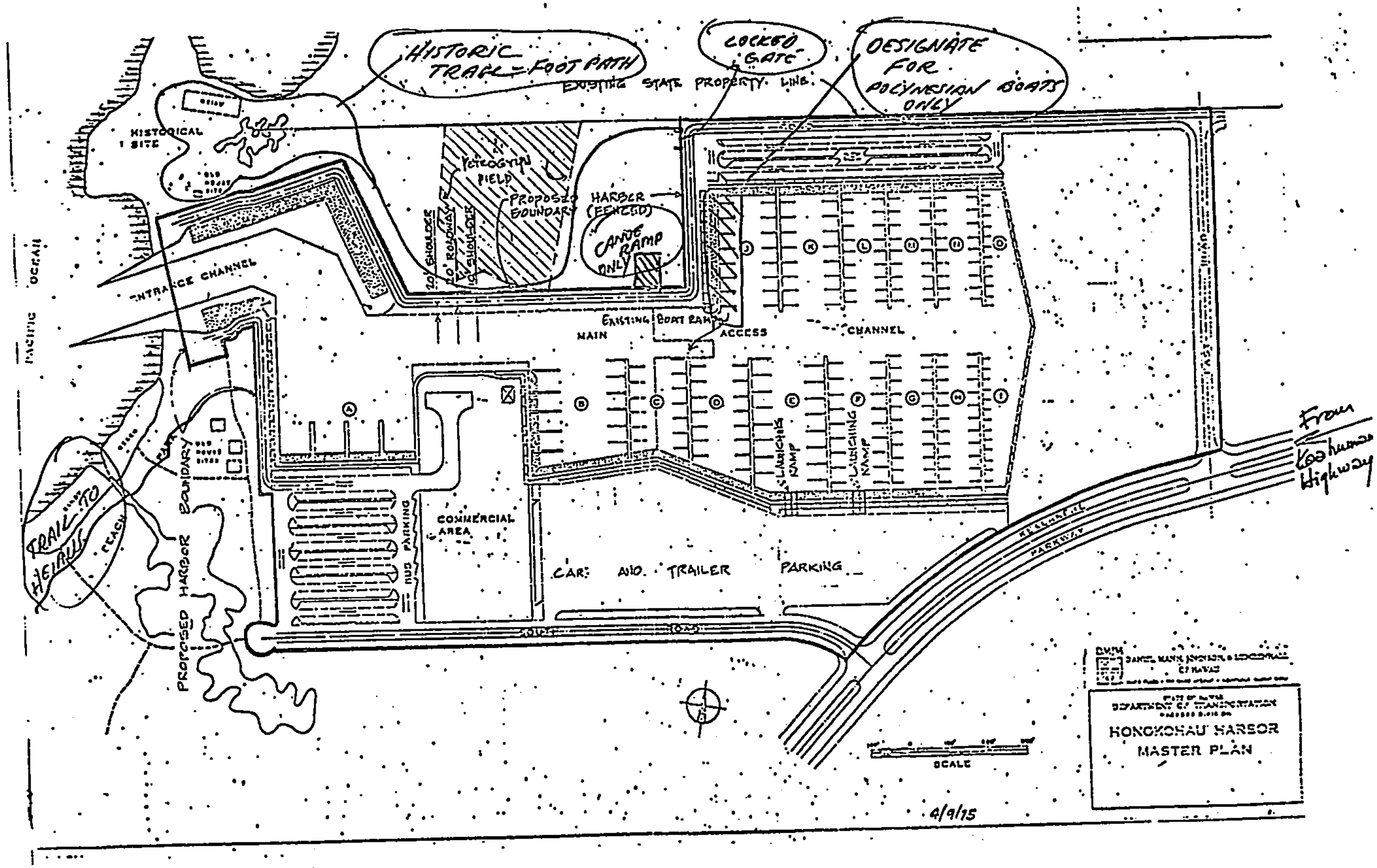
MOLOKAI

LANAI

KAUAI

HANALEI

KAUMALII


HISTORIC TRAIL = FOOT PATH
LOCKED GATE
DESIGNATE FOR POLYNESIAN BOATS ONLY
EXISTING STATE PROPERTY LINE
HISTORICAL SITE
PETROGLYPH FIELD
PROPOSED HARBOR BOUNDARY (FENCED)
CANOE RAMP ONLY
10' SHOULDER
20' ROADWAY
10' SHOULDER
ENTRANCE CHANNEL
PACIFIC OCEAN
EXISTING BOAT RAMP
MAIN ACCESS CHANNEL
LAUNCHING RAMP
LAUNCHING RAMP
COMMERCIAL AREA
BUS PARKING
CAR AND TRAILER PARKING
PROPOSED HARBOR BOUNDARY
TRAIL TO HEIAUS
BEACH
From Kaahumanu Highway
SCALE
HONOKOHAU HARBOR MASTER PLAN
DEPARTMENT OF TRANSPORTATION
4/9/75

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO:

October 24, 1975

HAR-ED 1459

Reverend Henry K. Boshard
Mokuaikaua Church
P. O. Box 1447
Kailua-Kona, Hawaii 96740

Dear Reverend Boshard:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Your comments of September 15, 1975, on the Honokohau Harbor EIS are appreciated.

We concur in the conditions stated in your paragraphs 1 and 2.

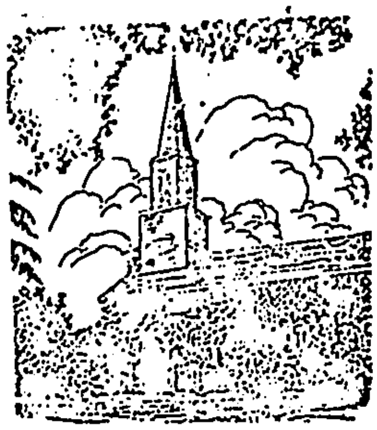
Section VIII B, page VIII-4, of the EIS suggests that hoists can be used in the future to provide launching capacity without increase in water space. The associated boat storage you suggest will be discussed at a public meeting to be held during the design stage of the Phase II development of the harbor. Financial aspects of boat storage, discussed on page 115 of the 1970 Master Plan of Boating Facilities for Honokohau Harbor, will have a bearing on plans for funding and construction of facilities.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: Oceanic Institute
OEQC



MOKUAIKAUA CHURCH

CHURCH OF THE CHIMES
Established 1820
P. O. Box 1447 KAILUA-KONA, HAWAII 96740

Minister
HENRY K. BOSHARD
B.A., M. Div., D. Min.

Mokuaikaua Nursery School
PHONE: 329-1589

September 15, 1975

Environmental Quality Commission
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Friends:

Having looked over the environmental impact statement on Honokahau Harbor prepared by the Dept. of Transportation of the State of Hawaii, and having been approached by members of the Hawaii Leeward Planning Conference regarding my opinion covering the expansion of the harbor facility, I feel that I can take an affirmative stand, but only upon the conditions stated in the following paragraphs:

1- As shown on the modified development plan, figure 4 of I-6A, the historic and cultural areas (heiau and petroglyph field) located just north of the harbor will not be intruded upon.

2- Expansion of the harbor facility will take place only toward the east.

3- That in the near future the Dept. of Transportation study the concept of shed-storage for the numerous small boats in use in the Kona area. The building would be very inexpensive as compared to excavation. It need only be constructed of steel posts, beams and roof. Hundreds of small crafts can be stored in the facility. When an owner wishes to make use of his boat, it could be hauled down to the water's edge, and a crane-type rig lift it into the water. This would eliminate a lot of the present-day hauling to home garages located miles away, and an inconvenience of trailer moving and parking.

Incidentally, I served as a member of the Honokahau Advisory Committee.

cc: Hawaii Leeward Planning Conference

Sincerely,

Henry K. Boshard

Henry K. Boshard

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O SWANSON

IN REPLY REFER TO
HAR-ED 1460

October 24, 1975

Dr. Doak C. Cox, Director
Environmental Center
University of Hawaii at Manoa
2540 Maile Way, Room 10
Honolulu, Hawaii 96822

Dear Dr. Cox:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Your comments on the EIS contained in your letter of September 19, 1975, are appreciated. Our corresponding notes are as follows:

1.c. Landforms, p. II-6; 2.0 Ground Water Hydrology, p. II-13

With respect to concerns over effect on adjacent ponds, it is conceded that there is a slight chance of a little change in salinity to Aimakapa Pond through possible diversion of groundwater flows from higher elevation toward the harbor. Aimakapa Pond is a well-known sanctuary for birds and there has been no observed effect on this bird population during the first increment of harbor construction. Consultation with others familiar with the biota of this pond indicate no likelihood of effects on biota with small changes in salinity here. In the discussion of our consultants in your office, it appears therefore that any harbor effects on Aimakapa Pond would be minimal and not adverse. Since Aiopio fishtrap is in direct contact with the sea, no salinity changes or adverse effects to the biota are anticipated.

The infrared photograph (page II-17), showing groundwater intrusions at the shore prior to the existence of the present harbor, indicates that the harbor is located in a region of conspicuous natural discharge of groundwater. In addition to indicating the subterranean permeability of the area, this situation suggests that the harbor area was and still is normally traversed by considerably more groundwater than the pond area to the north and the pond ecosystem has developed in response to this condition.

There has been no observed change in the groundwater intrusion to Aimakapa Pond as a result of excavation of the present harbor, suggesting that the present basin has not intercepted or diverted groundwater destined for the direction of the ponds in question, nor has any resultant change in permeability produced a noticeable effect on this intrusion. Further, the abundance of native birds (predominantly stilt and coot) found in the ponds has shown no change since the excavation of the present basin, suggesting that the ecosystem response to any environmental changes which might have occurred in this time have been negligible (Hawaii State Fish and Game Division). Communication by our consultants with the Hawaii Cooperative Fisheries Unit indicates that responses of the pond biota to small salinity changes would not be significant; thus, it is not anticipated that the food web involving these native birds would be adversely affected either.

It is felt that the random nature of the permeability between test holes would affect the resultant basal lens configuration predicted by the numerical hydraulic analysis of discharge distribution, suggested in your letter. Such an analysis was not feasible nor particularly appropriate to undertake within the context of this EIS.

The Aiopio water body (adjacent to the harbor), which was suggested in your letter to have had great impacts to its discharge as a result of the harbor is appropriately a fish<u>trap</u> rather than fishpond and has virtually free communication with the sea and thus is dominantly saline. It is not a preferred habitat for the birdlife in question.

<u>1.c. Unique Physical Features, p. II-7</u>

Drogue studies described a strong, well-defined, westward-flowing (out to sea), surface effluent exiting the harbor. This path was prevalent at least until the region of the buoy (<u>ca</u>. 200 meters from the harbor) where it came under the influence of the ocean current directed toward Ke-ahole Point. Mixing via wave action and currents in this area provide rapid attenuation of dissolved materials. Data show that the concentration of such constituents are attenuated by approximately 20:1 between the inner harbor and a point <u>ca</u>. 150 meters to sea. There is a possibility of some litter and debris bei , wind-driven to the shoreline in question, but observations in the spring of 1975 indicated minimal floating litter in the harbor and adjacent areas. Dissolved materials driven shoreward by the wind would be diluted to insignificant levels at the coast. Accordingly, with a 7-fold increase in boat launchings and 5-fold increase in boat berthing, any impact from normal oil/gas slicks, nutrients, etc., on adjacent beaches can reasonably be expected to be negligible/undetectable. Because this is a small boat harbor, no major fuel quantities are handled here. There is always the possibility of a spill, despite regulations (Department of Transportation, Harbors Division, Rules and Regulations and Tariff No. 4, 1975, Section 3430) and appropriate supplies of oil absorbent material will be kept on hand to deal with inadvertent spills.

P. II-10

Tsunami effects will be considered when the boat slips are designed, although it is recognized that there is no real "tsunami-proofing" that can guarantee no damage to boats or slips in a severe tsunami.

2.11 Physical oceanography, p. II-20-21; Water Quality Impacts, p. III-4-6; and Appendix B

Discussion of flushing in the proposed expansion is detailed in pages III-6-7 and in pages VIII-5-10 in the "Alternatives" section. The flushing discussion was placed in this section because the flushing capacities of the proposed configurations are felt to be significant environmental criteria in evaluating the alternative plans. The flushing dynamics of the alternatives are assessed by description of the half-lives of hypothetical pollutant spills. This method of assessment and reporting was chosen in preference to "residence time" values because of its enhanced applicability. For example, with a spot spill, most of the time involved with its removal is the time for uniform dispersal within the basin to occur; this internal mixing time is affected, to a large degree, by the internal circulation, which is configuration-dependent. These times, presented on page VIII-8, vary considerably among the proposed alternatives. This type of half-life data can be related to "residence times", but such a condition would assume an initially uniform distribution of the substance within the given area, i.e., that the values for any column in Table 1 were equal for all configurations. Because this is clearly not true, the true predictiveness of such values is limited. The given flushing analysis of the alternative configurations assumed the worst-case condition that no additional groundwater was encountered via the expansion.

II.c.2. Cultural Resources, p. II-53

Harbors Division will consult with the State Historic Preservation Officer prior to design and construction with regard to desirable salvage and with regard to appropriate protection of the petroglyphs and/or other adjacent archaeological sites.

Although there are no known or suspected archaeological sites in or near the proposed location for excess excavated material 1,000 yards south of the harbor, archaeological reconnaissance will be conducted there prior to construction. The area is a barren lava flow.

The extent of the archaeological survey shown in Figure 17, page II-56, was purposefully chosen large enough so that it would encompass any potential configurations and orientations of the completed harbor itself as well as any land needed for temporary construction activities. Equipment parking areas, supply, storage, etc., will all be located within the crosshatched areas shown in Figure 17. Bulldozer access (by wheeled trailer) will be along the present access road from Queen Kaahumanu Highway.

The EIS for the proposed National Cultural Park (page 77) states that the impact of the park, if it were implemented, would be to force expansion to the south or give up expansion. Subsequent investigations have made it clear that harbor completion with an eastern orientation can be compatible with the aims and objectives of the park planning so long as appropriate mitigating measures detailed in the harbor EIS are carried out. The harbor will not "encroach" on the proposed park. On the contrary, there are opportunities for joint use facilities at the interface of the harbor and the proposed park. Park boundaries at the harbor entrance will not require dredging, maintenance, or harbor modifications.

III. Impacts on Water Quality, p. III-4

The Harbors Division is concerned with the litter and pollutant increases that will come with increased harbor usage. The projected increases are not of overwhelming proportions, and it is reasonable to expect that present and proposed regulations can and will be enforced to prevent any serious problem.

IV.2.d

There are numerous permeable portions of the lava terrain so that drainage can be by swales to the appropriate low and permeable areas.

IV.B Water Quality, p. IV-3

Temporary and permanent sewage treatment facilities will be constructed at the earliest practicable date.

IV.D Blasting, p. IV-5

Specifications for blasting can and will be worded so as to preclude damage to the heiau. This is practicable. A statement will be included in the Revised EIS.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

University of Hawaii at Manoa

Environmental Center
Maile Bldg. 10 • 2540 Maile Way
Honolulu, Hawaii 96822
Telephone (808) 948-7361

Office of the Director

September 19, 1975

MEMORANDUM

TO: Richard Marland

FROM: Doak C. Cox

RE: Review of Draft Environmental Impact Statement for Honokohau Harbor

The Environmental Center review of the above cited DEIS has been prepared with the assistance of H. David Tuggle (Department of Anthropology), Frank L. Peterson (Department of Geology and Geophysics), Reginald Young (Water Resources Research Center), and Doak C. Cox, Jacquelin Miller and Clare Shinsato (Environmental Center).

In general, the draft EIS was adequate in its coverage of potential environmental impacts. However, there are several areas of concern which are not covered or need to be more fully addressed and included in the final EIS.

Our comments shall follow by section and page of the text.

1.c. Landforms, P. II-6; 2.0 Ground Water Hydrology, P. II-13.

Concerns have been expressed over the potential effects of the proposed harbor enlargement on the water level and salinity of nearby fish ponds. The Department of Transportation in their letter of 15 July 1975 to the USDI Fish and Wildlife Service states:

"2. The analysis of ground water flows indicates it is highly improbable that the harbor completion would affect either the water quality or water level at Aimakapa Pond."

The analysis referred to is not presented in the EIS, but it does not seem possible that any sound analysis could possibly reach the conclusion expressed above.

The strength of ground water discharge at the coast varies with the configuration of the shoreline and with the distribution of permeability in the rock. Discharge tends to be concentrated at inlets and in areas in which the permeability is greater than normal.

If the permeability could be assumed uniform, the distribution of discharge could be approximated by hydraulic analysis. The complications of the shore configuration are such that numerical methods of analysis would be required.

Permeability may in general be assumed highest in lava tubes in pahoehoe flows and in the clinker zones of aa flows, lowest in the interior parts of aa flows, and intermediate in the bulk of the pahoehoe flows excluding the lava tubes.

The actual combined effects of permeability distribution and shore configuration could best be determined in a general way by the measurement of mean head (averaging out tidal effects) in a number of test holes as well as isolated or semi-isolated ponds.

If a numerical model were constructed assuming uniform permeability and corrected by assigning a permeability distribution resulting in a fit to the measured head distribution, the corrected model might be useful in estimating the effects of the nearshore configuration that would result in the harbor enlargement by numerical methods. So far as we are aware no such analysis has been performed.

In the absence of such analysis, all that can be assumed is that the effects of the harbor on ground water flows to near-shore ponds are likely to be great at distances along the coast from the harbor that are small in comparison with the harbor dimensions (particularly the mauka-makai dimension), significant at distances approximating these dimensions, and insignificant at distances much greater.

The present mauka-makai extent of the harbor is about 1200 ft. The enlargement would make this about 2000 ft. Aiopio fishpond is about 600 feet distant; along the coast Aimakapa fishpond is about 2500 ft. distant, and Kaloko fishpond about 7500 ft. distant. Unless there are important effects of permeability distribution, therefore, it should be assumed that the present harbor has had great effects on the discharge to Aiopio fishpond and the proposed extention will add to these effects, that the proposed extension is likely to introduce significant effects to Aimakapa fishpond, but that there will be no significant effects at Kaloko fishpond.

Assuming that the discharge from the fishponds to the sea is fairly free, the mean water level in the ponds is only a little above sea level (head on the order of 0.1 ft. or a few tenths of a foot). The effects of the harbor on water levels in the ponds would therefore be slight. There is no reason to suppose that water from the harbor will reach the fishponds except by way of the sea. Hence the only significant effects of the harbor on the ponds are likely to be increases in salinity and reductions of rates of flushing by ground water.

1.c. Unique Physical Features, P. II-7.

What effects on water quality will the proposed project have on recreational areas such as the ". . . large sandy beach . . . to the north of the harbor." Is this and other beaches in the area susceptable to degradation of water quality due to oil, grease and gasoline slicks, debris, etc.? To what degree will water quality be affected? The methods for prevention as well as confinement, and cleanup of oil spills should be discussed fully in the final EIS.

P. II-10.

Have potential tsunami effects been considered in designing the boat slips?

2.11 Physical oceanography, P. II-20-21; Water Quality Impacts, P. III-4-6; and Appendix B.

The discussion on general circulation and flushing in the existing harbor is well documented. There appears to be a lack of discussion of potential flushing and circulation in the proposed expansion of the harbor aside from saying "There is no reason to suspect a major change in the flushing pattern." What criteria was used to reach such a conclusion? Since the "excellent flushing pattern" is cited in numerous areas throughout the DEIS as a major positive environmental feature in support of this project, documentation to indicate that the existing flushing pattern will be maintained in the existing harbor as well as flushing and circulation patterns in the proposed extended harbor should be included in the final EIS. What will happen if no additional ground water sources are encountered? What about sources of 10-20-30 etc. m^3/min of brackish water input from the new area? Can estimates of flushing be calculated for these varied situations? If so these estimates should be included in the final EIS.

II.c.2. Cultural Resources, P. II-53.

The environmental assessment on historical/archaeological resources of Honokohau Harbor appears to be accurate regarding the development area per se. With regards to the "Old House Site" (P. II-56), the DEIS follows the recommendation of the Bishop Museum report (Site D11-27; Appendix A) that the site may be destroyed without further archaeological work because it is deteriorated and has been damaged by recent bulldozing. Despite its present condition we recommend that the site be archaeologically salvaged before its complete destruction. It is a small site and cost would be minimal. Any site within the Honokohau-Kaloko-Kealakehe area should be salvaged, no matter how seemingly marginal, if this area is indeed "one of (or perhaps the) most valuable area in the state" (p. II-53). This site should also be salvaged because it has the geographic distinction of being the house site "[the farthest inland of any found during this survey. . .]" (P. A-1) quoted in the EIS from the original Emory and Soehren Honokohau survey of 1961.

A deficiency in the EIS is its minimal consideration of impact outside of the development area per se. Such impacts fall into two categories: 1) effects during construction, and 2) effects after completion of the harbor.

In none of the maps (most of which are missing units on the scale) could any location of construction work area be found (i.e. equipment parking areas, bulldozer access road, supply, storage, etc.). All of the maps appear to show only final development construction locations and the Bishop Museum survey area appears to be co-terminous with this final plan (with the exception of some survey to the north). This implies that there will be no construction activity outside of the final development area. Is this true? One statement in the report indicates that it is not true. On page III-2 there is the statement: "The tentative location for excess excavated material will be a depressed area in the lava fields about 1,000 yards south of the harbor on state land . . ." This area appears to be outside the zone surveyed by the Museum. Specifications for work outside the development area must be more clearly defined and archaeological survey and salvage should be conducted in any areas outside the zone surveyed by the museum. Have possible measures been considered to mitigate the potential destructive impact of vandalism, looting and general archaeological site destruction encouraged by greater access and increased traffic in this area?

What effect will the development of the proposed Kaloko-Honokohau National Cultural Park have on the harbor? Will the proposed expanded harbor encroach on the proposed National Park? We note that the harbor entrance will be within the proposed boundaries of the Park. Will this affect the dredging, maintenance or modification of the Harbor entrance?

III. Impacts on Water Quality, P. III-4.

It is noted in the EIS that "greater pollutant inputs in the harbor including nutrients, minor oil and gasoline slicks from motors, litter thrown by careless persons, and wastes from fish cleaning" will be a problem. Stringent controls should be established to prevent unnecessary and careless pollution to these waters.

IV.2.a. Historical/Archaeological, P. IV-1.

The "dark" concrete suggested in item a. is highly desirable from the esthetic point of view.

IV.2.d.

What type of drainage system will the project area have if curbs and gutters are omitted (as noted on P. IV-1)? This area of concern should be addressed in the final EIS.

IV.B. Water Quality, P.IV-3.

Concerns have been expressed over the suggestion that relocation of the temporary facility (existing septic tank and cesspool) will be considered "when monitoring indicates any downward trend in (water) quality." Judging from the discussions and data presented in the DEIS, water quality will almost certainly deteriorate with increased usage of these facilities. Why delay construction of adequate sewage treatment facilities and permit a potential buildup of organic material in the harbor?

IV.B. Water Quality, P.IV-4-5.

It is agreed that launching ramps and boat repair facilities must be located where they will have minimal negative impact on the harbor and coastal waters.

IV.D. Blasting, P.IV-5.

The effect of blasting outside the development area is not discussed. Have potential blasting effects on Pu'uoina heiau and other surrounding areas outside of the immediate blasting site been examined?

Thank you for the opportunity to review this DEIS. We will appreciate your consideration of our comments in the final EIS.

Doak C. Cox, Director

cc: Dept. of Transportation

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO

HAR-ED 1461

October 24, 1975

Commandant
Fourteenth Coast Guard District
677 Ala Moana Boulevard
Honolulu, Hawaii 96813

Dear Sir:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Comments in your letter of September 18, 1975, are appreciated.

The Department of Transportation will consult with the Coast Guard with respect to suggestions on oil/sewage pollution prevention, fuel docks, vessel pump-out facilities, and navigational aids. Harbor regulations with respect to bilge pumping and oily wastes will be given particular attention.

In the future, the Coast Guard will be included in the original distribution of the EIS for projects such as the Honokohau Harbor.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDER (mep)
Fourteenth Coast Guard District
677 Ala Moana
Honolulu, Hawaii 96813

5922
18 SEP 1975

Admiral E. Alvey Wright
Director
Department of Transportation
Harbors Division
869 Punchbowl Street
Honolulu, Hawaii 96813

Dear Admiral Wright:

Staff review of your Environmental Impact Statement for Honokohau Harbor, Hawaii has been completed, and the Coast Guard has no objections to the implementation of the project as proposed therein.

The Coast Guard is interested specifically in the following aspects of the project:

Oil/Sewage Pollution (and Pollution Prevention)

Fuel Docks

Vessel Pumpout Facilities (for Sewage and Oily Wastes)

Navigational Aids

It is noted that pollution, fuel docks, and pumpout facilities have been discussed in letters by other organizations, and these matters appear to have been adequately addressed. It can not be over emphasized that, in order to minimize the pollution potential, pumpout facilities must be provided at harbors and marinas for these boats which are being required to be equipped with marine sanitary devices and comply with other pollution prevention regulations.

The impact on existing aids to navigation appears to be minimal. One range will have to be relocated at an approximate cost of $17,000.00.

Is is assumed that the Coast Guard was inadvertently neglected during the original distribution of the EIS. Our copy was received from the State Office of Environmental Quality Control upon request after noting an article in a local newspaper concerning the project. It is hoped that in the future the Coast Guard will be permitted to review and comment on both the draft and final EIS's prepared for projects such as this.

Sincerely,

W. H. STEWART
Captain, U. S. Coast Guard
Commander, Fourteenth Coast Guard District
Acting

Copy to:
COMDT (G-WEP)
CEQ
EQC

GEORGE R. ARIYOSHI
GOVERNOR

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

IN REPLY REFER TO

October 24, 1975

HAR-ED 1462

Mr. Alan Tyler
RR 1, Box 125
Captain Cook, Hawaii 96704

Dear Mr. Tyler:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Your comments on the EIS contained in your letter of September 17, 1975, are appreciated. Our response follows:

NEED FOR HARBOR COMPLETION

The 1970 Master Plan of Boating Facilities for the Honokohau Harbor has a well-documented marketing analysis relating to the need for harbor completion. That market analysis was independently and thoroughly reviewed in the course of preparation of this 1975 EIS, with appropriate comments in Sections II C, III C, and VIII B. The method for analyzing "need" is valid. The EIS review (pages VIII-2-3) of the judgments in the 1970 "needs" analysis does indicate that a reduction from 450 berths to 350 berths would be appropriate and in line with the State's present policies for controlled growth. Furthermore, a petition dated August 14, 1974, calling for completion of the harbor and signed by approximately 400 local residents of Kona, is on file with the Harbors Division.

Boat ramps are given high priority within the harbor construction program. Other locations to supplement Honokohau ramps are being considered at this time.

Expenditures for the harbor (about $2,400,000 for the next increment and another $10,000,000 later) can be evaluated in the light of economic and social setting and impact and good to the community, both directly on harbor users and indirectly on others. This has been discussed in the EIS (Sections II C and III C).

HAR-ED 1462

Mr. Alan Tyler
Page 2
October 24, 1975

The benefits of public facilities, such as harbors, airports, parks, etc., accrue not only to direct users, but to other non-users in the community as well. Justification for such facilities is most appropriately assessed in this context. In the case of Honokohau Harbor, economic benefits accrue to the local community and to the State.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

RR1., Box 125
Captain Cook, Hawaii 96704
September 17, 1975

Department of Transportation
Harbors Division
79 South Nimitz Highway
Honolulu, Hawaii 96813

SUBJECT: Inadequate content and responses in Honokohau Harbor E.I.S.

Dear Gentlemen:

It is very gratifying that your department has recognized the benefits of the Honokohau Landmark Cultural Park, and included this proposal within your EIS

However, It is distressing that so many of the questions and concerns we raised in the above EIS response (which you included beginning on page IX-23) have been lightly brushed aside and left unanswered or undealt with by the director's reply (on page IX-20). For example:

THE NEED FOR HARBOR EXPANSION HAS YET TO BE SUBSTANTIATED. Nowhere in the EIS is there anything but vague references to a need for this $12 million project. No significant numbers of Kona boaters or residents have been quoted or surveyed, according to your EIS. No disclosure is made that when this harbor was planned and promoted by the State - along with Ke'ahole Airport and Queen Kaahumanu Hwy.- the state policy was THEN one of RAPID GROWTH, but recently has since become one of SLOW GROWTH. Therefore, former grandiose plans for mass-populating Kona are now obsolete - and with them the expansion of the harbor, or much of it.

While my letter spent most of the first page detailing specific concerns questioning the NEED for harbor expansion, the Director's 3-sentence reply evades answering these and instead talks about the "year 2010" and "features" of the harbor's facilities. Unless the presence or absense of an up-to-date need by the local boat owners in Kona can be shown, then this EIS is failing its duty as a disclosure document. Here is a suggestion:

THE NEED FOR HARBOR EXPANSION COULD BE SUBSTANTIATED BY A SURVEY. A survey of Kona's boating population obviously is long overdue by the D.O.T. Such a survey will probably show what other recent surveys during the last five years have shown These have been randomly taken by the Kona Citizens' Planning Council, and a high school students' group. The results were that the residents of Kona placed high priority on such items as beach parks, athletic fields, swimming pools AND boat ramps - whereas, they placed LOW priority on harbor expansion.

THEREFORE, BOAT RAMPS - NOT HARBOR EXPANSION - WAS AND PROBABLY STILL IS # 1.

The costs for boat ramps run as low as $35,000.[1], as compared to the price tag for Honokohau Harbor, which is 12 million dollars. Based on present rates[2], Kona's resident boaters - some 90% of whom trailer their boats [3]- need approximately 6 more boating ramps. At least some of these ramps should be in SOUTH Kona. This alternative should be thoroughly explored in your alternatives section, and as a separate alternative. (see again, our former suggestion submitted to you under "C" of Alternatives, on page IX -25, in which was said, ".. if people need ramps most urgently, ramps should be built first.")

DISCLOSING THE COST FACTORS OF "WHO PAYS vs. WHO PLAYS"

WHO is this harbor expansion to be for? This is another of the questions you did not answer. Apparently, it's primarily for upper-income people who can afford large boats longer than 24 feet. (page IX-4) Isn't this just backwards? A SMALL BOAT HARBOR that restricts use to LARGE boats? No one in Kona with a small boat under 25 feet can even get on the waiting list. It is these small boat owners that comprise the vast majority of Kona's boaters. They are mostly of low and medium incomes, which means that they contribute the greatest share of State tax money that is used to construct boat harbors[4]- such as at Honokohau Harbor. Yet, it is the upper-income boaters with crafts 25' or longer that are the ones eligible to use the harbor berths and get on the waiting lists, and they are the ones who pay proportionately the LEAST for the harbor construction. This inequitable tax burden and discrimination should be fully disclosed in your EIS before it is considered "adequate".

If in your final E IS you once again fail to forthrightly and completely answer the above and other questions asked, beginning on page # IX-23 of your E I S, then it will probably be necessary to request the Federal Government to do an adequate E I S, as per their laws such as the Rivers and Harbors Act, and also Public Law # 92-500, Sec. 404; because, harbor expansion into this National Historic Landmark will definitely 1) have an effect upon it, 2) that effect will necessarily be adverse, and 3) therefore, mitigating factors must be spelled out between the Advisory Council on Historic Preservation and the Corps of Engineers prior to any such expansion.

Yours truly,

Alan Tyler

Alan Tyler, Kona Conservationist

cc: Sec. of the Interior
Advis. Council on Historic Preservation
Corps of Engineers
Rep. Patsy Mink
O.E.Q.C.

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO:
HAR-ED 1463

October 24, 1975

Mr. David K. Roy, Jr.
Vice President
Congress of the Hawaiian People
P. O. Box 596
Kailua-Kona, Hawaii 96740

Dear Mr. Roy:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Your comments on the EIS contained in your letter of September 23, 1975, are appreciated. Specific suggestions with respect to details of harbor orientation and configurations so as to minimize visual impact on the National Historic Landmark will be considered in our imminent meetings with the State Historic Preservation Officer, National Park Service representatives, and other interested parties.

With respect to expected benefits from completion of the harbor, it is reasonable to conclude that indirect benefits will accrue to the economy of the community as related in the EIS (page II-17 and 18), so that criticisms based on a high capital cost per berth are not necessarily valid. With a moderate-scale harbor, these indirect benefits will justify the State expenditure for construction. With respect to your comments on direct benefits, the next increment of construction will give high priority to increasing launch facilities for trailered boats.

Your comments with respect to berths for full-time commercial fishermen will be given consideration. Although the State's small boat harbors are primarily for recreational boating, the need for assistance to commercial fishermen at Honokohau is recognized inasmuch as no facilities are available closer than Kawaihae.

Your comments with respect to harbor size based on population projections are concurred in.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

P. O. Box 596
Kailua, Kona, 96740
September 23, 1975

Mr. E. Alvey Wright, Director
State Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii - 96813

Dear Mr. Wright:

<u>Subject</u>: Environmental Impact Statement for Development of Honokohau Boat Harbor, Job H. C. 6047

We did not receive copies of the subject EIS, and therefore were unable to adequately absorb the information therein in time for the deadline for comments. I borrowed a copy over the weekend from an acquaintance of mine and I take this opportunity to address myself to you on the contents of this study.

My initial reaction to the proposed development (Fig. 4, pp. I-6A) is that your Department has indicated a total lack of sensitivity to the expressions of the many, many concerned citizens, who, in the past two years have actively sought to reach a reasonably satisfactory solution with your people. I dare say that your modified plan as presented in Fig. 4 of the EIS even ignores some of the recommendations expressed in the study. This plan is no more than that originally advanced by your Department in 1970 except for the relocation of the boat repair yard, car and trailer parking, and the boat launching ramp.

As you are well aware, this original conception of the Harbor development was objectionable from several aspects, and these objections were defined clearly to you and Mr. Lepine at a public meeting held before the Honokohau Study Advisory Commission at Farrington High School in Honolulu, in 1973. At that time your Department had not prepared an EIS as required and therefore had not thoroughly investigated all possible factors vitally concerned, nor had other alternatives been explored to the satisfaction of myself and many others. Now, after hurriedly scanning the present EIS, I find the situation unchanged for the most part. The physical layout of the Harbor is still the same. It is most disappointing to see that in this day of enlightment and deep concern for integrity, that the public layman has little reason for confidence in Government agencies such as yours. It seems that once a plan is prepared you will do everything possible to push it through come what may. This was done in the Honaunau Launching proposal also.

This attitude has been demonstrated similarly in the matter of the H-3 Freeway proposal. Rather than undertaking a sincere effort to resolve an existing public controversy, your Department undertook (at no little cost and with a maximum of technical resources available to the State through its staff members and elsewhere) to systematically breakdown the credibility of material offered by proponents of the preservation of Moanalua valley. At that time I could find no evidence of any attempts to seek a reasonable compromise or alternative to your plans. I note that at the present time, in the face of ever mounting opposition, efforts are still being expended towards the achievement of your aims as conceived, instead of seeking other solutions.

Returning to the subject at hand, it was a great surprise to me and others on the commission as well as the contracted consultants involved in the Honokohau Study, that you would find it necessary to contract the Bishop Museum to conduct a one day Archeological survey of the Honokohau and Kealakehe area in spite of exhaustive research in which the Bishop Museum was a prime participant and source of information already, the results of which were readily available to you at no cost. I might state without equivocation that the Honokohau Study was conducted by talented professionals whose objectivity was of the highest order and those of us who had the opportunity to collaborate with them were far richer for the experience and fortunate indeed. Appendix A in the EIS reflects high importance of the Historical and Cultural resources of the National Historical Landmark in which the Harbor has intruded, and recommends attention and consideration be given to the aesthetic qualities of the surrounding historical area. It is unfortunate that Mr. Sinoto seemed to be more concerned with individual sites and their relative significance (a value judgement) rather than the effect on the total composite presented in the proposed Honokohau-Kaloko National Cultural Park area. While the presence of sites is ample reason, it is by no means the only cause for concern. What is of major importance and significance is the physical intrusion of the Harbor and its related facilities on the fragile natural atmosphere of the Honokohau Study area. There, the interrelationships of sites to each other, to the land and sea, and other facets of the environment, as well as their cultural implications, past, present, and future, serve to comprise a total perspective which is difficult, if not impossible, to find elsewhere. An evaluation by authorities in the field of Archeology and Anthropology, placed the Honokohau-Kaloko National Historic Landmark at the top of the list of ten of the most outstanding and significant Historical places in the State. For the purposes of aesthetics, environmental appreciation, recreation, and research, not to mention educational potentials for generations to come, (local, national, and international), this pristine, natural environment and its related intangibles is invaluable and irreplaceable. A petroglyph or a number of them, a papamu, or a house site, or a burial, or other isolated archeological sites in themselves do not necessarily determine the value or significance of a historical or cultural location. It is felt that the quantity, quality, relationships to each other, functions in a past society, the kinds of locations, the very environment in which situated, and indeed, the subjective attitudes of the people in the culture, both past and present, go to make up a composite whole from which judgements on significance can be drawn. Therefore, the simple presence, or lack of one or more physical sites, does not, in my opinion and those of my associates, comprise the basis for a determination of the direction of expansion or configuration of the harbor. Rather, the adverse effect of physical intrusion into this total perspective, by this Harbor development and most important, the myriad tangible and intangible factors accompanying the establishment of harbor facilities (commercial activities of various types, etc) are the prime and determining considerations. This kind of effect or intrusion is a subject of great concern in the National Historic Preservations Act of 1966.

It is felt that in order to minimize adverse effects of tangible and intangible intrusion into the Honokohau-Kaloko National Historic Landmark, the configuration of the Harbor should be directed mauka or in an Easterly line for a reasonable distance followed by a 10 to 15 degree turn to a point approximating the South East, enclosing a square area equal to that necessary to accommodate the number of boats ultimately to be provided for. This would adhere to the findings of your consultants relative to the best flushing action and highest water quality, as indicated in Alternate B in the EIS. It would also be in line with the recommendation that development be commensurate to the concept of "controlled growth" presently existing in the County of Hawaii and elsewhere.

While we are inclined to recognize and support the needs of the boating population, we are unwilling accede to any encroachment into an area of such irreplaceable value when there is no real justification for it.

With regard to direct benefits to boaters, it is pointed out in the EIS that the "a" group of boaters (trailered boats) which has the greatest number of local residents will benefit directly from provision of adequate boating facilities. This is questionable. If this development were largely confined to benefits to trailered boats in the way of expanded launching facilities, parking and washing areas, restroom facilities, utilities (phone and electric), and other similar provisions along the Kona Coast which are related to this area of boating, we would readily concede the point and support the issue. We recognize that the primary need for local boaters is for more launching ramps with parking and washing facilities along the Kona Coast. However, we fail to see where berthing for 450 boats as proposed by your plan will be of direct benefit to trailered boats inasmuch as they will not realize the use of the berths. Of the 12 million dollars to be expended in the Harbor development possibly no more than 1% will be reflected in such benefits to the trailered boats. We wholeheartedly support the development of more facilities for the "a" class boaters who by far comprise the greater number of Kona fishermen, recreational and commercial.

Some sources claim that the development of the Harbor as proposed by you would encourage or induce a greater number to acquire larger boats requiring berths who would utilize the harbor facilities thus justifying the maximum expansion. This may be true in the case of commercial fishermen who might very well be encouraged to invest in larger fishing vessels by provision of safe and adequate harbor facilities to care for their needs. However, nowhere in the proposal is there any consideration for the bonafide members of the commercial fishing industry (Aku, Flagline, or bottom fishing boats) either for berthing or a designated area for facilities relative to their needs. However, even if this were provided, it can hardly be conceived that the number would be such as to occupy a significant portion of the contemplated area. Further than that, the assertion would be wishful thinking. Is it anticipated by your department that our population would be so unique as to suddenly blossom into a majority of affluent fishermen who would be able to acquire and maintain boats in the 30 to 40 thousand dollar class? Do you believe that the ordinary prudent fisherman would invest in such equipment when the fishing grounds are only a short run off the Kona Coast with calm waters prevailing for more than 300 days a year? There is hardly any justification for such an investment nor is the population of local residents so affluent as to afford the luxury. Certainly there will be some who will fall in this category, but hardly in large numbers. Historically, needs of commercial fishermen have been ignored in services provided and the situation remains unchanged. I, who have been an owner of a large commercial fishing vessel, am well acquainted with maintenance problems and expenses, not to mention acquisition costs.

The locations of the launching ramps, car and trailer parking, and related services suggested in Fig. 4, Modified Development Plan, are good but why not provide three launching ramps, one of which to be located facing the boat repair yard? With respect to the boat repair yard, I would like to state that in my experience anywhere, the most noxious element of any boating development, is a boat repair facility. As you propose, this would be located on the mauka or East end of the expansion. This would place it in a position facing the Kaahumanu Highway and would be the dominant sight as one approaches the Harbor premises. From an aesthetic standpoint, it would seem to be desireable that this area be set on the South edge of the mauka expansion, possibly across the approach roadway. Besides the aesthetic factor, it would be wise to consider the prevailing evening breezes which blow from the direction of the slopes to the sea, carrying every odor and sound with it through the proposed commercial area. This can be an unpleasant experience for the diner or the visitor.

As mentioned above, a concern in the Harbor configuration is that in promoting optimum flushing action and water quality, it would seem highly desireable to minimize any impediments to a natural and direct flow seaward. In other words, a straightline expansion with a 10 to 15 degree angle to the Southeast would seem to be advantageous towards promoting high water quality and the best flushing action. Another approach would be a straightline excavation to the mauka end, without a northward expansion. This would eliminate the corner created by your proposed northerly expansion with its attendant eddies, dead spots, and sluggish activity where debris and pollutants might tend to remain longer. While Alternate B indicates dispersal of pollutants in terms of hours and, in some cases, one day (pp. VIII-8), others reflect time periods of weeks and months. It is therefore suggested that the straight-line-oblique angle mentioned above would comform to conditions anticipated in Alternate B.

The matter of surge in the Harbor has been well covered in the EIS and I concur with their conclusion that none of the proposed alternatives vary significantly with this probability, and the choice among the Alternatives should rest on other considerations.

In view of the irreversible committment involved in this development, it is imperative that all possible effort be made to minimize the effects surrounding land areas, and you are urged to consider long run possibilities in all areas of growth in Kona. Undoubtedly, a great deal of planning has been based on anticipated population expansion. I would disagree with the contention that the population for Kona would reach monumental proportions of 92,664 by the year 2010. The figure of 22,000 estimated by the DPED seems more realistic. Therefore, it appears reasonable that a more conservative approach be assumed planning for expansion, and a smaller number of boats be considered, rather than the 450 proposed in the present plan.

According to the EIS, it would cost 12 million dollars to complete the basic facilities, and there is a sum of 2.4 million dollars presently available from prior appropriation. This would average out to approximately $27,000 per berth on the basis of 450 boats, and about $35,000 per boat on the basis of 350. This appears to be a lopsided benefit ratio when considering the requirements of the largest number of boaters, the Trailered boats, and would lead one to feel that greater consideration should be given for more launching ramps and related facilities, at the present time inasmuch as the need is at hand. Expansion of berthing facilities should be commensurate with real and predictable needs and demands.

It has been mentioned that the Honokohau Boat Harbor would readily be used by residents of Kohala and other such areas on the West Hawaii Coast with the implication that the demand is, or would be high. This writer suggests that this is a highly speculative position. With harbor facilities existing at Kawaihae, which is twenty minutes from Hawi and from Kamuela and more from Honokaa, it is inconceivable that a boater residing in this vicinity would prefer Honokohau. Travel time is lengthy, expenses high, and after the exertions of a full day of fishing, when the fisherman is a tired man, it would be quite inconvenient to cover an additional 30 or more miles on a regular basis. Therefore, I would tend to discount this consideration. The point is made on page II-46 of the EIS.

With respect to anticipated increased revenues, as pointed out in the Honokohau Study, inducements which would lead to extended visitor stays of from ½ to one day more than the present average, would result in substantial revenues. Recent National Park figures reflect a visitor count of 1 million at the Volcanoes area and 243,266 for the City of Refuge and a month's count of 3400 at Puukohola. The establishment of a park complex at Honokohau coupled with the recently opened Lapakahi State Park could conceivably be responsible for extended visits of no little significance. Assuming a rate of $41.00 per day per visitor, a ½ day extended visit for between 500,000 and 1 million visitors leads to possible revenues exceeding 10 million dollars, which would be directly funneled into the local economy. While the Harbor development would certainly enhance the local economy it is doubtful that it would equal the same proportions because this activity is confined to a relatively limited segment of the visitor population, whereas, other inducements would be reflected on the total spectrum.

Attached herewith is a sketch of the Harbor indicating the modifications discussed herein. You will note therein, one further consideration, namely, the relocation of sanitation facilities. According to the EIS, there has been some evidence of leaching into the harbor. With increased activity, this would undoubtedly lead to higher pollution levels. Since there is no immediate prospect for the provision of sewage treatment facilities by State, County, or Private sources, this should be a matter of immediate concern to be initiated in the first phase of development. We note that certain hotel and condominium developments provide their own sewage treatment facilities and it is felt that a development of this magnitude should include the same.

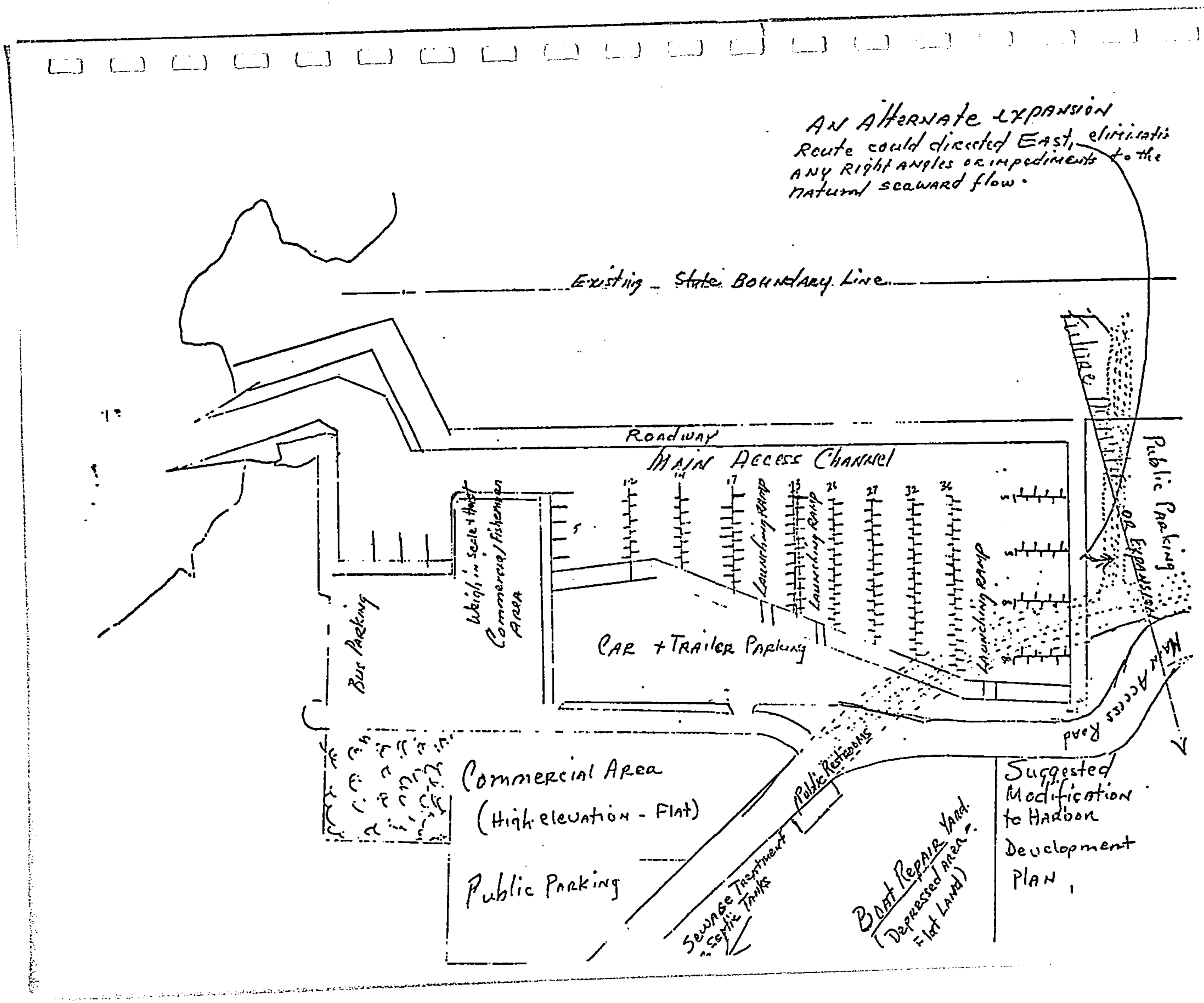
One final point. I know of colonies of mollusks existing in pools located in the vicinity of the southwest corner of the proposed harbor perimeter, known by the Hawaiians as "Hihiwai" which I believe to be indigenous. At one time this was an important food source to the Hawaiians as evidenced in Archeological diggings in Kaloko. It is still a delicacy on Molokai. Nowhere else in the area of Honokohau have I found them. Caution must be exercised not to disturb this valuable food item which is subject to extinction.

It is my hope and that of my associates that a reasonable solution to the problems at hand can be reached in order that the Harbor expansion can proceed. In closing, we again urge you to avoid any northward encroachment into the Honokohau National Historic Landmark.

Sincerely yours,

David K. Roy, Jr.
Vice President, Congress of the Hawaiian People
Past Vice Chairman, and Executive Officer, Honokohau Study Advisory Commission

cc: Office of Environmental Quality
Governor George Ariyoshi
Rep. Patsy T. Mink
Robert Barrel, Hawaii State Director
National Park Service


An Alternate expansion Route could directed East, eliminatis any right angles or impediments to the natural seaward flow.
Existing State Boundary Line
Future
Public Parking or Expansion
Roadway
Main Access Channel
Launching Ramp
Launching Ramp
Launching Ramp
Weigh in Scale + Hoist
Commercial/Fishermen Area
Bus Parking
Car + Trailer Parking
Main Access Road
Public Restrooms
Commercial Area
(High elevation - Flat)
Public Parking
Sewage Treatment or Septic Tanks
Boat Repair Yard
(Depressed Area. Flat Land)
Suggested Modification to Harbor Development Plan

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO:

October 29, 1975

HAR-ED 1472

Mr. Bruce Blanchard, Director
Environmental Project Review
U. S. Department of the Interior
Office of the Secretary
Washington, D.C. 20240

Dear Mr. Blanchard:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

This is to acknowledge receipt of your letter ER-75/969 of October 6, 1975, on subject EIS.

Since the items discussed in your letter fall under the purview of the State Office of Environmental Quality Control, we are forwarding a copy of your correspondence to them for their consideration and action.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

2637

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C.

DEPT. OF TRANS.
STATEWIDE TRANS.
PLANNING OFFICE
OCT 10 9 20 AM '75

OCT 6 1975

DEPT. OF TRANSPORTATION
OCT 9 12 49 PM '75
DIRECTOR'S OFFICE

In reply refer to:
(ER-75/969)

Dear Mr. Wright:

This is in response to your request of August 21, 1975, for the Department of the Interior's review and comments on the environmental impact statement for development of Honokohau Boat Harbor, North Kona, Hawaii. Unfortunately, this statement was not received at this office until September 25, 1975, which was six days after your comment period had closed. Accordingly, the Department of the Interior will not provide review comments on this proposal.

We understand that copies of the statement were furnished to several bureaus of this Department. These bureaus may comment directly to you, but their individual comments do not necessarily represent the comments of the Department of the Interior.

Incidentally, we would note for your information that this Department normally needs 12 copies of a draft environmental statement for intradepartmental review purposes by our several bureaus and offices. Moreover, in order to conduct an adequate review, we would urge that a minimum 45 day review period be allowed. However, when fourth class or other bulk mail is used, we would suggest that consideration be given to adding additional time to the review period.

Sincerely yours,

Bruce Blanchard, Director
Environmental Project Review

Mr. E. Alvey Wright
Director, State Department of
Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

E. ALVEY WRIGHT
DIRECTOR

DEPUTY DIRECTORS
WALLACE AOKI
RYOKICHI HIGASHIONNA
DOUGLAS S. SAKAMOTO
CHARLES O. SWANSON

IN REPLY REFER TO

HAR-ED 1474

October 29, 1975

Mr. Robert L. Barrel
State Director
U. S. Department of the Interior
National Park Service, Hawaii Group
677 Ala Moana Boulevard, Suite 512
Honolulu, Hawaii 96813

Dear Mr. Barrel:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, Job H. C. 6047

Your comments on the EIS contained in your letter of September 18, 1975, are appreciated.

Relative to the next step of coordinated planning which you suggest, a sketch, Figure 18A, is being added to the Revised EIS. This sketch of an alternate harbor configuration incorporates several elements of previous mitigating measures as well as suggestions received during the review period of this EIS.

Without delaying processing of this EIS or other required administrative action, the State Department of Transportation intends to work as soon as feasible with the National Park Service, State Historic Preservation Officer, Corps of Engineers and National Advisory Council on Historic Preservation to reach agreement on the details of mitigating measures.

Very truly yours,

E. Alvey Wright

E. ALVEY WRIGHT
Director

cc: OEQC
Oceanic Institute

United States Department of the Interior
NATIONAL PARK SERVICE
HAWAII GROUP
677 ALA MOANA BLVD., SUITE 512
HONOLULU, HAWAII 96813

IN REPLY REFER TO:
L7621

September 18, 1975

Mr. E. Alvey Wright, Director
State Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Wright:

Subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Job H. C. 6047

Thank you for an opportunity to comment on this draft environmental impact statement. It addresses the historic preservation deficiencies of the earlier (1972) draft, and is very helpful in providing a basis on which to evaluate the relationship between an expanded harbor and the Honokohau Settlement National Historic Landmark. In addition it provides a framework for evaluating the relationship between the harbor and a Kaloko-Honokohau National Cultural Park should such be authorized by Congress. Our comments are on those aspects of the draft.

Reference is made in several places to the review procedures required by the National Historic Preservation Act of 1966 in the determination of effect upon a property on the National Register of Historic Places, and a similar review in order to comply with Public Law 92-346. When those procedures are implemented, there will be further opportunity for the Advisory Council on Historic Preservation to comment on adverse effects, if any, and on measures designed to mitigate such adversity.

The position of the National Park Service has been made clear in a voluminous exchange of correspondence between the Service, the Department of the Interior, and the State of Hawaii on this subject. Briefly, we believe that with judicious attention to design and operation, both broad-scale and in detail, an expanded Honokohau Boat Harbor could exist next to the Historic Landmark, and to a park should Congress authorize it, without significant adverse effects. It is clear that this draft recognizes our position and begins the process of coordinated planning. We believe, however, that the final environmental impact statement should go into a more detailed analysis of several matters.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

The graphics in the draft are not adequate to support some of the discussion given in the Alternatives section. A proposed harbor boundary is shown on Figure 4, but other harbor configurations without boundaries are roughly detailed on Figures 18, 19, and 20. It is implied that Alternative B as shown in various forms on Figures 4 and 18 is the one preferred by your Department. Within that preference, however, there are several options as discussed on pages VIII-1 through VIII-5. We suggest that further amplification of that discussion with supporting graphics might well provide a basis for a Memorandum of Agreement between the Council on Historic Preservation and the State of Hawaii.

In this light, we would prefer to see a plan using a harbor orientation 15 degrees south of east. The brief description of such an option on page VIII-4 indicates that such an orientation would follow the lowest land, thus minimizing excavation. Presumably, then, this would be the least expensive excavation, and it is partly on the basis of excavation costs that the draft rejects the southerly alternatives described in Section VIII-C. We believe that planning based on such a 15-degree swing to the south might enable the launch facility and boat repair yard to remain on the north side of the harbor with minimum effect on historic and cultural values. (We agree that if boat repair can be kept on low ground, screening can minimize its visual effects.) The discussion in Section VIII identifies that side of the harbor as best for those functions from the standpoint of deep water, flushing, and minimal interference with other boat traffic. In such a design we believe that the harbor boundary should be carefully plotted to provide the least possible interference with the historic values to the north. For instance, it might be possible to bring the boundary closer to the entrance channel on the north side than as currently shown on Figure 4. In addition, it would be important to leave room between the perimeter road on the north boundary and the boundary itself to allow vegetative screening between the harbor and the historic values.

The salt pans identified in the archeological survey by Dr. Sinoto may not be of overwhelming historic significance, but should a cultural park be authorized, they would be an integral part of the interpretive story. It appears that they are located outside the proposed harbor boundary, but we believe that this should be clarified.

We agree that a joint maintenance facility might be possible and desirable should a park be authorized.

The discussion of Alternative B refers to detailed planning to be done in the design stage to ensure mitigation of adverse effects on historic values. We agree that this is extremely important, but believe that the final environmental statement could well nail down some of the design matters that are of vital concern to historic and cultural preservation. We appreciate the expressed willingness to design supporting facilities to blend with the environment and to create the least possible visual adversity.

I hope that these comments will be constructively helpful to you in preparing the final environmental statement.

Sincerely yours,

Robert L. Barrel
State Director

GEORGE R. ARIYOSHI
GOVERNOR

JOHN FARIAS, JR.
CHAIRMAN, BOARD OF AGRICULTURE

YUKIO KITAGAWA
DEPUTY TO THE CHAIRMAN

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
1428 SO. KING STREET
HONOLULU, HAWAII 96814

August 25, 1975

MEMORANDUM

To: Dr. Richard Marland, Director
Office of Environmental Quality Control

Subject: Honokohau Harbor

The Department of Agriculture appreciates the opportunity to review this Environmental Impact Statement.

Since there are no significant impacts on agriculture, the draft statement is herewith returned to your office.

Yukio Kitagawa
for John Farias, Jr.
Chairman, Board of Agriculture

JF:d:h
Enclosure

No response necessary.

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY SUPPORT COMMAND, HAWAII
APO SAN FRANCISCO 96558

AFZV-MD-HE

4 SEP 1975

Richard E. Marland, PhD
Director
Office of Environmental Quality Control
State of Hawaii
Room 301, 550 Halekauwila Street
Honolulu, Hawaii 96813

Dear Dr. Marland:

Thank you for the opportunity to review the Environmental Impact Statement on Honokohau Harbor.

We have no comments to offer at this time.

Sincerely,

LEE C. HERWIG, JR.
Colonel, MSC
Environmental Consultant to Commander,
U.S. Army Support Command, Hawaii

No response necessary.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY SUPPORT COMMAND, HAWAII
APO SAN FRANCISCO 96558

SEP 8 10 23 AM '75

HARBORS DIV.
DEPT OF TRANSPORTATION

AFZV-FE-RO

Department of Transportation
Harbors Division
State of Hawaii
79 S. Nimitz Hwy
Honolulu, Hawaii 96813

Gentlemen:

Reference is made to the subject: Environmental Impact Statement for Development of Honokohau Boat Harbor, Hawaii, 14 July 1975.

We have reviewed the above Environmental Impact Statement and have no comments to offer.

Thank you for the opportunity to review this document.

Sincerely yours,

CHARLES S. VARNUM
Colonel, CE
Director of Facilities Engineering

No response necessary.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

SEP 15 9 52 AM '75

HARBORS DIV.
DEPT OF TRANSPORTATION

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Division of Ecological Services
821 Mililani Street
Honolulu, Hawaii 96813

Reference: ES

September 12, 1975

Department of Transportation
Harbors Division
79 So. Nimitz Highway
Honolulu, Hawaii 96813

Gentlemen:

This provides comments on your environmental impact statement for Development of Honokohau Boat Harbor, Hawaii.

We have reviewed the statement and find it adequately covers matters within our areas of jurisdiction and fields of expertise. Our comments relate only to the adequacy of the statement as a full disclosure document and do not connote approval of the project or actions described in the document.

We understand a final statement will be prepared in the future. We would appreciate a copy of the statement for final review.

Sincerely yours,

Maurice H. Taylor

Maurice H. Taylor
Area Supervisor

cc: OEQ, Hawaii
RD, ES, Portland
OEC, Wash., D.C.
NMFS, Honolulu (J. Naughton)
HDF&G

No response necessary.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

HERBERT T. MATAYOSHI
MAYOR

EDWARD K. HARADA
CHIEF ENGINEER

BUREAUS AND DIVISIONS:
AUTOMOTIVE EQUIPMENT & MOTOR POOL
BUILDING CONSTRUCTION & INSPECTION
PLANS AND SURVEYS
ROAD CONSTRUCTION AND MAINTENANCE
SEWERS AND SANITATION
TRAFFIC SAFETY AND CONTROL

COUNTY OF HAWAII
DEPARTMENT OF PUBLIC WORKS
25 AUPUNI ST.
HILO, HAWAII 96720

September 12, 1975

Environmental Quality Commission
550 Halekauwila Street, Room 301
Honolulu, HI 96813

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT
HONOKOHAU HARBOR

The subject statement was reviewed and we have no comments to offer.

fr EDWARD HARADA
Chief Engineer

cc: Mayor
Planning Department

No response necessary.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
440 Alexander Young Building, Honolulu, HI 96813

September 15, 1975

Dr. Richard E. Marland
Office of Environmental Quality Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Dr. Marland:

Subject: Environmental Impact Statement for Honokohau Harbor

We have reviewed the subject document and have no comments on the proposed EIS. The statement adequately covers the environmental impacts and mitigation measures to be implemented.

Thank you for the opportunity to review this document.

Sincerely,

Francis C. H. Lum
State Conservationist

No response necessary.

KEAUHOU-KONA
RESORT / RESIDENTIAL COMMUNITY

KAMEHAMEHA DEVELOPMENT CORPORATION

700 BISHOP STREET, SUITE 601, HONOLULU, HAWAII 96813 / PHONE: 521-1408 / CABLE: KAMDEVCO

September 18, 1975

Office of Environmental Quality
Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Subject: Honokohau Harbor Improvements, North Kona, Hawaii

Gentlemen:

We note that the impact statement for improvements to the Honokohau small boat harbor is presently under consideration. Our company has been involved in the development of a destination resort surrounding Keauhou Bay, and has therefore had many contacts with fishermen and recreational boating enthusiasts in the Kona district.

Prior to construction of the existing improvements at Honokohau, Keauhou Bay offered the only sheltered mooring for boats during most periods of stormy weather. As the population of the Kona district grows, it is evident that additional safe moorings are needed to accommodate the fishing and boating activities of the area.

Although a relatively small portion of the population may be actively involved in the ownership of such boats, the value of a sportfishing industry, including events such as the International Billfish Tournament, are of undeniable importance to the economy and well-being of this part of our state of Hawaii. Further, from the standpoint of public safety, it is necessary that adequate facilities be available in West Hawaii for mooring, launching and retrieving smaller boats, and periodic maintenance and repair. The facilities for these activities at Keauhou-Kona are severely limited by the configuration of the harbor and the need for other uses of the surrounding land. Therefore we endorse the expansion and improvement of Honokohau boat harbor as the only logical alternative to Keauhou Bay.

Further, the initial improvements to Honokohau involved sizable investment of public capital. We feel that such a commitment should be continued in order that this investment not be wasted.

We believe that the present environmental impact statement for the completion of the harbor at Honokohau adequately presents alternatives and a program for action. We therefore hope that the statement can be accepted expeditiously, and that improvements can be undertaken soon.

Very truly yours,

Guido Giacometti
President

GG/ew

No response necessary.

GEORGE R. ARIYOSHI
Governor

HIDETO KONO
Director

FRANK SKRIVANEK
Deputy Director

DEPARTMENT OF PLANNING
AND ECONOMIC DEVELOPMENT

Kamamalu Building, 250 South King St., Honolulu, Hawaii • Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

September 23, 1975

Ref. No. 5363

MEMORANDUM

TO: Dr. Richard E. Marland, Director
Office of Environmental Quality Control

FROM: Hideto Kono, Director

SUBJECT: Draft Environmental Impact Statement for the Development of the Honokohau Harbor

Our staff has reviewed the subject draft and finds it to be reasonably adequate in its consideration of environmental impacts due to the proposed project.

We are also satisfied that our comments on the preliminary draft of the impact statement have been sufficiently responded to in this subject draft.

We do not have any further comments to offer at this time but appreciate this opportunity to review the draft statement.

No response necessary.

cc: Department of Transportation
Harbors Division

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 15th AIR BASE WING (PACAF)
APO SAN FRANCISCO 96553

24 SEP 1975

DEEE (Mr. Nakashima, 4492158)

Environmental Impact Statement for Development of Honokohau Boat Harbor Project on Island of Hawaii

Office of Environmental Quality Control
550 Helekauwila St., Room 301
Honolulu, Hawaii 96813

1. This Headquarters has no comment to render relative to the Environmental Impact Statement for Development of Honokohau Boat Harbor Project on the Island of Hawaii.

2. We greatly appreciate your cooperative efforts in keeping the Air Force apprised of your development projects.

BEN D KOSA
Asst Dep Comdr for Civil Engrg

No response necessary.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

September 11, 1975

Environmental Quality Commission
550 Halekawila Street Room 301
Honolulu, Hawaii 96813

Re: Honokohau Environmental Impact Statement September 1975

Gentlemen:

We have reviewed the Environmental Impact Statement as prepared for the Department of Transportation, State of Hawaii, in compliance with the Federal and State regulations in order to consider each impact of the proposed expansion of the existing Honokohau Small Boat Harbor.

We have reviewed the Environmental Impact Statement and note that:

> There is no physical detraction to the proposed historical park on the north side of the harbor.
>
> There are no significant historical sites being disturbed under the expansion.
>
> The expansion of the harbor is vital to the future economy of Kailua-Kona and particularly to the boating population including the Kona Mauka Trollers and others.
>
> The expansion of the harbor will help tourism and industry which is the major economy of Kailua-Kona.
>
> The alternative sites to the south would be too costly and that they do not provide for proper circulation of the water as proposed in the original plan.

We therefore feel that the harbor should be expanded at the earliest opportunity.

We therefore request that the Department of Transportation, State of Hawaii, proceed immediately with the finalization of the Modified Development Plan which is attached.

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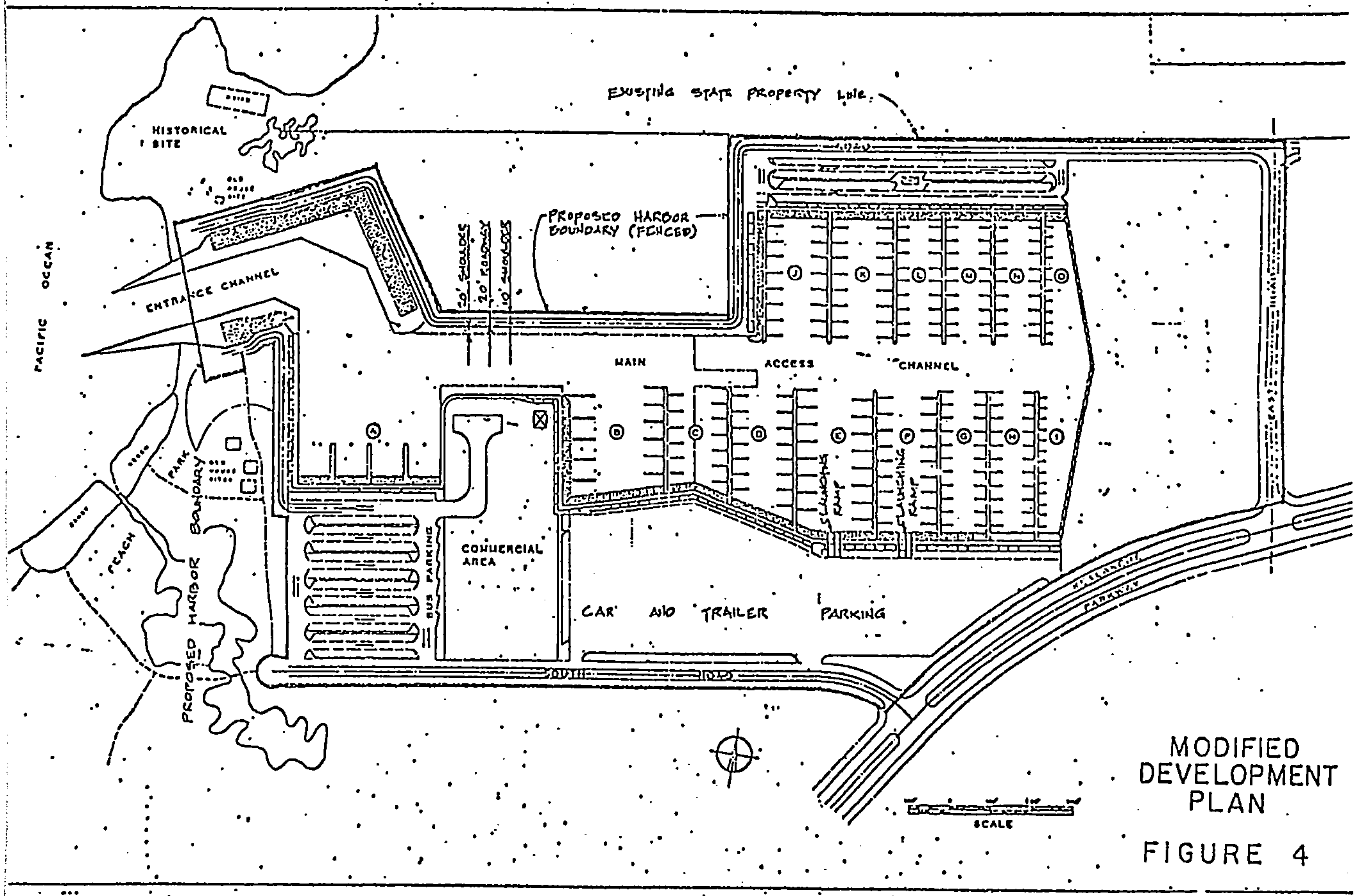
1. Richard Yano	Box 1001 Kona.
2. James M. Tanaka	P.O. Box 785 Kona
3. Wilbert M. Shinada	P.O. Box 1343 Kona.
4. Jeffrey Romeo Yager	P.O. Box 763 CAPt Cook
5. Eddie Medeiros	Box 242 Holualoa



MODIFIED DEVELOPMENT PLAN

FIGURE 4

NAMES	ADDRESSES
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7. Herman Fergustrom	P.O. Box 333 Kailua
8. Cafley Hao	P.O. Box 46 Holualoa
9. [illegible]	P.O. Box 232 Kealakekua
10. Charles T. Yoshida	P.O. Box 374 Holualoa
11. Douglas Cataraha	P.O. Box 2454 Kailua
13. Wm. A. Lawrence Jr.	P.O. Box 279 Holualoa
14. L Isemoto	P.O. Box 1161, Hilo
15. Russell Kaganey	P.O. Box 224 Holualoa
16. Tsuneo Matsumoto	P.O. Box 357 Holualoa
17. Leslie Fujiwara	P.O. Box 711 Kealakekua
18. [illegible]	P.O. Box 1542
19. Jerry Y Egami	P.O. Box 1165 Kealakekua
20. Blue Maikai	P.O. Box 411 Honaunau
21. Harriet P. Brown	R.R.1 Box 593 Kailua
22. Nancy Sullivan	P.O. Box 3002 Kailua
23. [illegible]	Box 1540 Kailua

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26. Ross S. Yamashita	Box 126 Holualoa
27. Michael J. Gay	Star Route Box 4 Capt Cook
28. Wayne Morimoto	Box 1080 Kealakekua
29. Wm. Burkhauser	Box 2486 Kailua Kona
30. Charles Yamashita	Capt Cook, HI
31. Clarence Iwamura	Box 804 Kealakekua
32. Dennis N. Nakano	Box 1100 Kealakekua
33. Wally Ikeda	Box 12 Kealakekua
34. Kenneth Iwako	Box 324 Capt. Cook
35. Harold Hayashida	" 35 Kealakekua
36. Sachiko Kurihara	Box 254 Honaunau
37. Harold K. [illegible]	Box 1301 Kealakekua
38. Anna Caudell	Box 331 Honaunau
39. [illegible signature]	Box 66 CC HI 96704
40. Llewellyn Mills	Box 427 Kailua Kona

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41.	Raymond Salley	Kailua, Kona, Hawaii 96740
42.	Katherine Shimizu	Honaunau, Kona
43.	[illegible]	Amainaa Kona
44.	Robert Kanzaki	KEEI Kona
45.	Frank Yamamoto	Capt. Cook, Kona
46.	Helen W. Weeks	Keauhou, Kona, Hawaii
47.	John W. Weeks	Keauhou, Kona, Hawaii
48.	Cynthia H. Salley	Kailua Kona, Hi 96740
49.	Vashti Thomas	Kailua - Kona
50.	Manuel Belanio Jr.	Kailua, Kona, Hi 96740
51.	Richard Uchijima	Kealakekua, HI 96750
52.	Toshio Uchijima	Kealakekua Hi. 96750
53.	Bessie Matsuyama	Capt. Cook. H. 96704
54.	Andy Matsuyama	Capt. Cook. Hi 96704
55.	Michael A. Silva	Holualoa, Kona 96725
56.	Richard [illegible]	Kealakekua, Hi 96750
57.	Henry Spina	Box 261 Kailua

(over.)

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59. [illegible]	P.O. Box 266 Kailua. Kona
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61. Lui Knight	Box 1544 Kailua Kona.
62. Carl K. [illegible]	Box 795, Kailua-Kona H,
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77. Minoru Inouye	Bx 65 Capt Cook
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79. Carl S. [illegible]	P.O. Box 7101 Kailua, Kona
80. Warren [illegible]	Box 417 Capt. Cook
81. Richard Sialova	Kailua, Kona
82. [illegible]	Capt. Cook, Honaunau
83. [illegible]	Kealakekua Hawaii
84. Irving Fujino	Box 146 Capt. Cook, Hi.
85. Gerald H. [illegible]	Capt. Cook, Kona, Hawaii
86. Glenn M. [illegible]	Kailua, Hawaii
87. Walter Lee	Capt Cook Hawaii
88. Onaul Yoneyama	Kailua, Kona, Hi
89. [illegible]	Capt. Cook Kona
90. [illegible]	Kealakekua, Hawaii

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95. Peter Tidaldi	Box 1034
96. M McCarty	Box 2055 KK
97. Kathy Souza	Box 2158 KK
98. Alan K. Harris	Box 963 Kealakekua
99. Patricia Boudreau	P.O. Box 977 Kealakekua HI
100. Robert H Boudreau	PO Box 977 Kealakekua
101. Jon Lowenbein	Box 1866 KAILUA KONA
102. Jim Nottage	PO Box 1233 Kailua-Kona
103. Pete Centolini	P.O. Box 212 HOLUALOA
104. Eva Groat	Box 2608 Kailua Kona
105. Jane Neal	P.O. Box 2392 - Kailua, Kona
106. Cecilia Jake	P.O. Box 212 Holualoa 96725
107. Emmy Bechtold	Box 794 Kailua Kona HI 96740

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108. Marion Cecil	P.O. Box 756 Kailua-Kona-Hi
109. Mary Jane Villaluede	Po Box 1743 Kailua Kona Hi
110. Judi [illegible]	P.O Box 1684 Kailua, Kona
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112. Gordon Phillips	PO 688 Kailua Kona
113. Gordon Larson	RR1 Box 8101 Holualoa
114. Robert White	P.O. Box 1684 Kailua, Kona
115. Jim Jasper	P.O 2631 Kailua Kona
116. Carmen DuBray	P.O. 163 Holualoa, Kona
117. Kenneth C. McWheeler	P.O Box C Kailua Kona
118. Marla M. Robbins	P.O. Box 2536 Kailua Kona
119. Martha K. Holobahi	P.O Box 84 Kailua Kona
120. John Brossa	Box 1703 Kailua-Kona Hi.
121. Barry Williamson	Box 402 Kealakekua
122. [illegible] Lapp	Box 1024 Capt. Cook
123. Michael E Anderson	Box 758 Kailua Kona
124. Mary Lou Moulena	Box 203 Kailua-Kona
125. Mary J. Condella	Box 502 Kona, Hi 96750
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129. Dorothy Kaai	R.R.I Box 384 Holualoa Hi
130. Rachel Kema	R.R.I Box 384 Holualoa Hi
131. JANIS VASQUEZ	P.O. BOX 1933 Kailua-Kona
132. Frances Yoes	Star Rt Box 6019 Capt Cook
133. Barbara Beik	P.O Box 1464 Kealakekua, Hi
134. R. A. Beik	P.O. Box 1464, Kealakekua, Hi.
135. Joan L. O'Brien	P.O. Box 1502, Kailua Kona
136. Robert Corsair	POB 1599 " "
137. Pat Kihara	Kealakekua, Hi
138. [illegible]	Kailua Kona -
139. Randal Rhoades	Box 1683 Kailua Kona
140. B Cramer	P.O. Box 1626 KK 96740
141. Susan Conner	PO Box 1016 KK 96740
142. Roy Darby	PO Box. 1567 KK 96740
143. Albert Medeiros	Hookena
144. F.A Cisneros	KAMUELA Hi

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146.	[illegible]	P.O. Box 2850 KAILUA-KONA
147.	Thomas W Rogers	Box 375 Kailua-Kona
148.	Robert [illegible]	P.O. Box 8.21 Kailua Kona
149.	Lance Williams	RR1-Box 46 Kailua-Kona
150.	Capt Bernie [illegible]	P.O. Box 1244 Kailua Kona
151.	[illegible] Matsumura	P.O. Box 267 Kealakekua, Hawaii
152.	Masashi [illegible]	Capt Cook, Kona
153.	[illegible] K. [illegible]	P.O. Box 38 CAPT. COOK, Hi.
154.	Russell Jackson	P.O. Box 588 Capt. Cook, Hi.
155.	[illegible]	RR1 Box 243 Holualoa, Hi 96725
156.	Edward Medeiros	RR1 Box 242 Holualoa, Hi 96725
157.	Richard [illegible]	PO Box 234 Kealakekua
158.	[illegible]	Box 1121 Kealakekua
159.	Paul [illegible]	Box 725 Kealakekua
160.	Wm Bowlin	Box 452 Kailua-Kona

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163. Carol Johnson	P.O. Box 1594 Kailua Kona 9674[illegible]
164. Marilyn Ferreira	P.O. Box 2405 Kailua Kona 967[illegible]
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166. [illegible] Yeoman	P.O. Box 1330 Kailua-Kona
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169. [illegible]	P.O. 1748 Kailua-Kona
170. [illegible]	PO Box 1867 Kailua
171. H. Mossman	Po Box 171 Kailua Ko[illegible]
172. [illegible]	P.O. Box 226 Kealakekua Hi. 967[illegible]
173. [illegible] McClain	Box 3000 Kailua Kona, Hi.
174. John M. LaPlante	P.O. 2115, Kailua-Kona

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176.	K. Nelson	" " 443 Kealakekua, Kona
177.	Samuel A. Kawamoto	" " 1042 Kealakekua Kona
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179.	Fred N. Gonzales	P.O. Box 513 Kailua Kona
180.	Roy K. Iwata	PO Box 1775 Kailua-Kona
181.	Colette Flores	Po Box 1511, Kailua Kona, HI
182.	Ed. K. Ku	P.O. Box 1028 Kealakekua, HI
183.	Donald Taniyama	P.O. BOX 1885 Kailua, Kona
184.	Robert M. Oda	RR1 Box 252 Holualoa Kona
185.	Richard K. [illegible]	P O Box 142 Kailua
186.	Ernest N. Wong	P.O. Box 685 Kailua Kona
187.	Pearl Rein	Kailua-Kona, Hi
188.	Kent Nakashima	Kailua-Kona, Hi
189.	Louis K. Kahanamoku Jr.	" " "
190.	Colleen [illegible]	" " "
191.	Josephine K. Chandler	Kealakekua-Kona
192.	Kathryn Faye Glenn	Kailua Kona Hi.
193.	William Wong	P.O. Box 1392, Kailua-Kona
194.	Hiroshi [illegible]	" " 535, Kealakekua, Haw.
195.	Logan P. Williams	" " 4130, Kailua-Kona 96740
196.	[illegible]	# 3 Malia Rd. Kailua-Kona 96740

	NAMES	ADDRESSES
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198.	[illegible]	Rt#1 Box 50 " " "
199.	Capt. John Jordan	PO Box 2728 Kailua-Kona
200.	[illegible]	P.O. 1328 Kailua Kona
201.	[illegible]	P.O. 1326 Kailua-Kona
202.	[illegible]	P.O. Box 1995 Kailua-Kona
203.	Sidney J. Weninii	P.O. Box 127, Kailua, Kona, Hawaii
204.	A. L. Bell	P.O. Box J Kealakekua
205.	[illegible]	Capt. Cook
206.	[illegible]	P.O. Bx 1507, KAILUA-KONA
207.	[illegible]	P.O. 1148 Kailua-Kona
208.	[illegible]	P.O. Box 616 Kealakekua
209.	Arthur B. Penrose	Kealakekua Hi. 96750
210.	Eugene B. Penrose	Kealakekua Hi. 96750
211.	Margaret Spinney	PO Box 183 Holualoa, Hawaii 96725
212.	Stanley [illegible]	Honaunau, Hawaii 96726
213.	HAIRRAU MATHEWS	KAILUA-KONA 96740
214.	Richard Bonnvell	P.O. Box 1151 Kailua Kona 96740
215.	[illegible]	P.O.B. 1078 Kailua 96740
216.	[illegible] Kuyanagi	P.O. Box 151 Holualoa 96725
217.	William W. [illegible]	RR#1 Box 598 Kailua Kona 96740

NAMES	ADDRESSES
218. David M. Pauley	Box 545 Kealakekua H.
219. Harry Wyatt	Kealakekua Hi
220. [illegible]	" "
221. [illegible]	" "
222. Carl A. Carlson	Holualoa Hi
223. Neal M. Walker	Keauhou Bay, Hi
224. Roger Barbieto	Box 1671 Kailua, Kona
225. Elisara Paogofie	Box-K " "
226. Jerry F. Kenney	Box K " "
227. Bernadine Kenney	P.O. Box K Kailua - Kona 96740

No response necessary.

APPENDIX "A"

REPORT ON THE ARCHAEOLOGICAL RECONNAISSANCE SURVEY OF THE HONOKOHAU SMALL-BOAT HARBOR EXPANSION AREA KEALAKEHE, KONA, HAWAII ISLAND

by
Aki Sinoto
Department of Anthropology
Bernice P. Bishop Museum

The Department of Anthropology of Bernice P. Bishop Museum conducted a one-day archaeological reconnaissance survey of the Honokohau Small-Boat Harbor Expansion Area at Kealakehe, Kona, Hawaii Island, at the request of Spencer, Koebig and Koebig. Fieldwork was completed on March 26, 1975, by Aki Sinoto and Timothy Lui-Kwan. The purpose of this survey was to determine the presence or absence of any sites of possible archaeological or historical significance, as well as relocating, verifying, and determining the condition of all previously recorded sites within the project area.

The project area is a relatively flat, open stretch of land occupying approximately 100 acres adjoining the eastern portion of the present harbor facilities (Fig. 1). The area consists primarily of open pahoehoe with sparse, low, ground-cover vegetation with occasional trees and shrubs of *koa haole* [*Leucaena glauca* (L.) Benth], *noni* (*Morinda citrifolia*), klu [*Acacia farnesiana* (L.) Willdenow], and *kiawe* (*Prosopis* sp.).

The entire project area and some additional areas surrounding the project boundaries were traversed on foot. No new (previously unrecorded) archaeological or historical sites of any kind were found within the project area. There are, however, three previously recorded sites within the proposed expansion area. Two of the sites were recorded and described in 1961 by Emory and Soehren: *

> "D11-27 At this old house site, the farthest inland of any found during this survey, only the rubble fill of the stone walls remains. The outline of

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*Emory, Kenneth P. and Lloyd J. Soehren. *Archaeological and Historical Survey, Honokohau Area, North Kona, Hawaii*. Report 61-1. Department of Anthropology, Bernice P. Bishop Museum. Site numbers given are prefaced by 50-Ha- (50 = State of Hawaii; Ha = Island of Hawaii).

a house platform and enclosure can be traced, but the exact dimensions are indeterminate. Probably the large stones were incorporated into the long fence a hundred yards to the west." (p. 15)

"D12-3 The large concrete salt pans inland from Aiopio were certainly designed for mass production. The structure is built of lava, much of which was obtained from adjoining house sites and sealed with concrete. The upper basin is about 35 feet by 100 feet and it was into this that salt water was first pumped. The second basin, about 1 foot lower and 35 feet by 50 feet, empties into five small pans at the north end for the final stages of evaporation. The date of construction has not yet been ascertained, but it probably antedates 1900." (p. 18)

The third site was recorded by archaeologists from the State archaeology lab. A letter dated March 22, 1972, from Sunao Kido of the Board of Land and Natural Resources, to Dr. Fujio Matsuda of the Department of Transportation, refers to Dr. Newman's survey of the Honokohau Harbor area: "Only one small cluster of *papamu* (the Hawaiian *konane* checkerboard) was found in the northeast part...". This site has been assigned the State number ________________.

EVALUATIONS AND RECOMMENDATIONS

Site D11-27. As indicated by the description above, this site was already in a state of destruction at the time of the 1961 survey. The house site was located during the present survey, but was found to be further destroyed by bulldozing, probably as the result of clearing for the present parking area for the trailer ramp. Since this site is in poor condition, and midden is sparse, no further archaeological work is warranted.

Site D12-3. This historic site lies on the boundary of Kealakehe and Honokohau 2 *ahupua'a* and will be physically affected by the harbor expansion. However, since the design and use of concrete suggest recent origins, this site can be considered to be of marginal value.

Site ____________. *Papamu* occur quite frequently in other areas of Hawaii. Several clusters are reported from this area, among the coastal sites and the petroglyphs [Emory and Soehren 1961]. This site can be classified as marginal; however, due to its small size, salvage and relocation are recommended.

Since our one-day survey produced no new archaeological or historic sites, and because of the paucity and low calibre of previously known sites within the immediate project boundaries, we have concluded that the situation permits the planned expansion of the harbor. All three sites fall within the Historic Landmark boundaries, and therefore the State Department of Land and Natural Resources, the regulatory agency for historic sites, should be consulted before any action is taken.

The project area is near other important sites (see Fig. 1). The value of these sites, from an aesthetic point of view, will be affected by the development of the harbor area. Therefore we recommend that as few buildings as possible be constructed in this area, and particularly recommend against multiple-story buildings--a low profile is necessary to blend in with the atmosphere of vastness, openness, and isolation. Local materials (e.g., lava rocks) should be used for the necessary walls and barriers, and landscaping or planting of introduced tropical exotics should be avoided as much as possible.

If additional expansion or development is planned outside of the boundaries indicated for this report, especially near the coastal areas, a reassessment of the sites that may be affected is necessary. At the time of formulation of a preliminary plan for future expansion or development, the Department of Land and Natural Resources and/or Bishop Museum should be consulted.

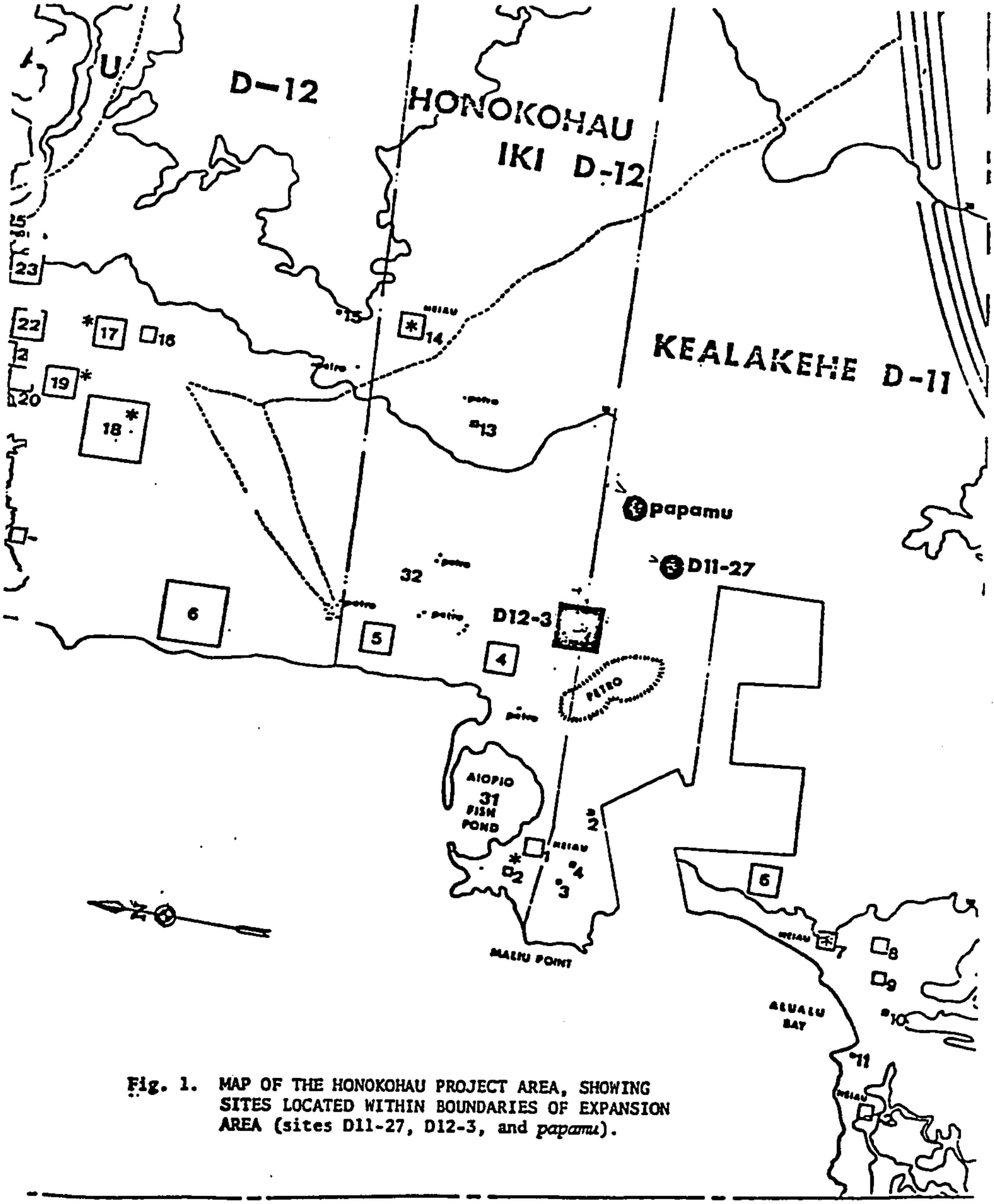

Fig. 1. MAP OF THE HONOKOHAU PROJECT AREA, SHOWING SITES LOCATED WITHIN BOUNDARIES OF EXPANSION AREA (sites D11-27, D12-3, and *papamu*).

APPENDIX "B"

APPENDIX B

THE OCEANOGRAPHY OF HONOKOHAU HARBOR, HAWAII

A Data Report Describing the Physical, Chemical and Biological Results of the 1975 Reconnaissance.

Conducted for Harbors Division, State of Hawaii, in Connection with the "Environmental Impact Statement for the Developmentment of Honokohau Boat Harbor, Hawaii, Job H. C. 6047".

Oceanic Institute
Makapuu Point
Waimanalo, Hawaii 96795

Paul Bienfang

May 20, 1975

The sample collections, analyses, data reduction, graphics and report preparation were made possible by the assistance of members of the Oceanic Institute technical staff:

Wendy Brandt
Rosine M. Koningsberger
Craig Pelton
Alan Tiedeman

Physical oceanographic analyses, e.g. tides, circulation and flushing, was conducted by Dr. Brent Gallagher, University of Hawaii Oceanigraphy Department.

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SAMPLING PROCEDURES, MATERIALS AND METHODS

The most recent field reconnaissance of Honokohau Harbor was conducted between February 23 and March 1, 1975. Typical climatic conditions for the area were prevalent during this time. Skies were generally clear to partly cloudy, becoming more overcast in the late afternoon, air temperatures averaged 75 °F, and winds were negligible. Surf conditions in the area were generally 1 - 2 feet, excepting 2-27-75 when surf rose to ca. 4 feet and declined by the next day. Tides displayed mixed semi-diurnal characteristics, having two low and two high tides of unequal magnitude daily. High tide values were variable throughout the week and ranged to +2.2 feet, and low tide values were comparatively constant at 0.0 ± 0.2 feet. Complete description of the tidal cycles is given in Figure 11, page 23.

Four stations were established within the harbor for routine chemical and phytoplankton sampling. The locations of these stations, shown in Figure 25 (p. 67), were the mauka (Station 1) and makai (Station 3) berthing areas, the interconnecting channel (Station 2), and the entrance channel (Station 4). One station (oceanic-control) was located outside the harbor approximately 150 meters from the entrance channel. The exact location of routine sampling varied at a given station from day to day so that results, to some extent, express the spatial variability at each station; this is most apparent in the results from within the mauka berthing basin. Sampling was conducted using a 5-liter Van Dorn bottle. Samples were collected from 0.5, 1.5 and 3.0 meters depth in each of the two berthing basins and from 1.5 and 3.0 meters in the two channel stations; the subsurface sample at Station 5 was taken from 5 meters. A. M. sampling (2/24 and 2/25/75) took place between 0800-0900 hours during ebbing tide (+0.6 ± 0.2 feet) and P. M. sampling (2/26 and 2/27/75) was conducted between 1200 and 1300 hours while flooding tide conditions (-0.2 to +0.2 feet) prevailed. A complete vertical profile was taken at Station 3 on 2/2/75 at 0630-0700 hours during falling tide conditions (+1.4 - 1.2 feet).

Chemistry samples were prefiltered through Whatman GF/C glass fiber filters and frozen pending analysis at the Oceanic Institute laboratories. Nitrate concentrations were determined by the cadmium-copper reduction method of Wood, Armstrong and Richards (1967). Nitrite was determined by the azo dye formation technique described by Strickland and Parsons (1968). The phenolhypochlorite method, developed by Solorzano (1969), was used to measure the ammonium concentrations. The extinctions for nitrate, nitrite and ammonium were measured on a Unicam SP-800 spectrophotometer and a Bausch and Lomb-700 spectrophotometer was used for phosphate measurements. Nutrient values for any given day represent the mean of duplicate analysis.

Phytoplankton standing stocks, assessed by the measurement of chlorophyll-a densities, were determined on the particulate material collected on the filter during nutrient filtration. Phytoplankton chlorophyll-a and phaeophytin densities were measured according to the method of Holm-Hansen et al., 1965.

Productivity rates of suspended phytoplankton were determined by *in situ* incubation of radiocarbon (C^{14}) labeled samples according to the Steemann Nielsen (1952) technique described in Strickland and Parsons (1968). Both A. M. and P. M. production rates were assessed using 1 μ Ci and 10 μ Ci $NaHC^{14}O_3$ purchased from New England Nuclear Corporation. Sample incubations on 2/24 and 2/26/75 were conducted using 1 μ Ci $NaHC^{14}O_3$ and incubations on 2/25 and 2/27/75 utilized 10 μCi ampoules. The vertical profile of primary production, conducted on 2/28/75, was determined using 1 μ Ci C^{14} and 10 - 11 hour incubation. Samples were filtered through 0.45 μ Millipore filters to collect the phytoplankton, dried in a vacuum desiccator and the radioactivity determined using a Nuclear Chicago Model 1042 Geiger-Muller Counter at the Oceanic Institute Laboratory.

Samples of zooplankton biomass were collected by making horizontal tows with a 0.5 meter net having a mesh size of 212 μ. The net was equipped with a flow meter, calibrated to allow quantification of the volume of water passed through the net. Tows were conducted in the morning while falling tide conditions (+0.8 to +0.2 feet) prevailed. Duration of the tows was ca. 10 minutes, and the net was maintained in the subsurface oceanic layer as much as possible. Duplicate tows were taken within the mauka berthing basin (tows 3a and b), the makai basin (tows 2a and b) and outside the harbor in the region of Station 5 (tows 1a and b). An aliquot of each sample was taken immediately for dry weight estimates (mg dry weight/m^3) and the remainder preserved for determinations of organism density (individuals/m^3) and species composition. The latter was accomplished using a Folsom plankton splitter and microscopic inspection.

Vertical profiles of oxygen concentration (ml O_2/l) were taken at 30 locations within the harbor. Measurements were made at 0.5 meter intervals using a YSI Model 54BP oxygen meter equipped with a pressure-compensated sensing probe, and by Winkler titrations (Strickland and Parsons, 1968).

Vertical profiles of temperature, salinity and turbidity were taken at 0.25 meter intervals at 34 locations within the harbor at both high and low tide conditions. Simultaneous determination of these three parameters was made with an Inter-Ocean Model 503D probe connected to a digital data console (DDC) developed by the engineering group at the Oceanic Institute. Probe signals are recorded by the DDC on magnetic tape, formulated for later teletype printout and automatic computer entry.

The tide was measured continuously in the outer basin for 5-1/2 days. Water level was monitored by a pressure sensor positioned at the south edge of the basin (Figure 1). The sensor was about one meter above the water surface, with pressure being transmitted via a water-filled tube whose lower end was submerged in and open to the basin. Calibration was checked in the laboratory and found to be accurate before and after the field deployment. Readings were recorded by a Rustiak recorder having a 15 second sampling interval. Time marks were generated by an independent crystal oscillator every five minutes.

Transport rates through the entrance and connecting channels were determined by measuring currents, temperature and salinity in a vertical section across each channel throughout a tidal cycle. Temperature and salinity were monitored at 0.25 meter depth intervals from the surface down to three meters, and 0.5 meter intervals thereafter, using an Inter-ocean Model 550 CSTD probe. Currents were measured at 0.5 meter depth intervals from the surface to the bottom with a Hydroproducts Model 460S current meter.

In order to get valid time-averaged flow rates, we used current drogues. Current crosses, two feet wide and one foot deep, were set at a depth of one-half meter to measure surface flow. They were implanted across each channel and tracked repeatedly throughout a tidal cycle. The deep flow was monitored similarly, with current crosses measuring 2 x 2 feet and set at depths of 2-1/2 and 3 meters. Colored lights were put on all drogues so that they could be distinguished and tracked throughout the night. Most measurements were conducted at night in order to minimize interference from boat traffic.

Bacterial assessments, including measurements of total coliforms, fecal coliforms and fecal streptococci, were made according to the methods described in Standard Methods (1965) and Millipore Corporation (1967). Surface and subsurface (3 meters) samples were taken at 12 locations within the harbor. The volumes filtered included 100, 200, 500 ml (total coliform and fecal coliform) and 400 and 600 ml (fecal streptococci). Because bacterial densities derived from these measurements were frequently undeterminable, another assessment was made (May 4-6, 1975) using 10, 30 and 50 ml (total coliforms); 15, 60, 100, 200 ml (fecal coliforms); and 25 and 100 ml (fecal streptococci) volumes.

Sediment loads and character were determined by diver observations and by sample collection. Sediment thickness was measured by driving cores into the substrate and numerous locations within the harbor. Twenty-one sediment samples were collected and analyzed for particle size - frequency distribution by sieving and weighing (Inman, 1952) and for percent organic matter by combustion of desiccated samples at 550 °C.

Statistical analysis of data was conducted using interactive basic programming language and the Kentron Time sharing system facilities at Oceanic Foundation.

PHYSICAL OCEANOGRAPHY

Temperature.

Twenty-nine vertical profiles (0.25 meter intervals) of temperature were taken within Honokohau Harbor at both high and low tide (Figure 1). The results, rounded to the nearest 0.5 °C, are presented as harbor cross sections (Figures 2 to 4), and selected stations are given as vertical profiles (Figure 5) to show the thermal structure variation in response to tidal conditions.

An outstanding feature of these results is the presence of a cold surface layer lying upon a warm oceanic layer. This condition is maintained by the continuous inflow of cool brackish water through the harbor walls and floor. This ground water is less dense than the warmer seawater because of its reduced content of dissolved salts. A vertical temperature gradient is thus established between the cool surface waters and the subsurface oceanic waters. The extent of this gradient varies with tidal flow and location within the harbor.

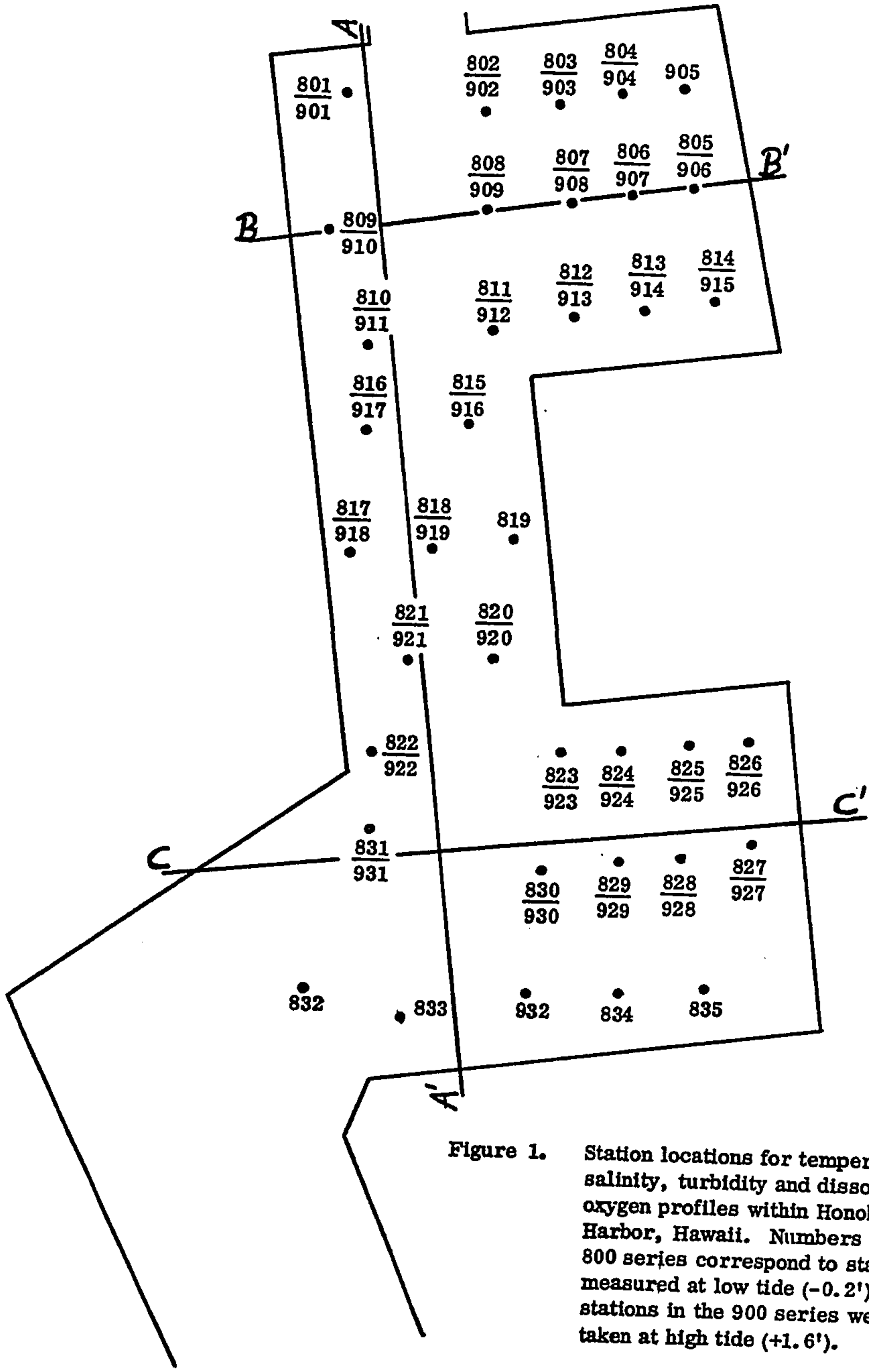


Figure 1. Station locations for temperature, salinity, turbidity and dissolved oxygen profiles within Honokohau Harbor, Hawaii. Numbers in the 800 series correspond to stations measured at low tide (−0.2') and stations in the 900 series were taken at high tide (+1.6').

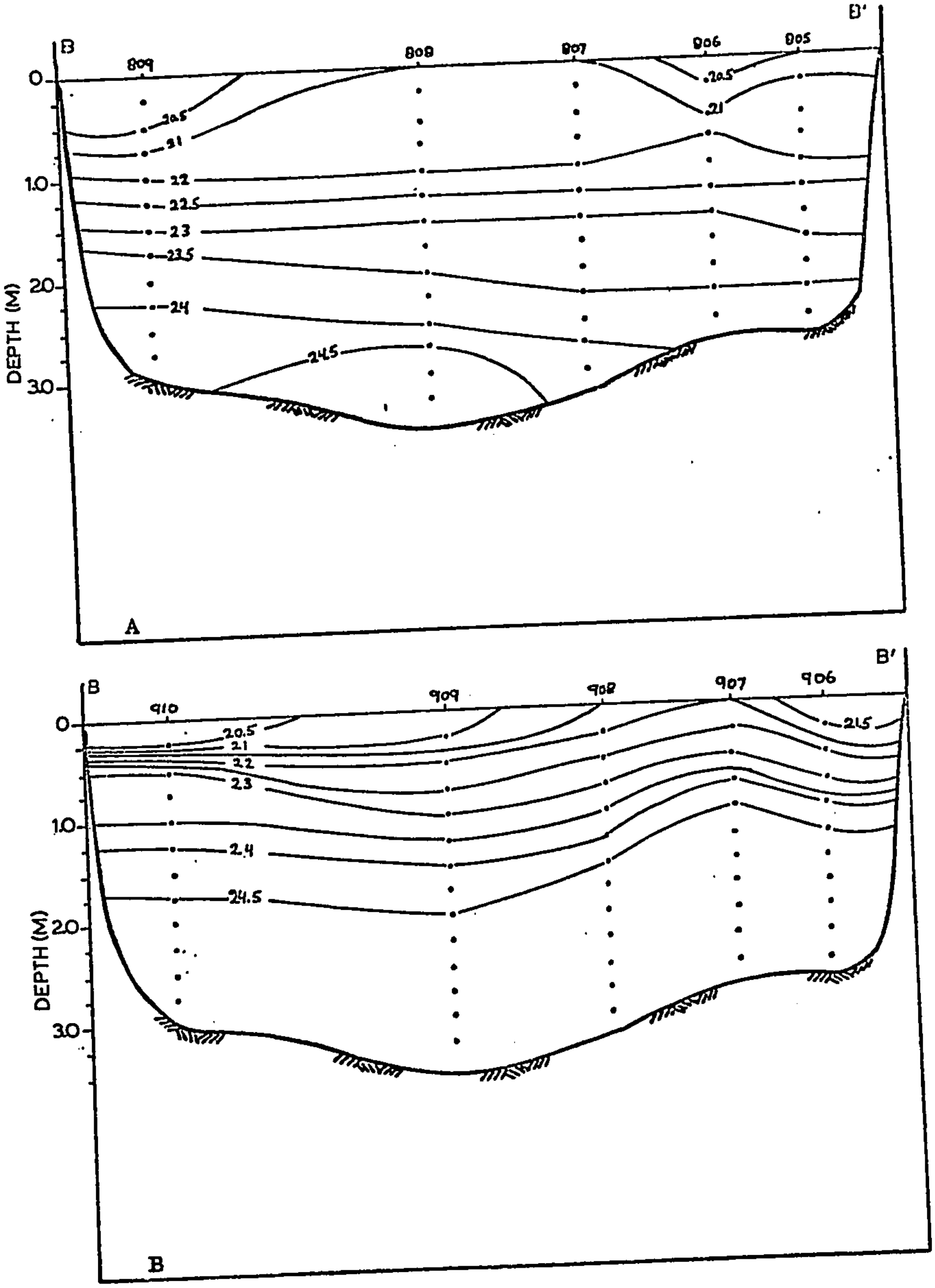


Figure 2. Temperature sections within Honokohau Harbor at low (A) and high tide (B) along transect BB' (see Figure 1 for location).

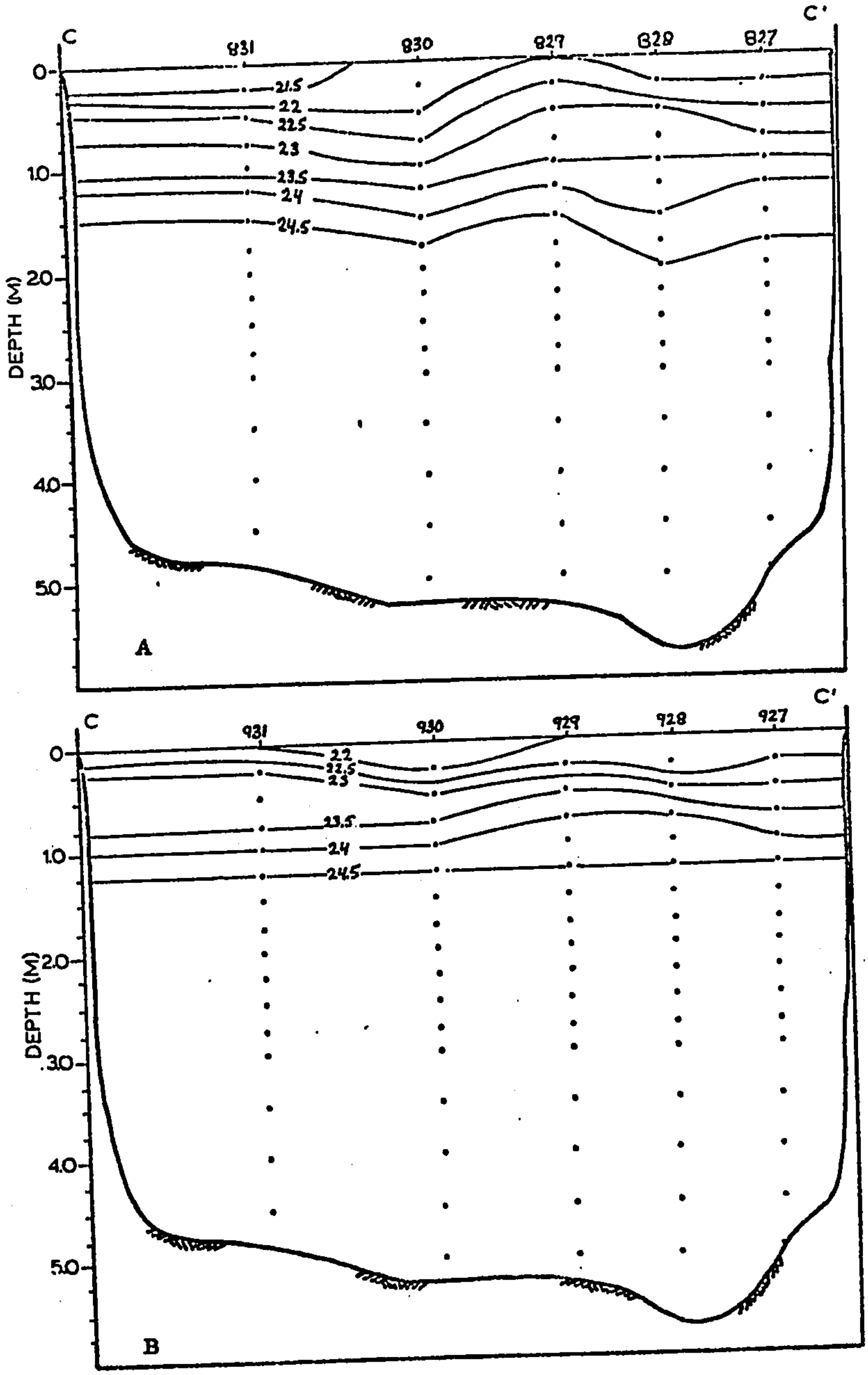


Figure 3. Temperature sections within Honokohau Harbor at low (A) and high tide (B) along transect CC' (see Figure 1 for location).

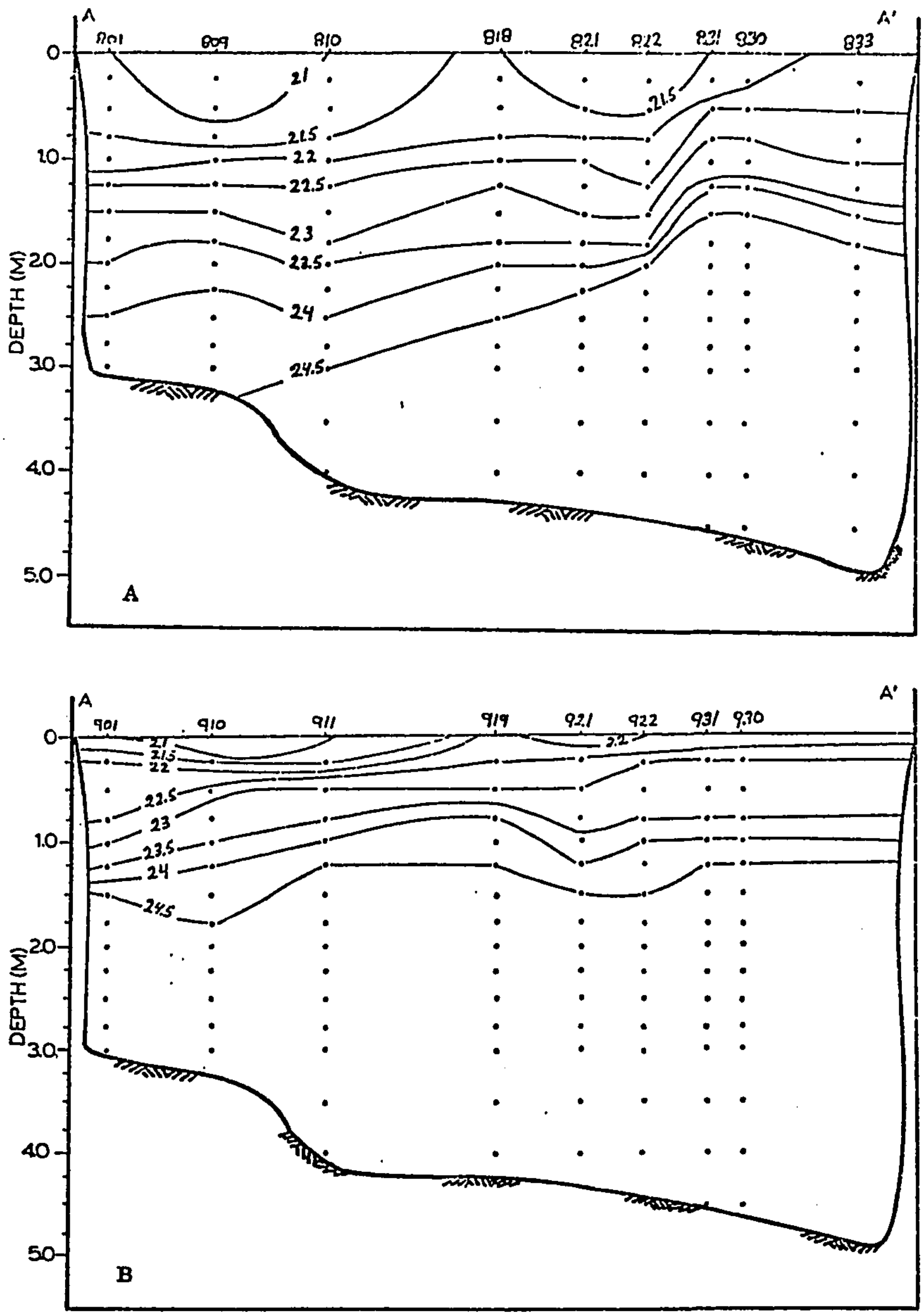


Figure 4. Temperature sections within Honokohau Harbor at low (A) and high tide (B) along transect AA' (see Figure 1 for location).

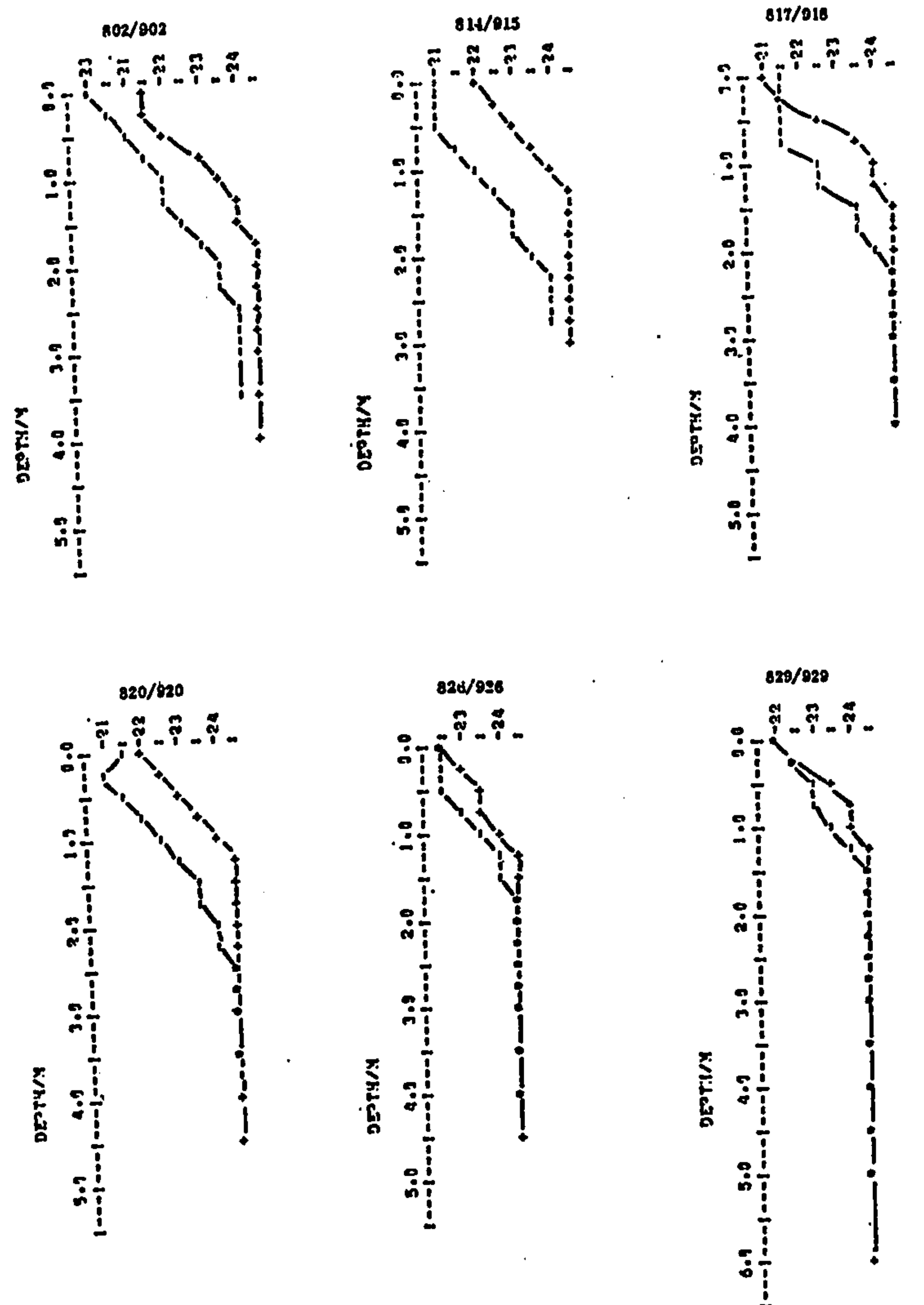


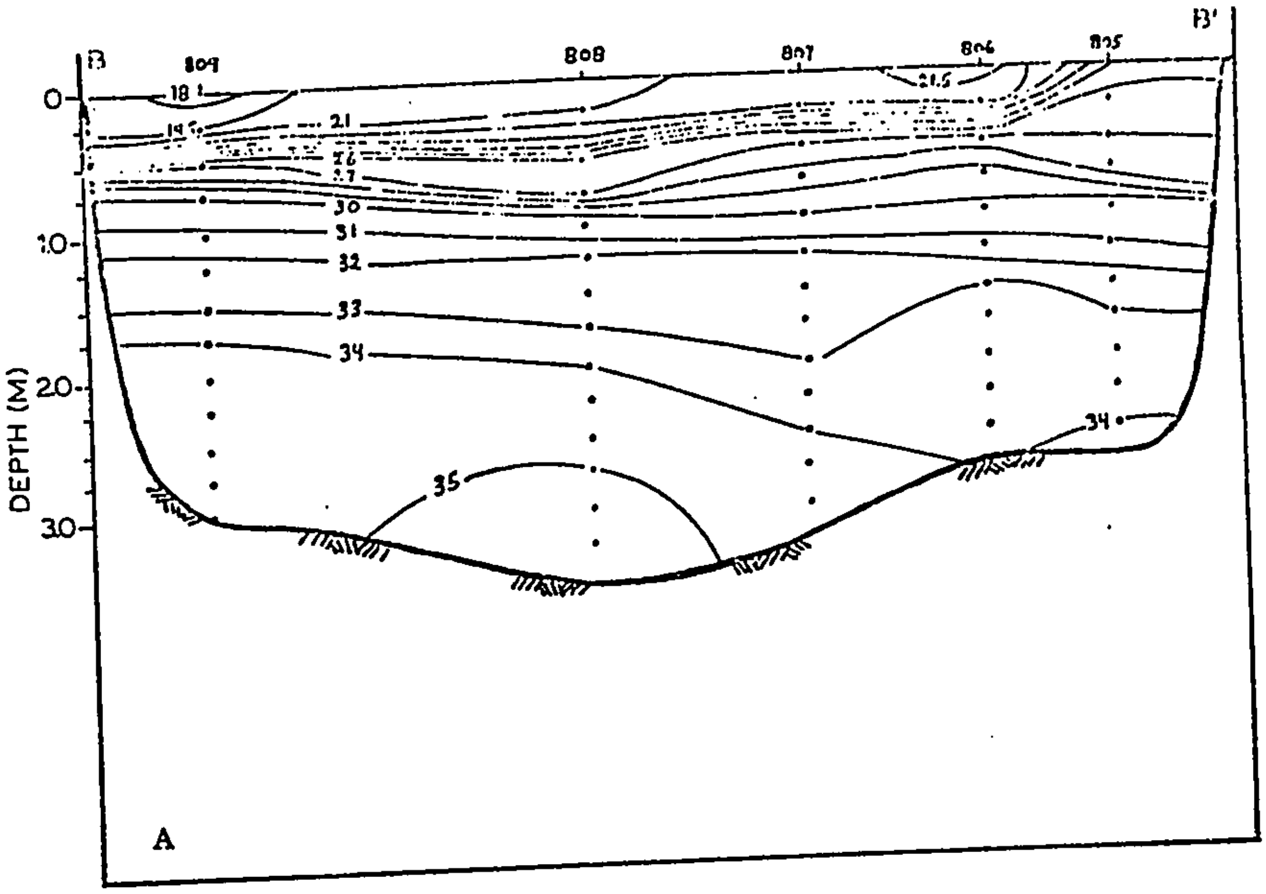
Figure 5. Vertical profiles describing tidal variation in temperature at selected stations within Honokohau Harbor (- : value at low tide, 800 series, + ; value at high tide, 900 series, * : same value high and low tide).

Water temperatures range from 20.5 °C at the surface of the mauka basin to 24.5 °C at the bottom (Figure 2). In the makai basin the temperature of the surface waters is 21.5 °C - 22 °C; this 1 - 1.5 °C increase over the surface waters of the mauka basin results from solar heating during passage from the mauka basin (Figures 3 and 4). There is no definable layer of cool unmixed, surface water; rather there exists a continuous gradient of temperature down to the depth of the oceanic layer (24.5 °C). Temperature sections of the mauka berthing basin (Figure 2) show that the majority of this basin contains water of sub-oceanic temperatures at low tide. The comparatively gradual temperature gradient is maintained by solar heating, mixing and diffusion processes. Waters of oceanic temperature constitute only a small portion of this basin volume at low tide; however, at high tide the entire basin contains such waters at depths in excess of 1.75 meters, and the gradient is considerably more steep. In the deeper makai basin this gradient is less pronounced and oceanic layer is attained at 1.5 meters. Figure 3 shows that the majority of this basin is oceanic at both high and low tide. Ambient ocean temperature is attained at ca. 1.5 m at low tide, and at high tide this layer extends to ca. 1.25 m. The east-west harbor transect (Figure 4) illustrates the temperature variations of the basins and channel in response to tidal flushing. Vertical profiles (Figure 5) describe the variations of the mixed layer in response to the tide in the various provinces of the harbor. The temperature gradients are steepest at high tide regardless of location, but the depth at which oceanic temperatures are attained shows greatest variation in the mauka basin.

Salinity.

Vertical profiles of salinity were taken simultaneously with those for temperature. Salinity shows a distribution similar in several features to that of temperature; namely, a surface layer dominated by ground water inputs, steep vertical gradients, and a sub-surface oceanic layer varying in size in response to tidal conditions (Figures 6 to 9). The lowest salinity (18.5 ‰) was found in the mauka basin, the area of ground water input. The majority of the ground water inputs have a salinity of 24 - 26 ‰, though there are isolated, lower volume inputs which have a more reduced salinity. These are represented by the surface "pockets" appearing in Figure 6.

The salinity gradient extends virtually to the bottom in the mauka basin at low tide. Throughout the harbor this gradient is maintained by advective processes, vertical mixing and diffusion. The extent of tidal flushing is implied by Figures 6 and 8 which show the variation in the depth of the 35 ‰ layer in response to the tide. The surface waters of the makai basin are <u>ca.</u> 30 ‰; this increase over the surface waters of



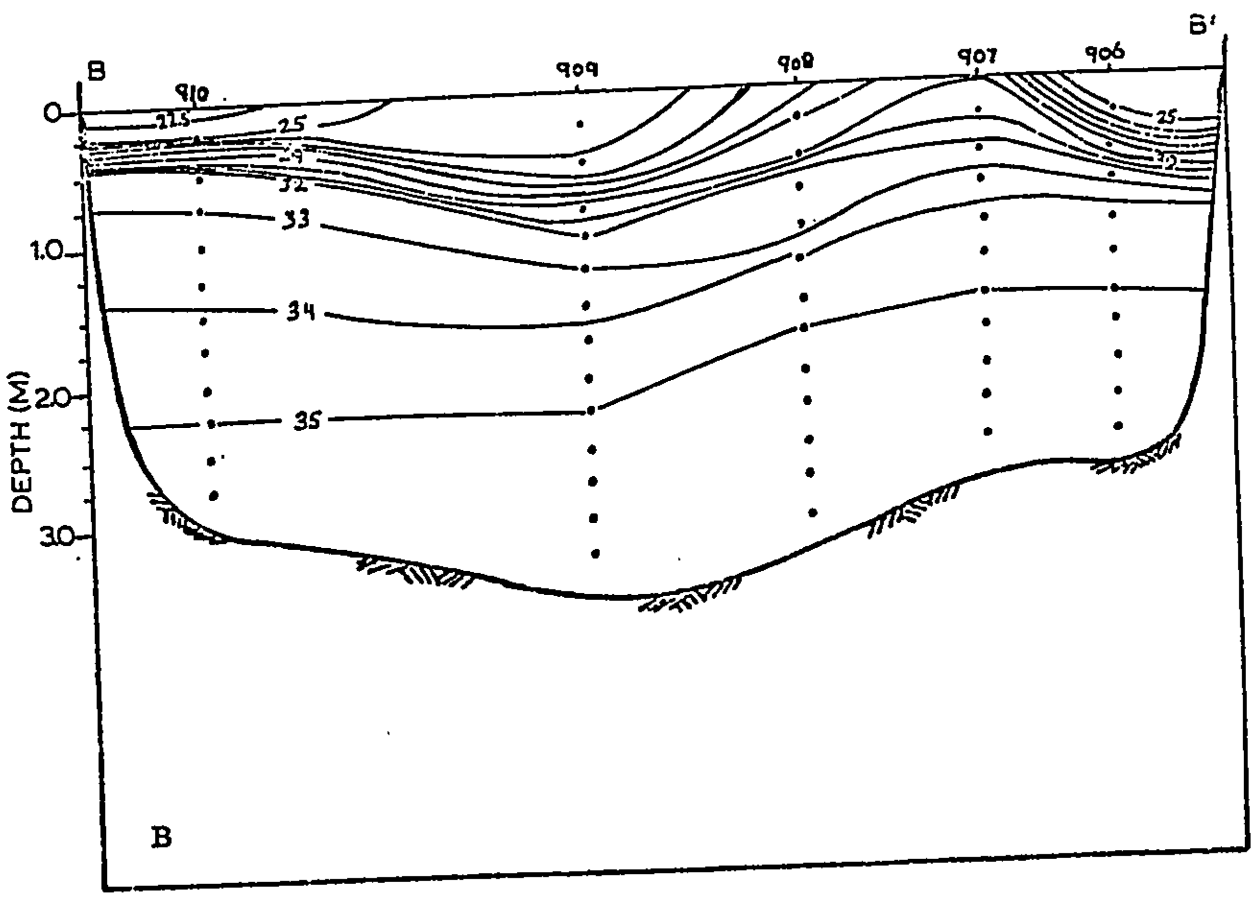


Figure 6. Salinity sections within Honokohau Harbor at low (A) and high tide (B) along transect BB' (see Figure 1 for location).

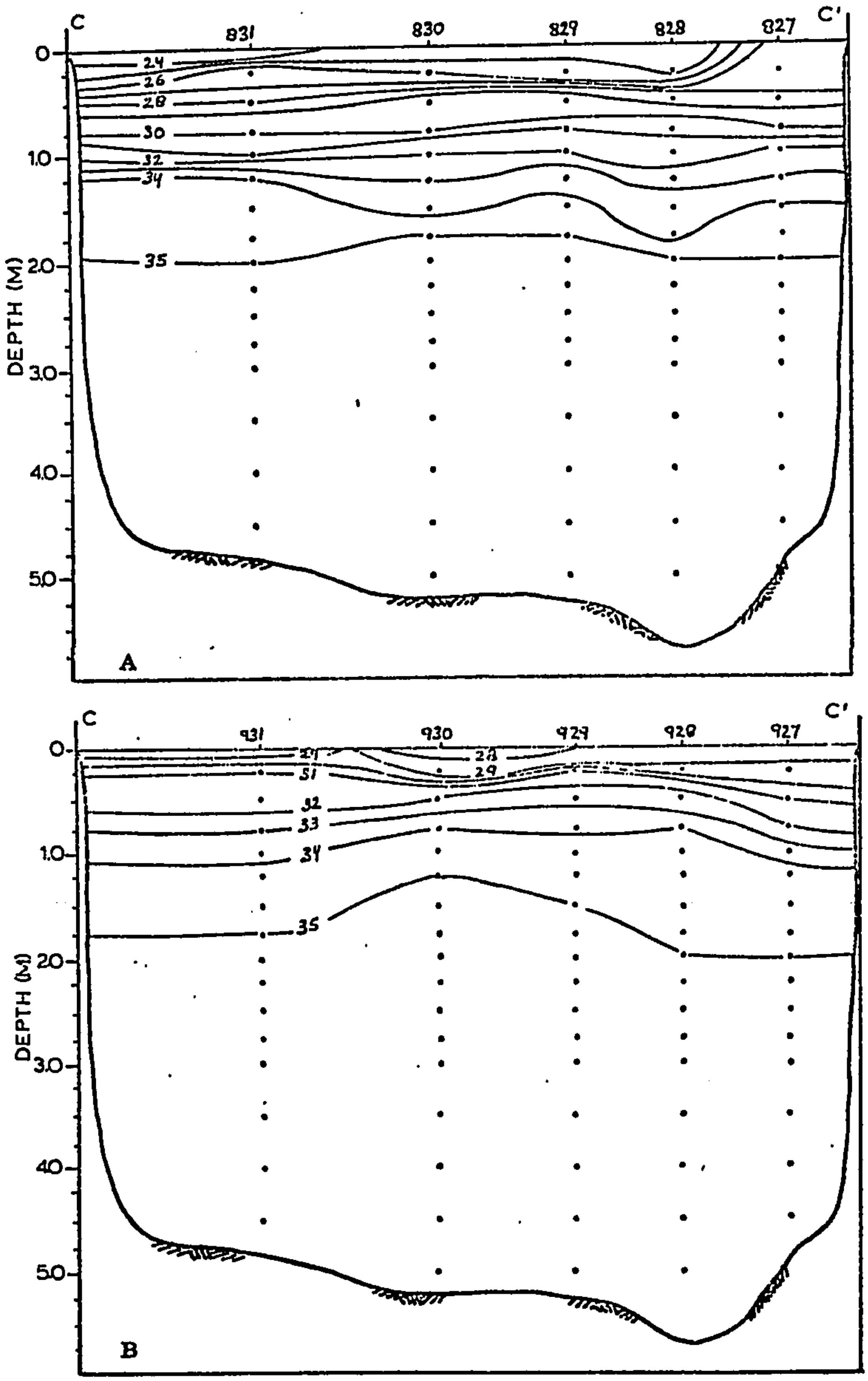


Figure 7. Salinity sections within Honokohau Harbor at low (A) and hightide (B) along transect CC' (see Figure 1 for location).

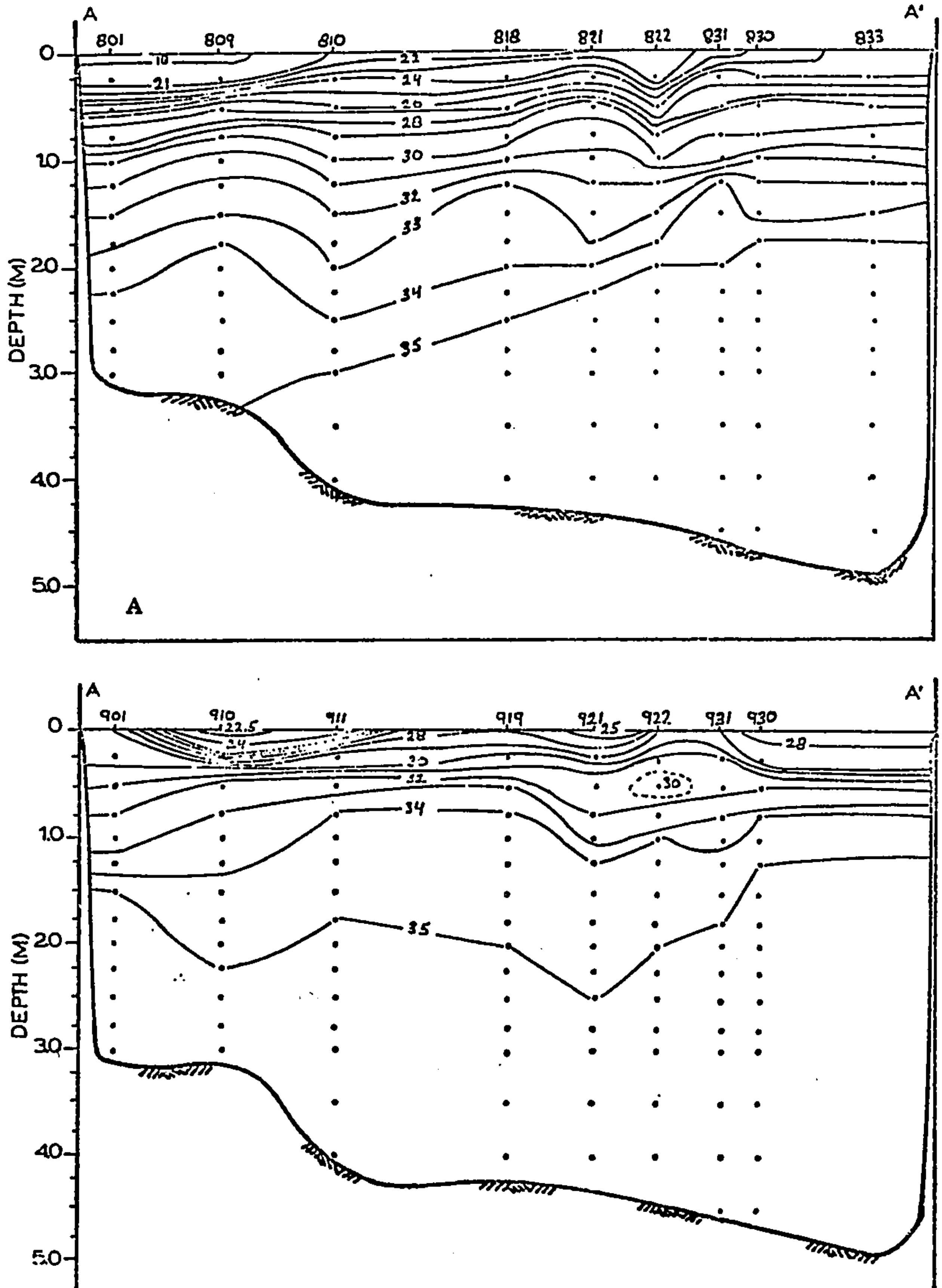


Figure 8. Salinity sections within Honokohau Harbor at low (A) and high tide (B) along transect AA' (see Figure 1 for location).

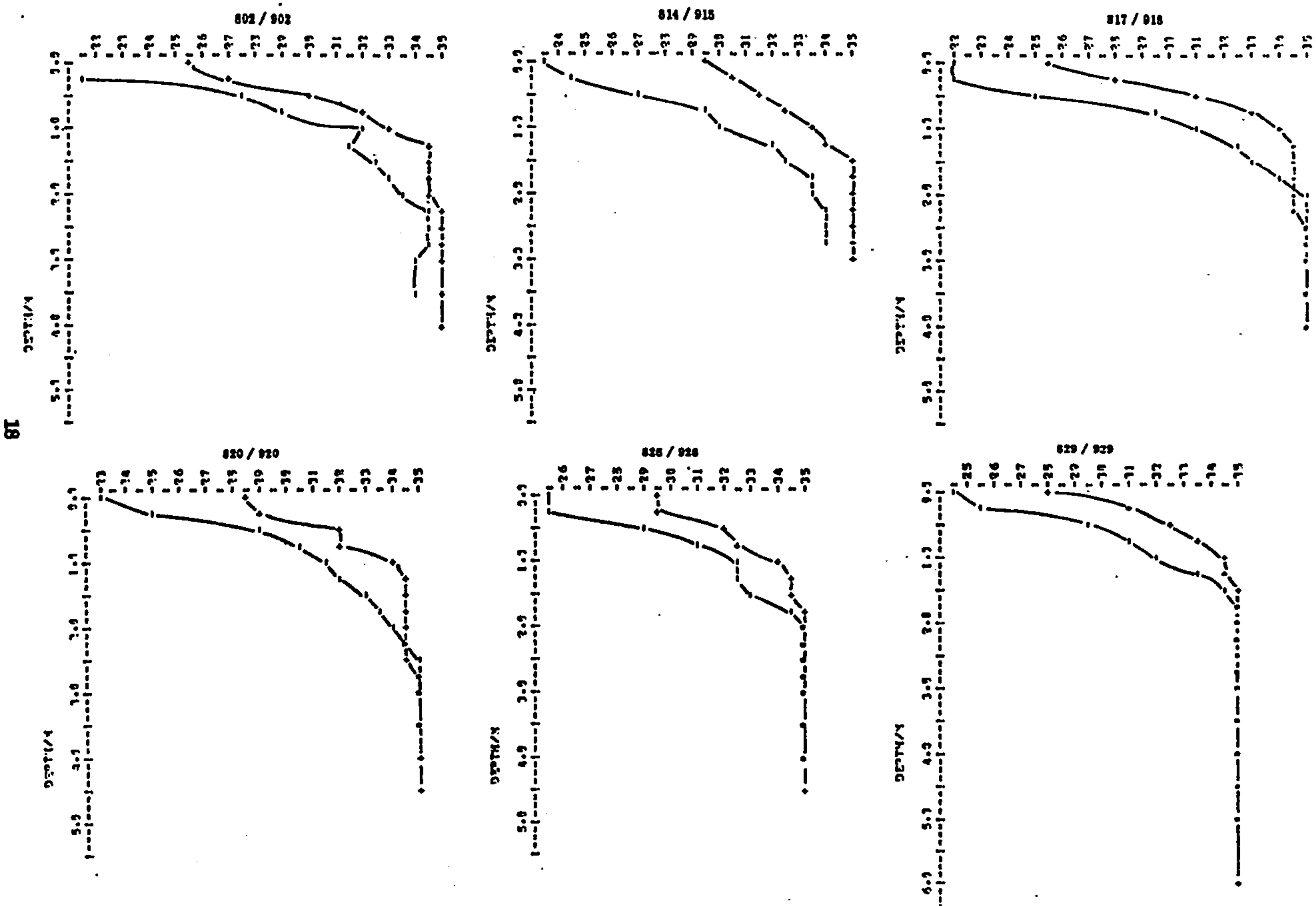


Figure 9. Vertical profiles decribing tidal variation in salinity at selected stations within Honokohau Harbor (- : value at low tide, 800 series, + : value at high tide, 900 series, * : same value high and low tide)

the mauka basin result from mixing which occurred since its origin in the mauka basin. The makai basin contains undiluted oceanic waters below a depth of 1.75 m at high tide and 2.0 m at low tide. The longitudinal cross section of salinity describes the distribution of the salinity gradient and the oceanic layer, and the tidal response of each throughout the harbor. This is described in detail for selected stations in Figure 9.

Dissolved Oxygen.

Vertical profiles of dissolved oxygen concentrations were taken at 0.5 m intervals at 30 stations within the harbor using a YSI oxygen probe equipped with a pressure compensating sensing probe. Unfortunately, malfunction of the sensing probe yielded erroneously high dissolved oxygen levels and it was necessary to re-determine oxygen concentrations using the Winkler technique. Discrete samples were taken from both the surface and subsurface waters of the two berthing basins and analyzed for oxygen content via titration.

Dissolved oxygen levels in the mauka berthing basin were 4.53 ml O_2/l in the surface waters and 5.83 ml O_2/l in the waters near the bottom. The slightly lower values at the surface may reflect the recent introduction of this brackish water which was previously out of contact with the atmosphere. In the makai berthing basin, which does not directly receive large quantities of brackish water input, the dissolved oxygen measured

5.44 ml O_2/l at the surface and 5.18 ml O_2/l in the subsurface layer. The surface layer in the makai basin is maintained by the brackish inputs originating in the mauka basin. The higher oxygen levels in these waters, relative to those of the mauka basin, result from contact with atmospheric oxygen, as this layer flows seaward. Oxygen levels in both areas and depths are near saturation concentrations for the existing temperature and salinity conditions.

Turbidity.

Turbidity was measured simultaneously at all stations and depths with temperature and salinity. These results are expressed as "percent transmittance" which is the inverse of turbidity; thus high percent transmittance values connote low turbidity and vice versa. The results show that low turbidity conditions prevail in the harbor as a whole. Percent transmittance values are nearly always greater than 90%. Turbidity shows non-systematic variation with both depth and location within the harbor. For this reason, the turbidity results are shown only via a set of representative profiles for the two basins and the interconnecting channel (Figure 10). The 800 series describes low tide values and the 900 series describes the high tide values at a given location, shown in Figure 1 . The absence of vertical and tidal variation is most pronounced in the mauka basin and the connecting channel, which are extremely well mixed by the groundwater

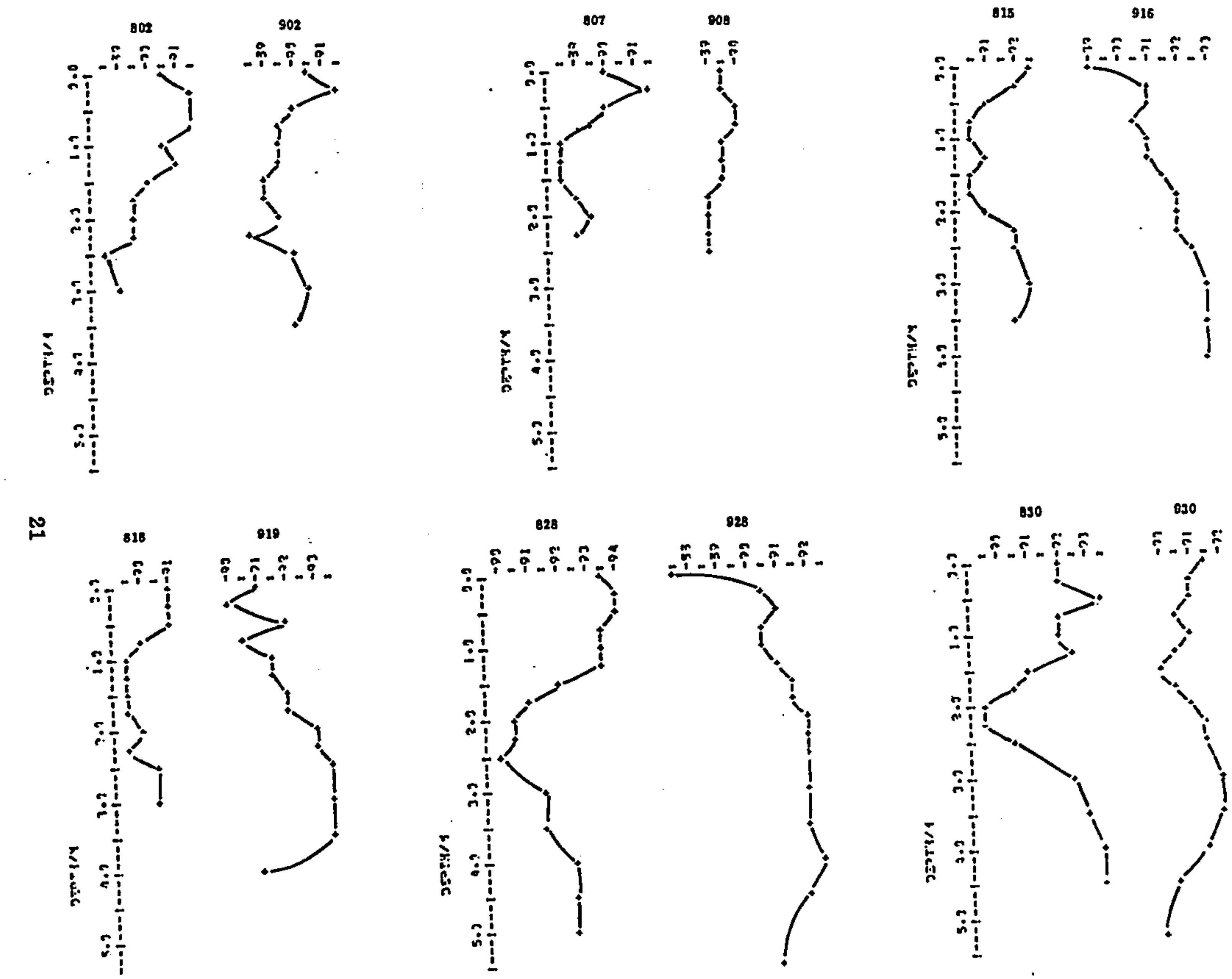


Figure 10. Vertical profiles describing tidal variation of transmission at selected stations within Honokohau Harbor (- : value at low tide, 800 series, +: value at high tide, 900 series)

and tidal effects. In the makai basin, the subsurface inflection, occurring at 2 - 2.5 m, may represent turbidity resulting from the phytoplankton biomass distribution. The less defined inflection observed during the afternoon may reflect the comparative widening of this peak as a result of photosynthesis occurring during the day together with vertical mixing. It is interesting to note that turbidity does not show a tendency to increase in the back reaches of the harbor at either high or low tide, indicating the adequacy of flushing processes in maintaining water clarity.

Tides.

The recorded tide is shown in Figure 11. This measurement period coincided with spring tides, and the range at Honokohau was about one foot, with only a weak diurnal inequality present. (The record, taken in the harbor, would also be a good representation of the shoreline tide outside; the dimensions of the harbor and entrance channel are such that the tide wave suffers no appreciable attenuation or delay between ocean and harbor.)

It may be of practical interest to compare the Honokohau tide with that predicted for Honolulu.

The times of high and low water at Honokohau generally agree well with the Honolulu prediction as corrected for Kealakekua Bay; the times are about 16 minutes earlier at Honokohau than at Honolulu. However, the

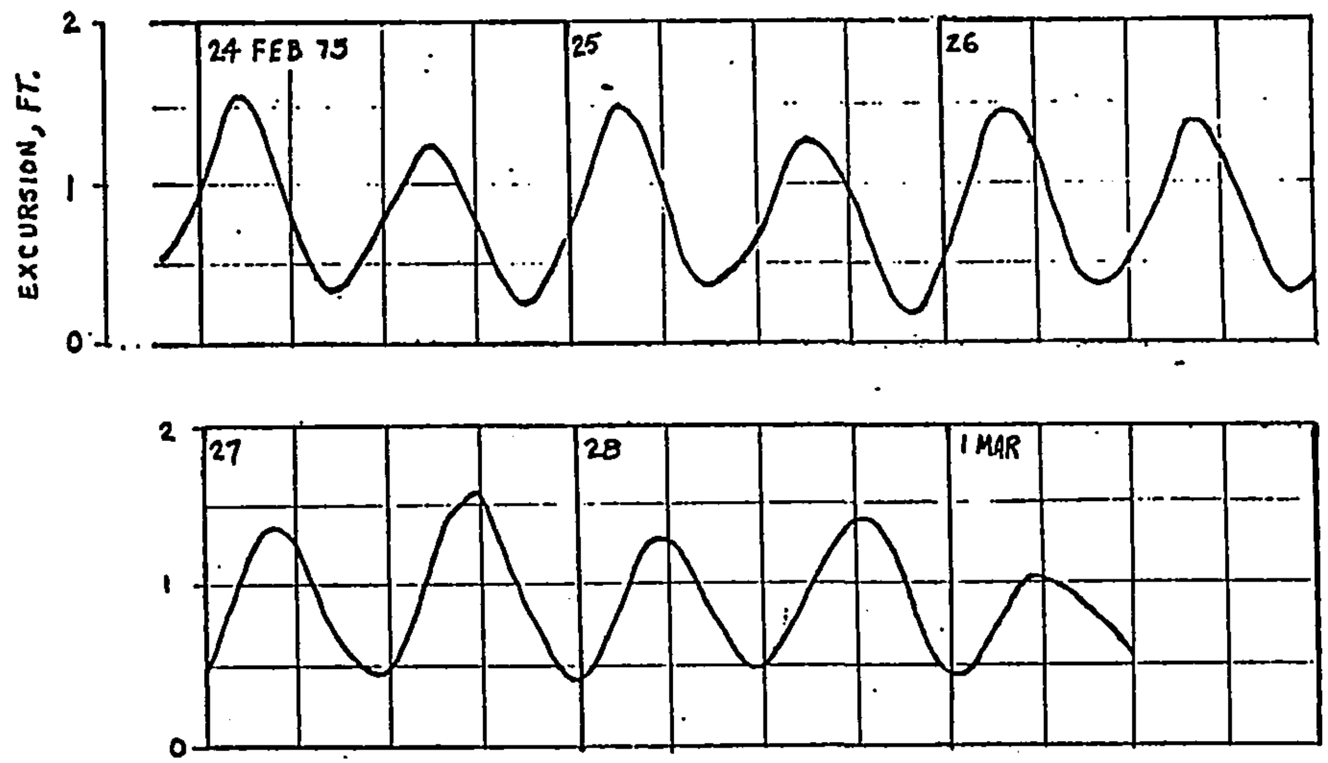


Figure 11. Tidal cycle at Honokohau Harbor, February 24 - March 1, 1975.

Honolulu prediction does not very accurately represent the actual water level excursion at Honokohau. This is because the Hawaiian island/ridge system causes distortion of the diurnal and semidiurnal tidal waves as they propagate through from the open ocean. Understanding and predicting these distortions is a topic of ongoing research, and we are not yet in a position to give a full theoretical explanation of the observed tides at various stations around the islands. However, it is known that appreciable local differences are produced; the variation in height between Honokohau and Honolulu is not surprising.

In summary, Honolulu predictions (corrected to Kealakekua Bay) can be used to find times of high and low water at Honokohau. Periods of spring and neap range can likewise be predicted, and the ranges will be grossly similar. Details of the daily pattern will be different, however, and our short record suggests that the diurnal inequality is much weaker at Honokohau.

Circulation and Current Patterns.

The overall object of the observation program was to develop a good picture of the main flow systems within the harbor, concentrating on the ultimate aim of computing flushing rates. An important subsidiary goal was to learn the rate of brackish water input from land seepages. Put more simply, we wanted to answer the question, "What's happening?" as far as major physical processes are concerned. Answering this question for the present harbor is prerequisite to assessing the probable effects of various expansion proposals.

Our efforts were concentrated on two main tasks. The first was to determine the transport rates through the main entrance channel and through the channel connecting the two harbor basins. Knowing these transport rates throughout a tidal cycle is necessary for computing overall flushing rates for the basins, and for calculating the salinity and input rate of the brackish water entering through seepages and submerged springs.

Observations showed that the currents were essentially two-layered in structure, but at the same time the data revealed a significant surging in both layers. Currents in the interconnecting channel displayed strong time variability (including reversals) with a predominant period of about 2-1/2 minutes; it was not possible to get meaningful spot measurements with which to construct cross sections.

The second primary task was to determine the nature of the circulation within the harbor. This information was needed for estimating how well or how poorly various parts of the harbor are flushed. Data were collected by implanting drogues throughout the harbor and tracking them over a tidal cycle, and by making a high density survey of temperature and salinity throughout the harbor at high and low tides.

Day-long records of current were also made at two locations shown in Figure 12,sampling speed and direction every ten seconds.

The Overall Pattern of Inflow and Outflow.

The harbor is essentially a two-layer system. Warm, high salinity water originating from sea water makes up the lower layer, and a mixture of sea water and cold, brackish spring water forms an upper layer which is 1/2 - 2 meters thick. This structure can be seen in Figure 13,and our discussion will be framed in terms of the flows in the two layers.

Honokohau Harbor has an unusual circulation pattern which produces excellent flushing. The pattern is caused by the fact that a large volume of brackish water enters the harbor through several bottom springs in the back basin. This spring water rises through and mixes with water from the lower layer, producing a large volume of surface water which continually flows out of the harbor. Furthermore, deep water is constantly supplied to replace what has mixed and flowed out at the surface; an effective pumping action is created which draws deep water into the back basin. This pattern of deep inflow and surface outflow dominates the circulation. It is modified by the tide, but its main features persist throughout the tidal cycle.

For measurement we divided the harbor into two parts: the inner

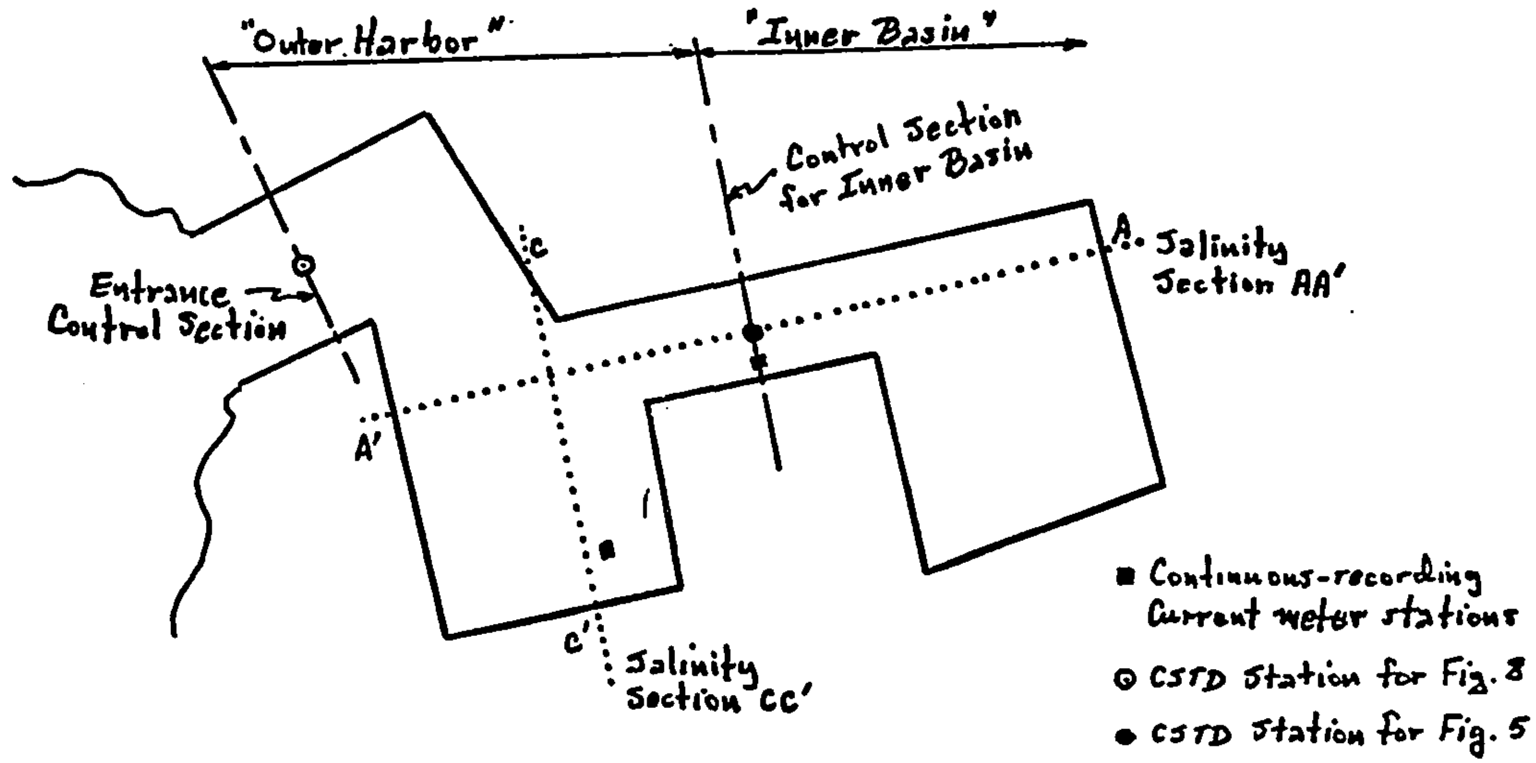


Figure 12. Location sketch showing section and measurement positions

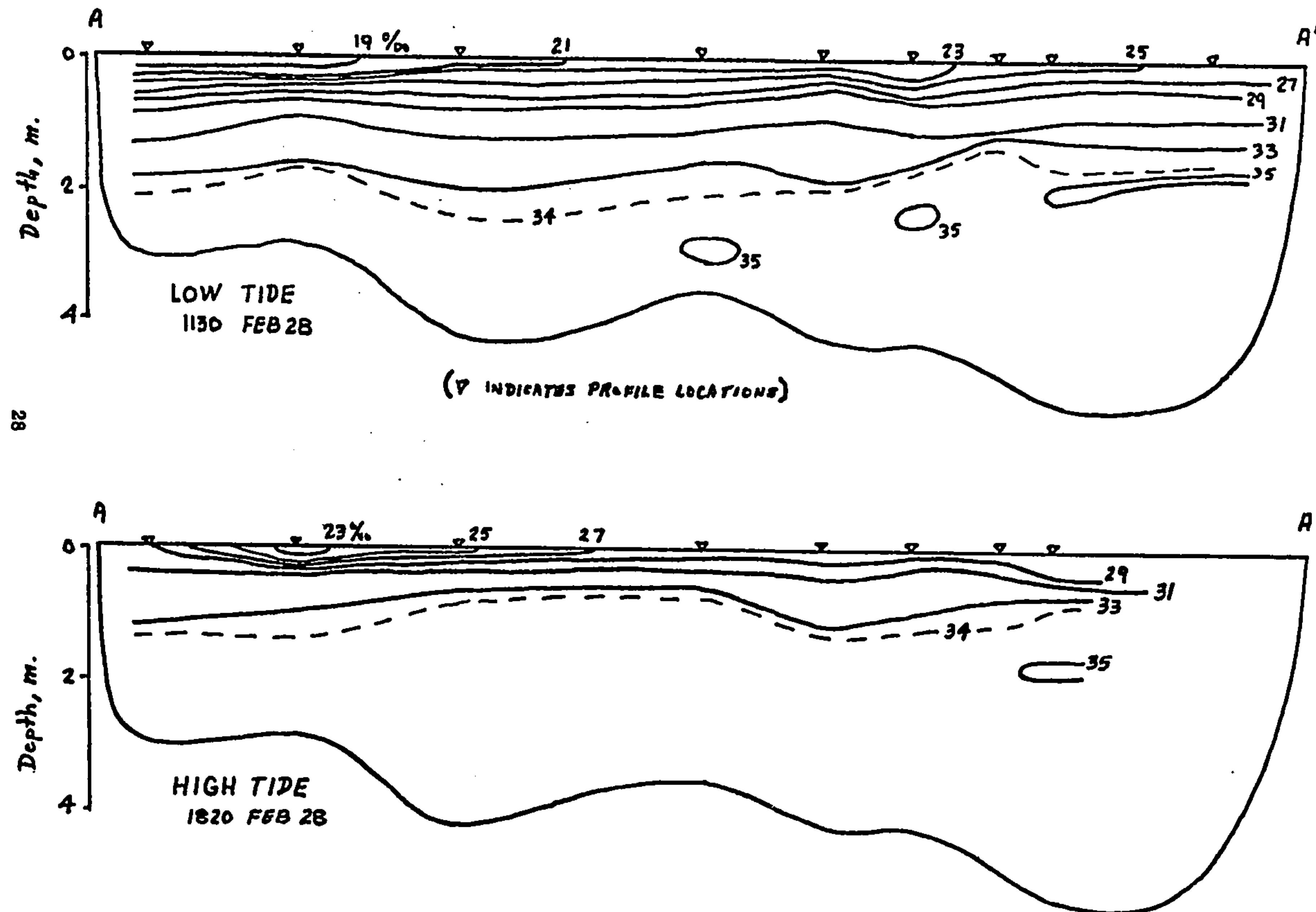


Figure 13. Salinity section AA'

basin and outer harbor, with the boundary midway along the channel connecting the two berthing basins (Figure 12). Fluxes into and out of the back basin were monitored at this boundary over the period 1130 to 2430 on 27 February, covering one complete flood and ebb cycle. Similar observations were repeated across the main harbor entrance channel over the flood and ebb cycle 1130 to 2430 on 28 February. Weather on the two days was the same (clear with no wind except for very light evening breezes), and the tidal patterns were quite similar. We feel it justified to assume the harbor's behavior was very nearly the same on the two days and to combine the data sets in constructing a composite picture.

We will now discuss the volume fluxes into and out of each harbor segment, presenting what happens in the upper and lower layers as the tide rises and falls.

Inner basin. We will discuss the flood tide picture first. Although high frequency variations had rendered the current meter profiles unreliable with respect to absolute speeds, the profiles served to place the depth of mean flow-reversal at about 1.75 meters in the interconnecting channel. Drogues in the deep layer showed that the flood tide inflow was confined to the northern third of the channel, with a mean speed of 2.3 m/min. (see Figure 14). From these observations we estimate the deep inflow rate of 63 m^3/min. at flood tide. Surface drogues showed

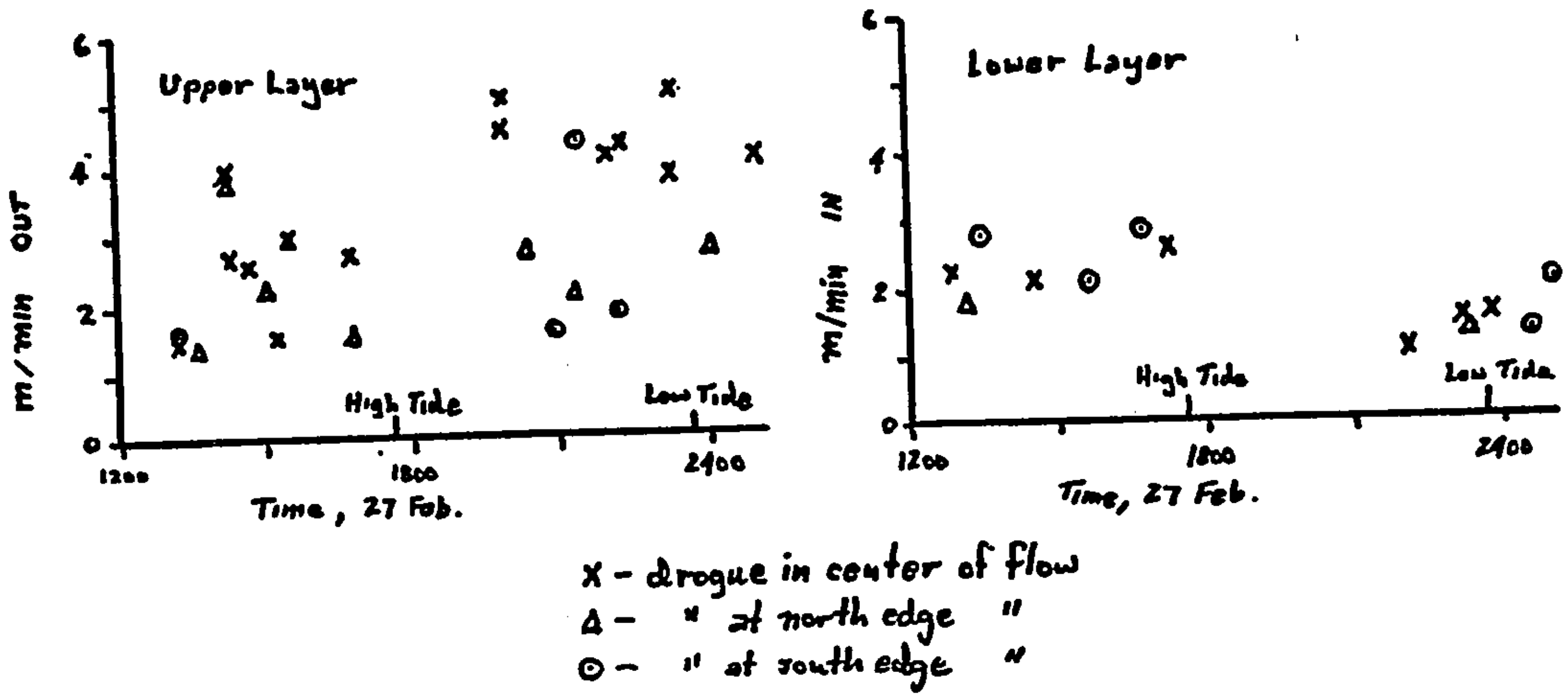


Figure 14. Drogue speeds in interconnecting channel

the upper layer to be outflowing across the entire width of the channel with a mean speed of 1.8 m/min., giving an estimated outflow rate of 122 m^3/min. The tidal volume of the inner basin increased at 12 m^3/min. A budget calculation then gives an estimate for the rate of brackish water input from springs and seepages in the back basin: 71 m^3/min. Figure 15 depicts these flows schematically.

If we look at the time history of salinity in the interconnecting channel (Figure 16), we see the deep inflow of salt water from the outer basin and the surface outflow of brackish water. Late in the flood cycle there is a deep intrusion of water having a salinity greater than 35 °/₀₀, and from drogue studies to be discussed later, we believe this is a penetration of water directly from the ocean. For a salt budget, we computed depth-averaged salinities in the two layers midway through the flood cycle (upper: 29.2 °/₀₀; lower: 34.6 °/₀₀). During flood tide there is also an accumulation of salt in the inner basin (seen in Figure 13), and we took the salinity of the accumulating water as that of lower layer water. A budget then puts the salinity of the brackish spring inflow at 25.3 °/₀₀. This is consistent with diver-sampled salinities in the mouths of several back-basin springs (25.01, 17.65, 26.45, 26.67 °/₀₀), and this consistency serves as a rough check on the water and salt flux calculations.

During ebb tide the basic flow pattern through the interconnecting

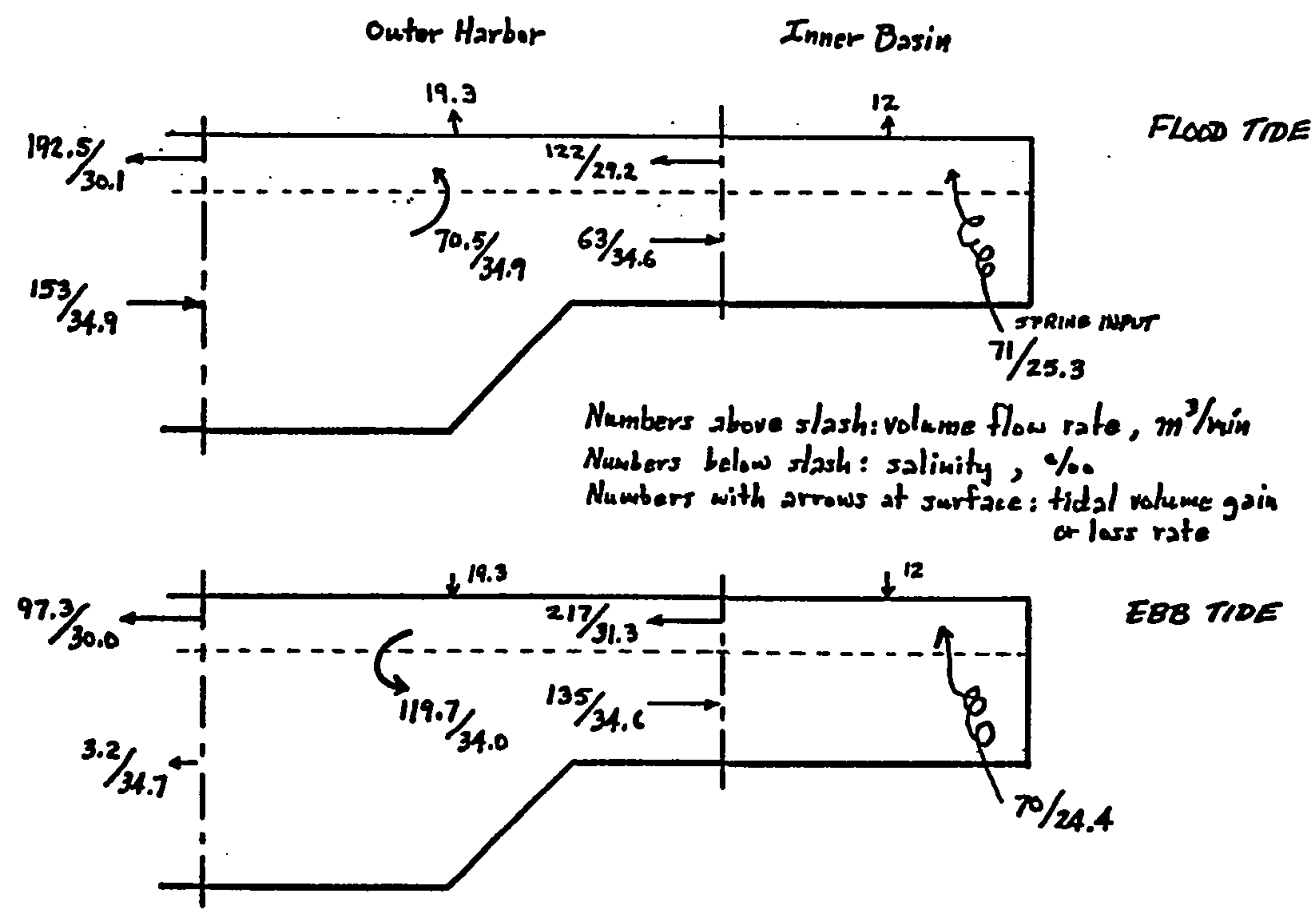


Figure 15. Schematic of flux rates and salinities

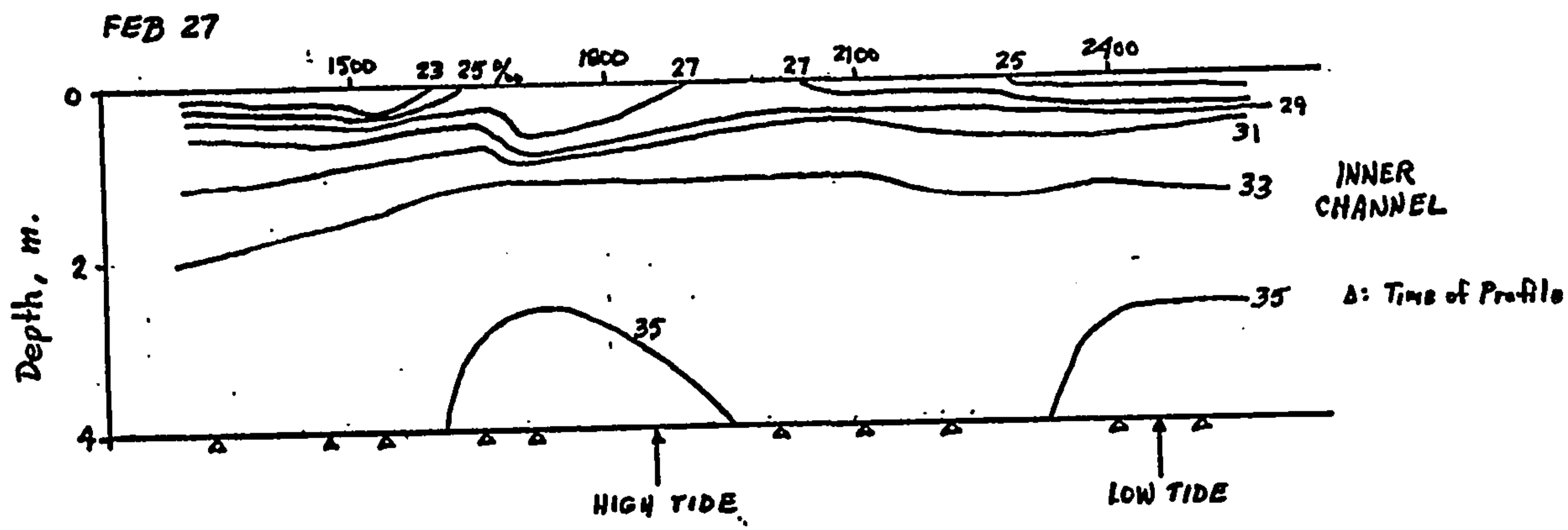


Figure 16. Time record of salinity at control section in inner channel

channel remains the same as during flood tide, but becomes more vigorous. As the tide falls, the surface layer flows outward more freely, increasing the mixing/pumping action in the back basin and reversing the salt accumulation that took place during flood. From the salinity sections, we estimate the outflow of the surface layer deepens from 1.75 meters to 2 meters, and the surface drogues now move out at a mean speed of 2.8 m/min. The surface outflow rate is then 217 m^3/min.--nearly twice the flood tide value. The deep drogues show the inflow has broadened, now occupying about half the width of the channel, moving in along its northern edge at a mean speed of 2.7 m/min. Allowing for an ebb tide volume loss rate of 12 m^3/min. for the inner basin, we find 70 m^3/min. of brackish spring-inflow will balance the water budget.

A salt budget was made using depth averaged salinities for the flows at the midpoint of ebb tide (from Figure 15, 31.3 ‰ in the upper layer, 34.6 ‰ in the lower). If we assume the volume lost during ebb tide consists of lower-layer water, we arrive at an estimate of 24.4 ‰ for the salinity of the brackish spring input. Again, this is consistent with the diver-sampled salinities mentioned earlier, and it tends to confirm our budget estimates of water and salt fluxes.

Outer harbor. Our computations for the inner basin, above, were based on measurements of salt and water fluxes through the interconnecting channel, and this data was used to make redundant estimates of salinity and input rate for the submerged springs. This is mentioned for contrast with the approach taken for the outer harbor, where there is negligible brackish input and a different set of unknowns in the salt and water budgets. We will present these differences first and then discuss flux rates.

Direct input of brackish water appears negligible in the outer harbor. Diver explorations and salinity sections (Figures 13 and 17) revealed no bottom springs like those present in the back basin. Small surface seepages can be detected visually around the edges of the outer harbor, but again, the salinity sections show these having no appreciable effect. We therefore feel it is a good approximation to neglect direct brackish input.

An important factor in the outer harbor circulation is the exchange of water between upper and lower layers. This can be seen in Figure 13, for example, where the salinity changes in the upper layer indicate that water and salt exchanges are taking place with the lower layer. The volume of this exchange and the mean salinity of the net exchange are unknowns to be computed in the outer harbor.

A third difference arises because the volume transports in the entrance channel are less reliably known than in the interconnecting channel. This is primarily because the flow in the lower layer was very irregular. During flood tide, two drogues moved in through the entire length of the

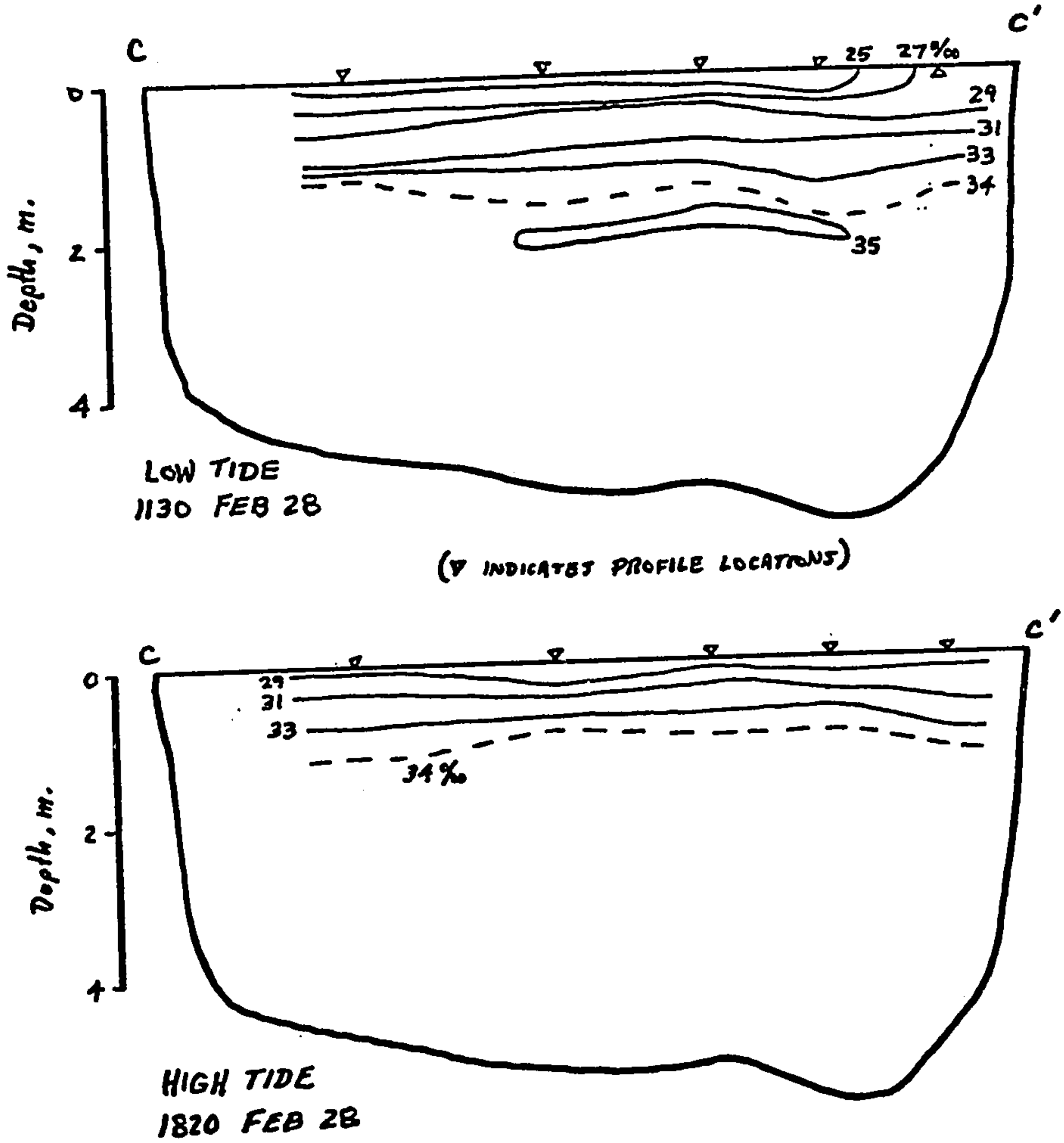


Figure 17. Salinity section CC'

entrance channel, and their speeds are shown in Figure 18. However, several others moved in erratic patterns, and we did not feel confident that we had a reliable measurement of the net flow. During ebb tide the deep flow was very slow, and again inconsistent, with some drogues moving into the harbor and others leaving. The surface drogues showed a consistent outflow (Figure 18), but we could not be sure of its thickness. Thus we did not think the observations were good enough for reliable estimates of net volume fluxes.

Our approach to the outer harbor fluxes was to employ simultaneous salt and volume budgets, using observed values for the variables that had been measured most reliably and computing the others. The most reliable observations were those of the fluxes into and out of the back basin, the time history of salinity in the entrance channel (Figure 19), and the salinity sections for high and low tide (Figure 17). From these data we were able to estimate mean salinities for the flows through the entrance and rates of salt accumulation or loss for each layer in the outer harbor, and could then calculate the interlayer exchange and the entrance channel volume fluxes. In these calculations, it was necessary to choose some dividing line between the upper and lower layers. The depth of the 33‰ salinity surface was suggested by our observations in the interconnecting channel, and using this as a guide we chose the interlayer boundary at

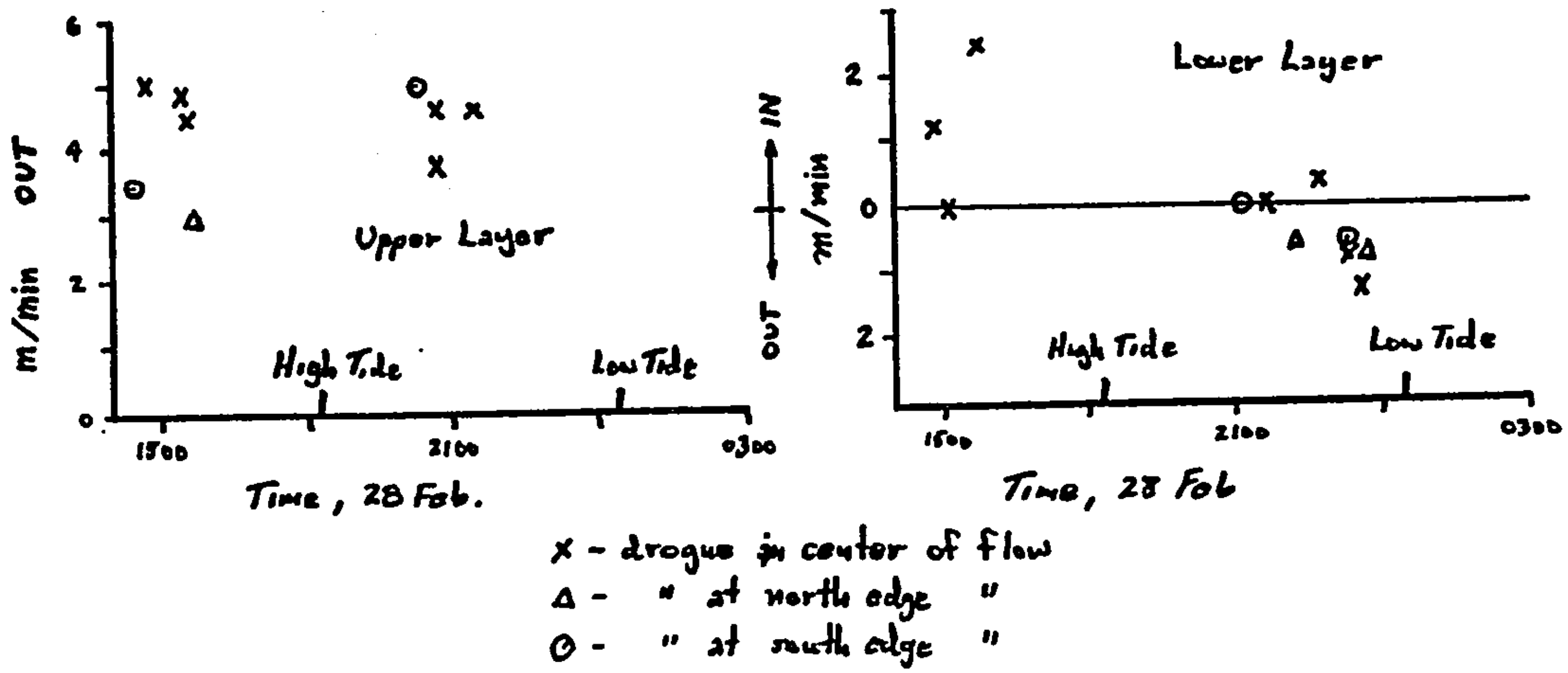


Figure 18. Drogue speeds in entrance channel

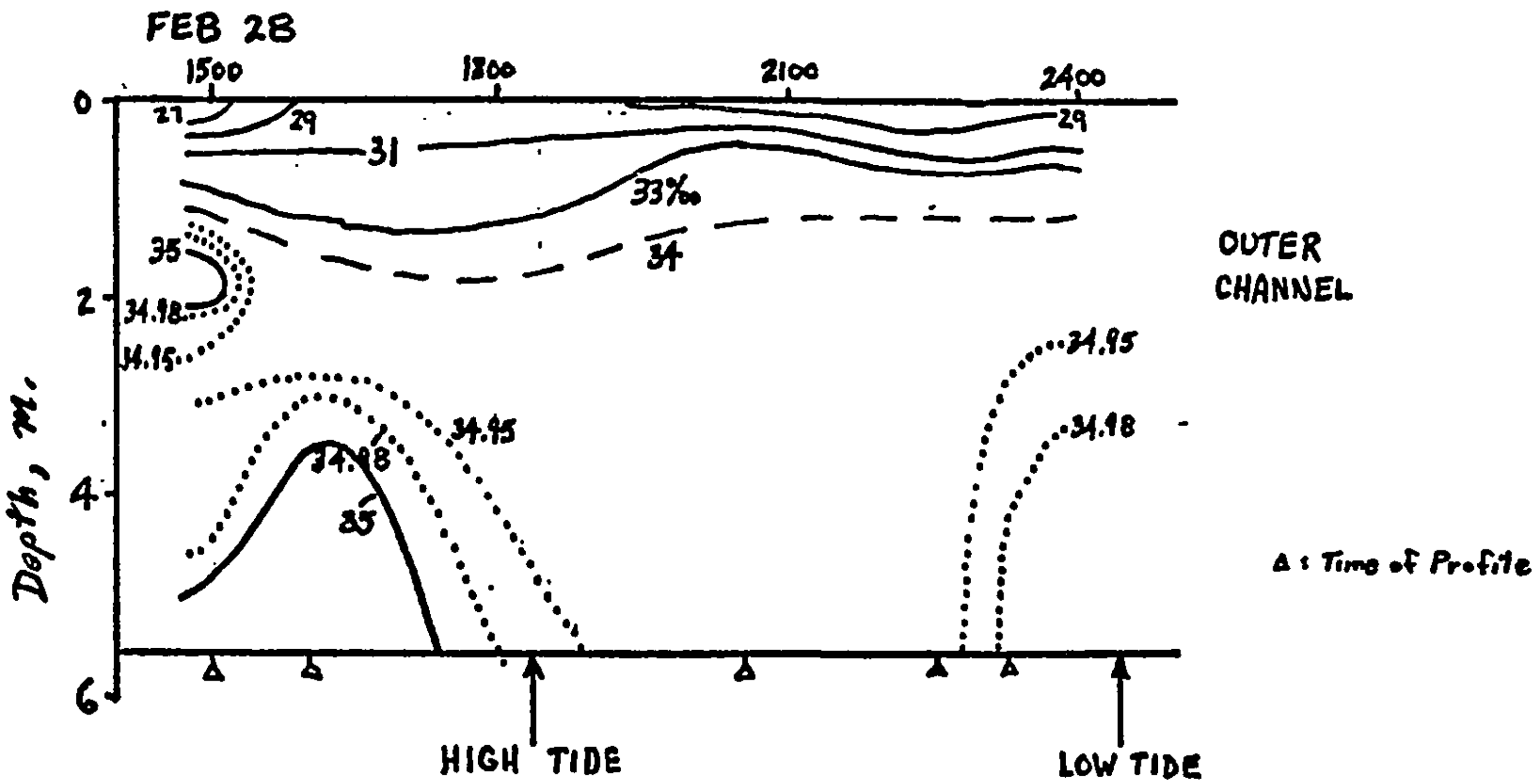


Figure 19. Time record of salinity at control section in entrance channel

a depth of 1 meter everywhere except in the entrance channel at ebb tide where the 33 ‰ surface indicated that 1/2 meter was more suitable. A check on the calculations is provided by comparison of observed and computed surface outflow speeds.

The following picture emerges for the outer harbor, and is shown schematically in Figure 15. During flood tide water in the lower layer enters the harbor at a mean rate of 153 m^3/min. A small part of this raises the tidal level of the outer harbor (19.3 m^3/min.). Mixing has the net effect of moving deep water up into the surface layer at the rate of 70.5 m^3/min. The mean salinity of this flux is calculated at 34.9 ‰, which agrees with the observed salinity of lower layer water. The balance of the net deep influx replaces water that is entering the back basin (63 m^3/min.). Considering the surface layer, we have a flux from the inner basin of 122 m^3/min. As it traverses the outer harbor its volume is increased by net exchange from the lower layer so that 192.5 m^3/min. flow out through the harbor entrance. During its trip, the mean salinity of the surface flow is increased from 29.2 ‰ to 30.1 ‰ by the addition of the saltier water from below. The above numbers allow the calculation of mean surface outflow speed (3.7 m/min.), and deep inflow speed (.9 m/min.), and these are consistent with observations plotted in Figure 18.

During ebb tide, the outer harbor develops a stronger recirculation pattern in response to the more vigorous pumping taking place in the back basin. Lower layer water flows into the back basin at 135 m^3/min., and the bulk of this is resupplied within the outer harbor by a net exchange from the upper layer (119.7 m^3/min.). The calculated mean salinity of this supply is 34.0 ‰, which is consistent with the salinity observed at the bottom of the upper layer at high tide. If we assume that the tidal drop (19.3 m^3/min.) is due to loss of water from the lower layer, the budget calculations indicate a very small lower layer outflow through the entrance channel (3.2 m^3/min.).

In the surface layer the continuous outflow is decreased by losses to the lower layer so that of the 217 m^3/min. which enter from the back basin, only 97.3 m^3/min. leave through the entrance channel. The loss of salt is reflected in a salinity reduction from 31.3 ‰ to 30.0 ‰. Computing outflow speeds in the entrance channel, we get 3.8 m/min. and 0.02 m/min. for the upper and lower layers; these are consistent with the drogue observations plotted in Figure 18.

Assessment of the flux budgets. We want to consider briefly how accurate the above picture is and how well it may represent general conditions. Although we have developed the picture carefully, applying checks wherever possible, we should point out that the observed quantities such as flow speeds and layer depths may contain errors on the order of

10 percent, and that derived quantities such as the spring inflow rate could be off by perhaps 20 percent. The picture is quite useful for understanding the physical processes at Honokohau, but we want to avoid giving the impression that the numbers are perfectly exact.

A remaining question is whether our picture represents typical behavior. The answer to this depends strongly on whether the submerged spring input rates were typical or unusual during the study period. The spring water is a mixture of sea water that has penetrated the coastal lava structures, and fresh water percolating down to the coast from higher elevations. This brackish water flow is not unusual--submerged springs and seepages are common along the south and west coasts of the island. But the strength of the flow probably depends on the recent history of rainfall on the adjacent mountain slopes. We can find no studies on the response of these coastal seepages to weather conditions, and are therefore unable to make confident statements about whether the computed spring outflow rate is typical. It is reasonable to speculate that some spring activity is usual, because the local harbor users report that the surface layer outflow is a persistent condition. It further seems reasonable that the spring input rate does not decrease by an order of magnitude, because the resulting surface outflow would probably not be noticeable to the local boaters. Thus we speculate that the rate of 70 m^3/min. is a typical order of magnitude for the spring output. Then as seen above, the tidally-driven components of the flow are of secondary importance; our picture developed for a period of spring tides would be roughly the same during neap tides as well.

Last, we must briefly mention weather conditions. During the study period the weather was typical for non-Kona conditions--the observed harbor behavior could be greatly modified during times of strong local winds and heavy rain.

Horizontal Circulation within the Harbor.

In the previous section, we considered the overall flows into and out of the two main sections of the harbor. Our concern was with currents in the channels, rates of brackish water input, and vertical exchange between the two water layers. Now we consider additional features of the horizontal flow patterns in each layer in order to provide a more complete picture of how water circulates within the harbor. This picture, in turn, will guide us in deciding how the harbor is mixed internally and in computing flushing rates for various parts of it.

The horizontal circulation is best described by the pictures given in Figures A - D. These figures show the tracks of 100 drogues that were used to trace surface and deep water movements.

The drogue tracks show that there are many irregular, random motions occurring in the harbor. However, a general, overall pattern also appears. During flood tide, deep water enters the harbor and joins two large-scale eddying motions--one in the elbow of the entrance channel and one in the outer berthing basin. There is strong flow through the inner channel, with the water's momentum creating a large clockwise eddy in the back basin. The three eddying motions in the deep water can be seen in Figure A. They have dimensions comparable to the berthing basins, and speeds such that water takes on the order of six hours to make one

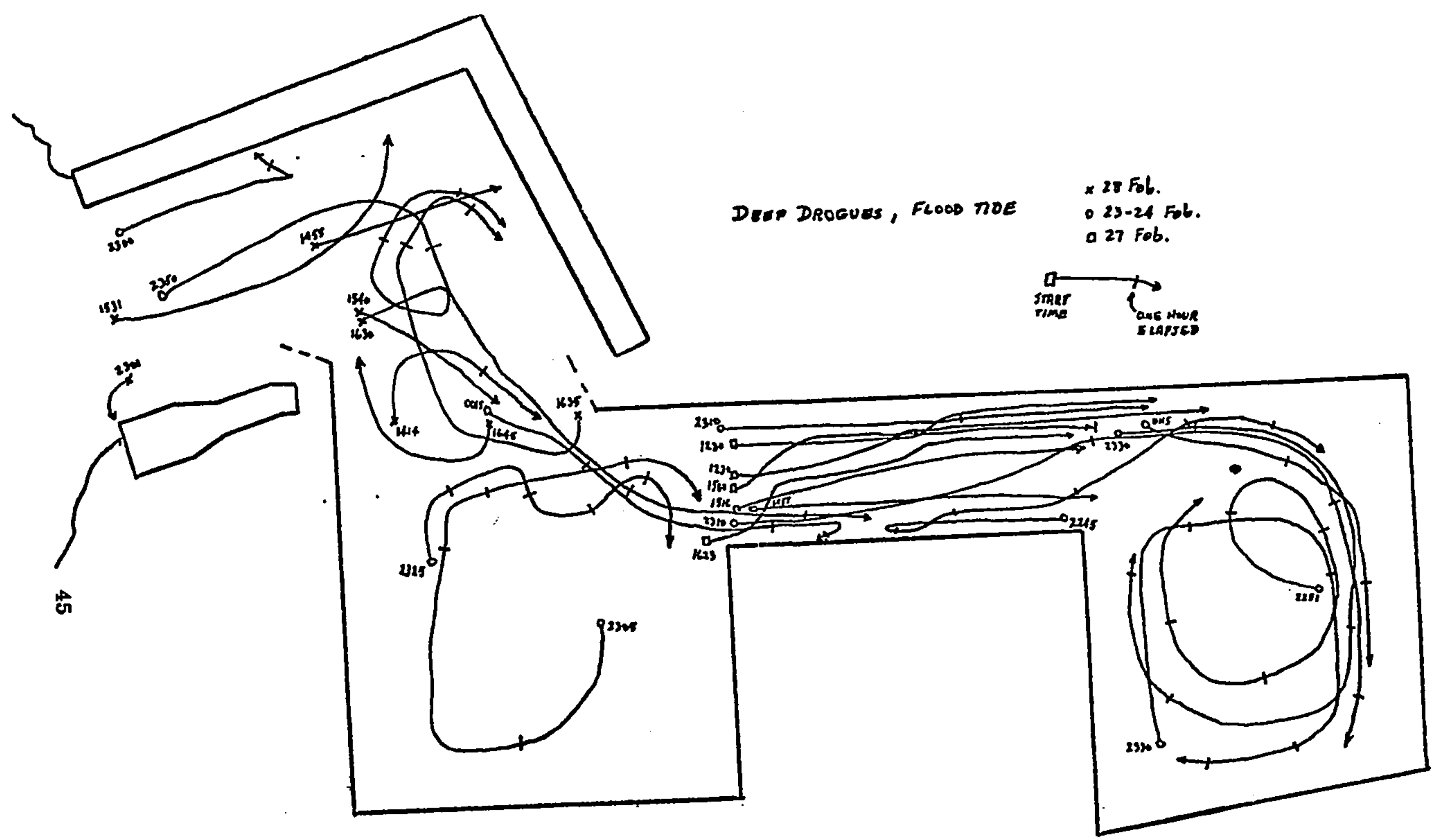


Figure A. Tracks of drogues in the deep layer during flood tide.

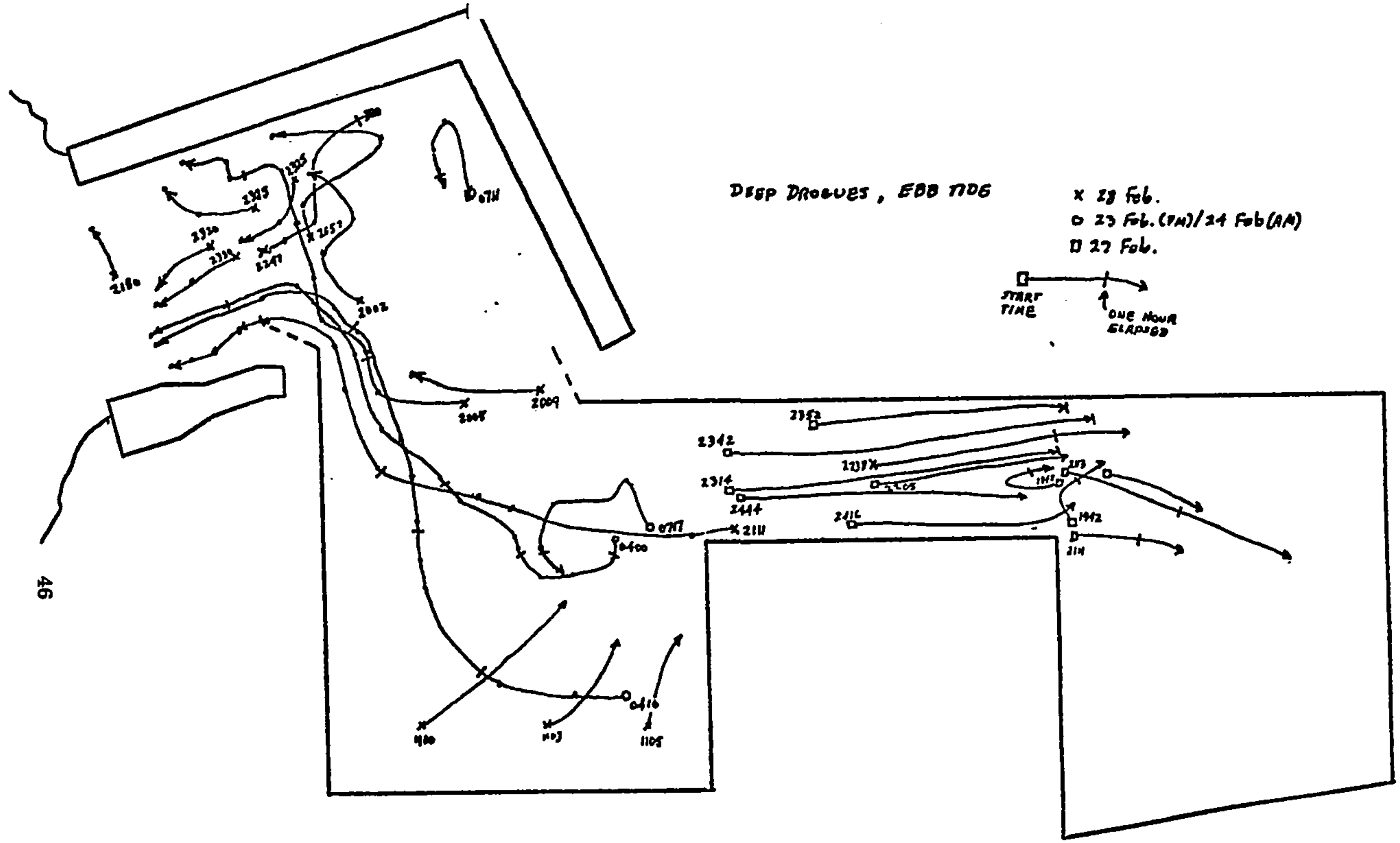


Figure B. Tracks of drogues in the deep layer during ebb tide.

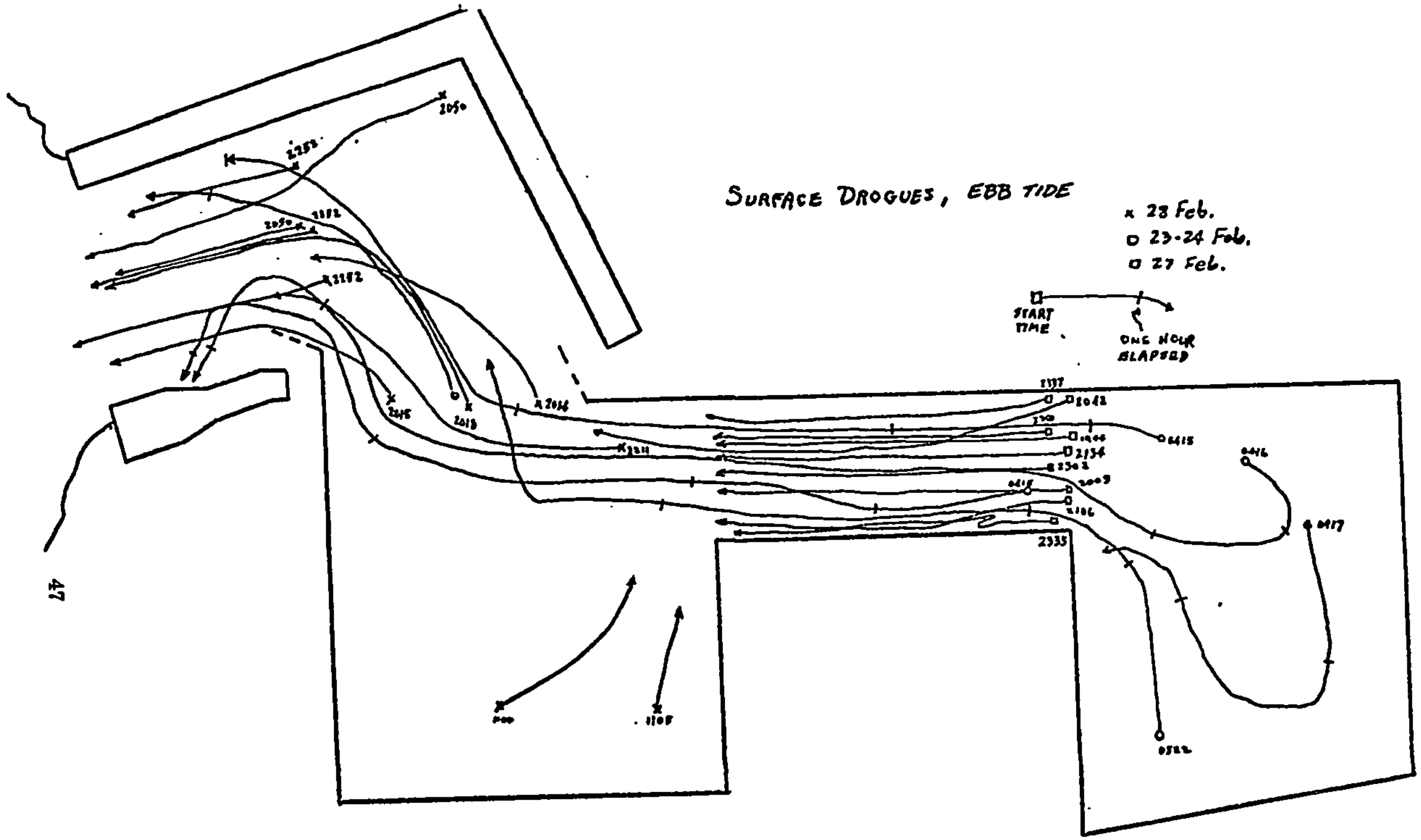


Figure C. Tracks of drogues in the surface layer during ebb tide.

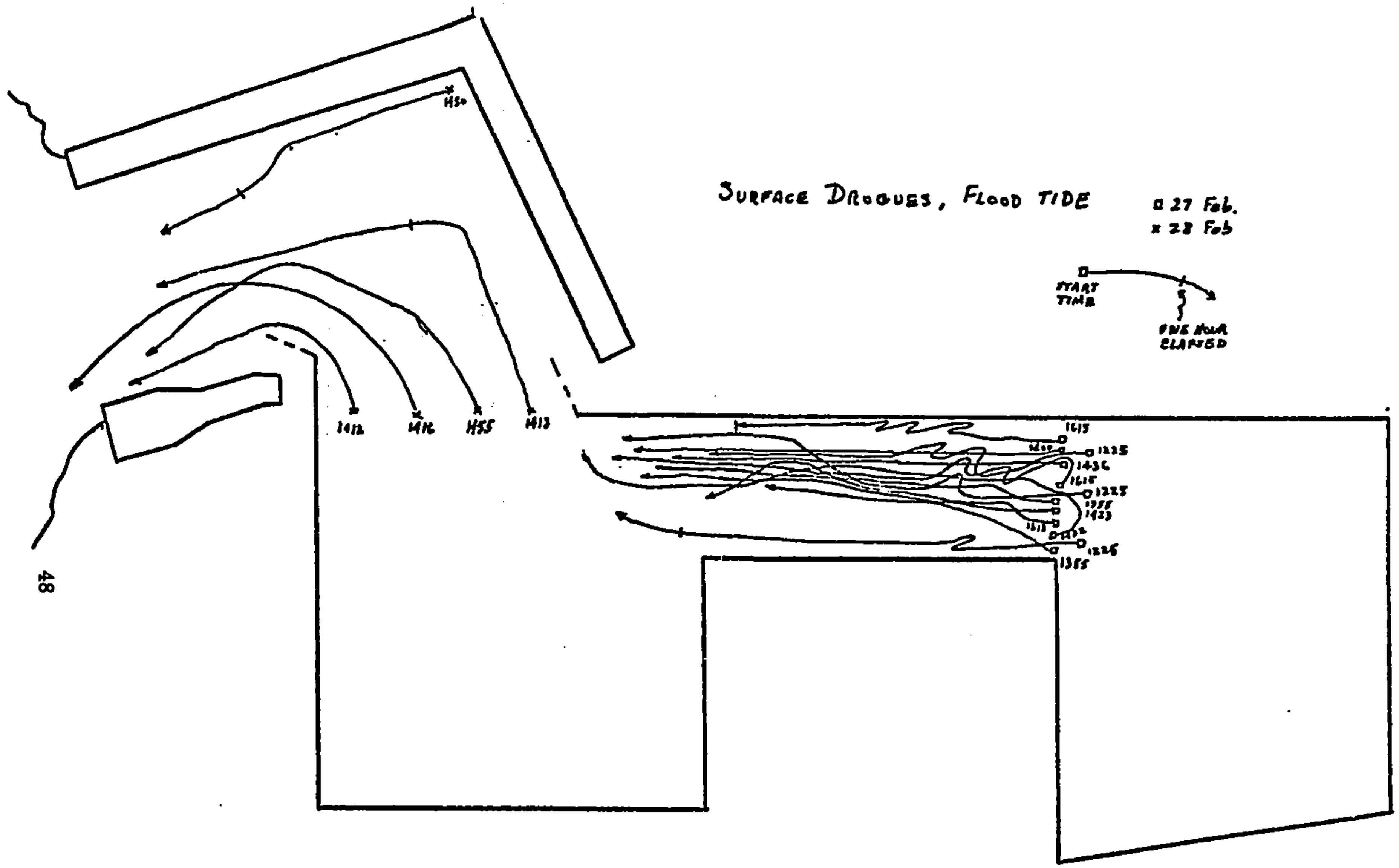


Figure D. Tracks of drogues in the surface layer during flood tide.

cycle. As the tide is falling, the above pattern of deep flow persists in the inner harbor, but the two main eddies in the outer harbor appear to break down into smaller, irregular motions, with a weak net outflow to the ocean (Figure B).

The surface flow pattern is relatively simple. Water persistently streams outward along the main axis of the harbor (Figures C and D). Within the berthing basins it appears that the eddying motions of the deep layer are transmitted to the surface water. No significant change of pattern was observed from flood to ebb tide.

Flushing and Residence Times.

The present harbor is flushed extremely well, and this is due directly to the existence of the strong flow of brackish water from springs in the floor of the back basin. We will shortly present details about residence times, but first we want to strongly emphasize several important things about the role of the brackish springs. This is of paramount importance because the water quality in any expanded version of the harbor will depend critically on whether or not certain interactions between spring inflow and harbor configuration can be maintained. The fortuitous factors about the present harbor are as follows:

1. The brackish springs are located in the innermost (landward) part of the harbor. Because of this, their influence is felt

throughout the entire harbor.

2. The bulk of the brackish inflow is through the basin floor. This maximizes the amount of mixing between the brackish water and water in the lower layer of the harbor; the process produces a larger volume of surface water, a larger surface outflow, and a much larger deep inflow than would occur if the brackish input were near the surface.

3. The brackish spring inflow rate is large (about 70 m^3/min.), so that its effect is large. In the present harbor the net flow through the back basin is about ten times what it would be if it were caused by tidal action alone, and the net exchange for the entire harbor is over six times larger than would be produced by the tides.

4. The plan shape of the present harbor enhances internal circulation. The relatively narrow channel between berthing basins causes an acceleration of flow which helps to produce the circulating eddy patterns within the basins. These eddies circulate water through parts of the harbor that are not directly affected by the spring inputs and help to prevent the development of stagnant areas.

The above factors helped in developing a simple model for predicting residence times in the harbor.

For the estimation of residence times, the harbor was divided into segments, each of which might be reasonable well-mixed internally during a half tidal cycle. Known fluxes between segments (including the time-varying tidal effects) were employed, and the network of interconnected segments was modeled on a computer. Concentrations of dissolved substances are then simulated by stepping the model network through time.

The observed eddy patterns tend to divide the harbor into three main parts, each of which would be fairly well mixed internally: the inner basin, the outer basin, and the entrance channel. (In this scheme, the boundary between the inner and outer basins is at the midpoint of the interconnecting channel; a line which is the extension of the north wall of this channel forms the boundary between the outer basin and the entrance channel.) The upper and lower layers of each section were considered separately, so that a total of six interconnected segments was used in the model (see Figure E). The ebb and flood tide volume fluxes between segments and at the harbor mouth were taken as those presented earlier (Figure), and the fluxes at other times were computed by assuming a semidiurnal sinusoidal variation between ebb and flood values. The single free parameter in the model designated how much of the total vertical exchange in the outer harbor occurs in the outer basin and how much of it occurs in the entrance channel.

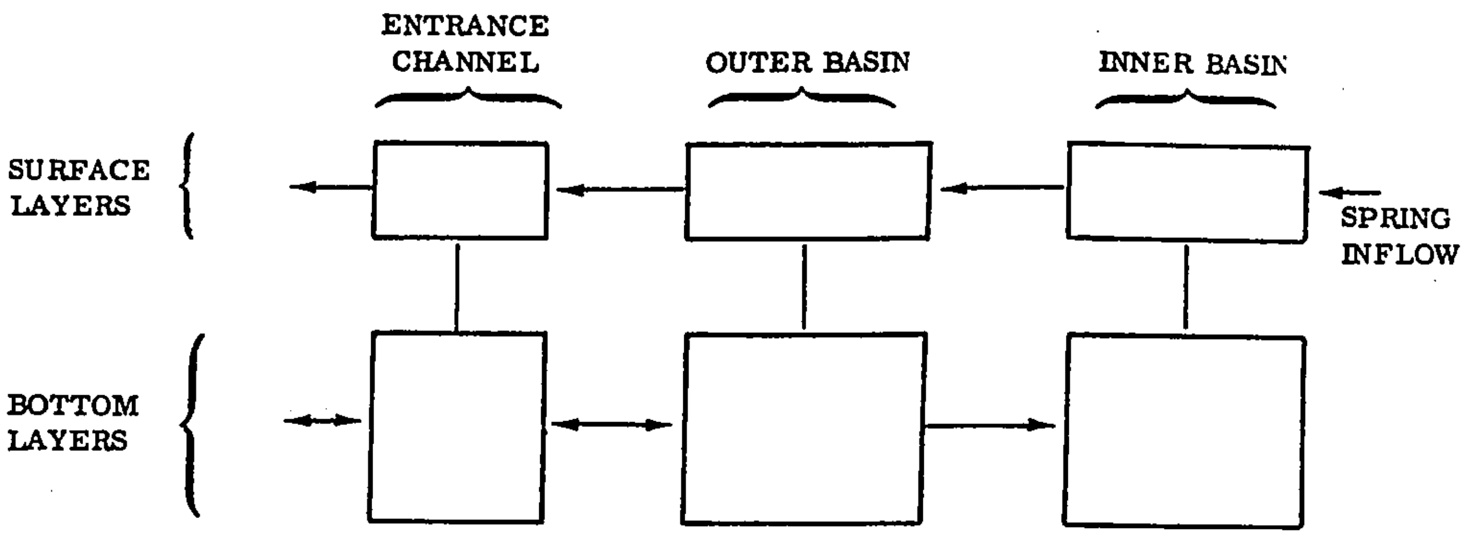


Figure E. Schematic representation of the model used to simulate flushing in the present harbor.

The model was checked by specifying the salinity of the deep inflow at the entrance and that of the brackish spring influx, allowing the model to run through many tidal cycles until a steady, periodic salinity was obtained in all six sections of the model, and then comparing these salinities with observed mean values from the harbor itself. Good agreement was obtained, and it was best when the vertical, interlayer exchange in the outer harbor was assumed to take place entirely within the outer basin (i.e., no vertical fluxes in the entrance channel). This check served as a rough verification of the model, and it fixed the value of the single free parameter mentioned in the previous paragraph.

The model was next used to study the fate of hypothetical spills of pollutant in various parts of the harbor. In each case, it was assumed that a quantity of dissolved or suspended material was introduced by some initial event in one harbor segment, and that it took one tidal cycle to become initially dispersed within that local segment of the harbor. The pollutant was then followed as it dispersed through all harbor segments, and the history of its mean concentration in each segment was computed. In every case, the pollutant was introduced at low tide, since this results in the longest residence times.

Six cases were run, with the initial pollution injected into two layers (surface and bottom) each of the inner basin, of the outer basin, and of the entrance channel. Figure F shows how the concentration behaves in time in each harbor segment. (We point out again our assumption that the substance took 12 hours to become dispersed throughout the deep layer of the outer basin before any of it began to move into other harbor segments.)

It is seen that the concentration dies exponentially in the deep outer basin; the material subsequently enters other harbor areas and then again decays exponentially. The surface layers of the outer basin and entrance channel display two concentration peaks, corresponding to the direct introduction of material by vertical transport within the outer basin and a later introduction of material that has first circulated through the inner basin. Concentration in the deep inner basin reaches about 40% of the initially dispersed value in the deep outer basin. The surface layers all reach about 25% of this level, while the deep layer of the entrance channel experiences only about 1%. The results of this example are given in Table A.

With the above model we have also estimated residence times for each harbor segment--the average period that a molecule or small particle of pollutant will spend in the harbor segment where it is originally introduced. The flows through the present harbor are so large that the greatest part of the residence time in any location is the time required for the initial dis-

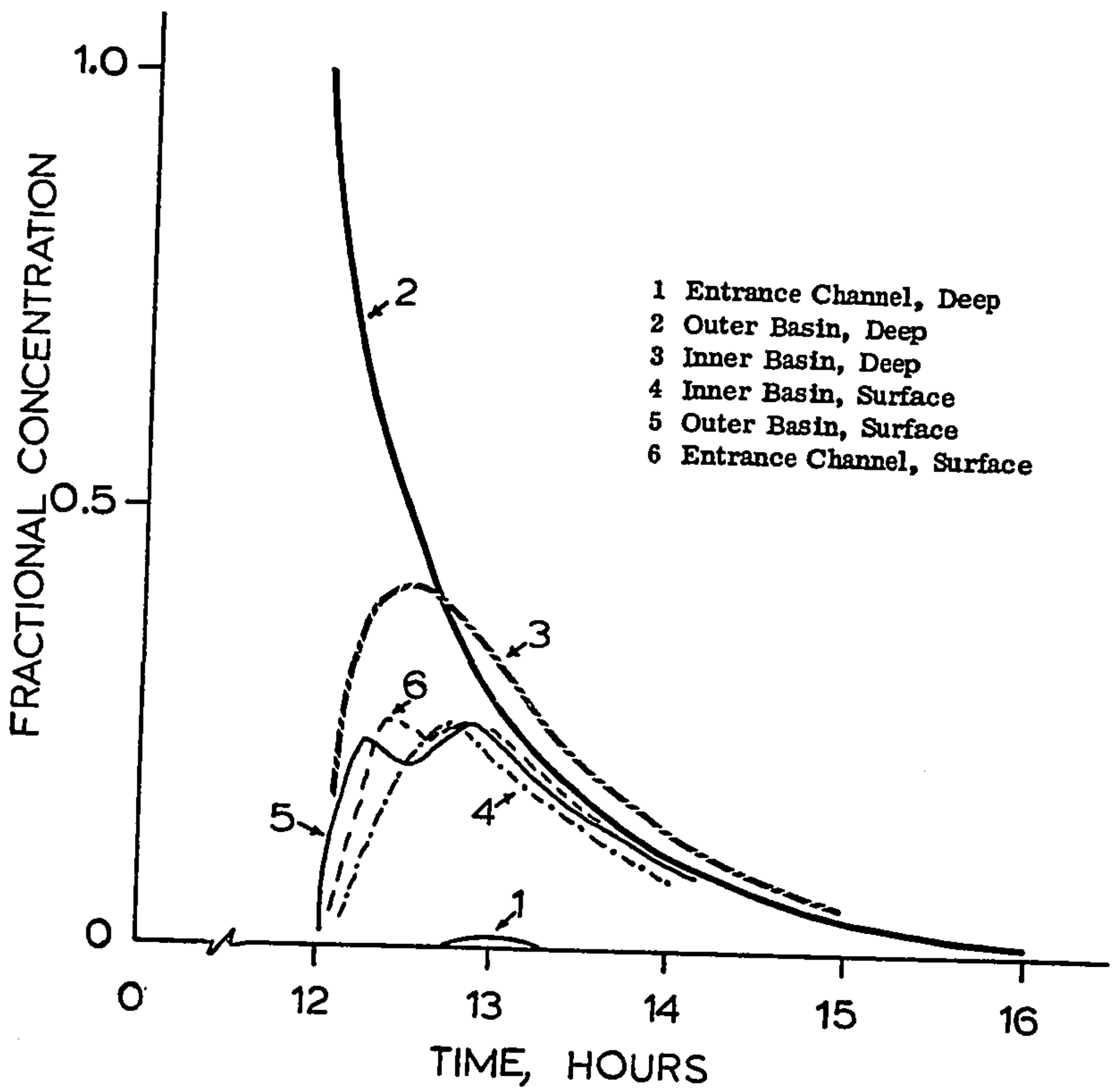


Figure F. Time history of pollutant concentration in each segment of the present harbor. In this example a spot spill of pollutant was introduced and given 12 hours to disperse locally within the deep layer of the outer harbor. It then began to enter large scale exchange processes, entering and moving through other harbor segments.

	Entrance Channel Surface Layer	Entrance Channel Deep Layer	Outer Basin Surface Layer	Outer Basin Deep Layer	Inner Basin Surface Layer	Inner Basin Deep Layer
Time to reach peak concentration, after introduction of pollutant at low tide in lower layer of outer basin.	12.4 hr.	12.9 hr.	12.9 hr.	12.0 hr.	12.8 hr.	12.5 hr.
Relative concentration of peak in above example.	26%	1%	26%	100%	26%	43%
Mean residence time of a pollutant introduced in the indicated harbor segment, assuming 12 hours are required for initial dispersion within the segment.	12.09 hr.	12.29 hr.	12.11 hr.	12.54 hr.	12.13 hr.	12.38 hr.

Table. Residence times of various harbor segments and time course results of a hypothetical pollutant spill.

persion of the pollutant within the harbor segment where it is introduced (estimated from the drogue studies to be about 12 hours on the average). Once the material has dispersed locally and begins to be transported by the larger scale flows through the harbor, it is flushed out quite rapidly; once this flushing begins to take effect the mean concentration drops to half its original value in less than an hour in all harbor segments. The estimated residence times are given in Table A for various parts of the harbor. If the entire harbor is treated as a single system, it has a mean residence time of 12.45 hours.

Sediment Loads.

A contour map describing sediment thickness within Honokohau Harbor is shown in Figure 20. For the most part, the sediment depth ranges from 1 - 25 cm, but isolated areas as thick as 70 cm also exist. The floor of both the entrance and the interconnecting channels showed a very thin sediment cover ($\leq$ 5 cm). On the floor of the mauka berthing basin rocky outcroppings predominate. Isolated sediment pockets, about 10 cm deep, exist between the rocks but these pockets constitute less than 10% of the center area. There is slightly more sediment along the northern wall of the mauka basin than exists along the other walls and this may be related to the increased amounts of groundwater entering in this area. Sediment thickness in the deeper makai basin was similar to that in the mauka basin with the exception of generally higher values in the southerly

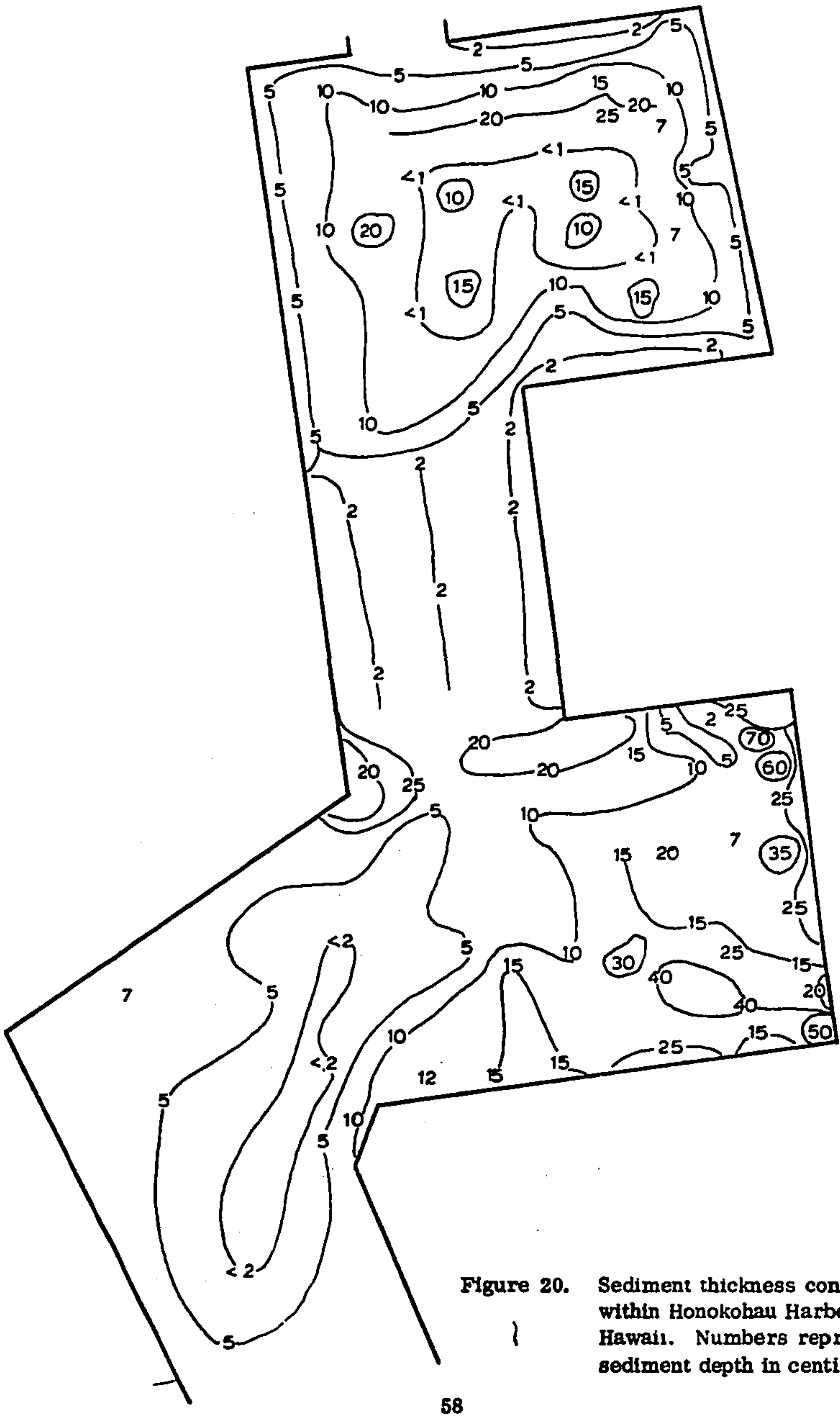


Figure 20. Sediment thickness contours within Honokohau Harbor, Hawaii. Numbers represent sediment depth in centimeters.

end. Since no comparable data is available it is not possible to determine how much of this sediment was present initially in order to calculate annual rates of sedimentation. Sediments are black pumice throughout the entire harbor and appeared to be residues of ground lava rock, possibly the result of blasting activities which created the harbor.

The percent organic matter contained within the harbor sediments ranged from 0.79% to 2.81% and values showed no distributional trends (Table 1 and Figure 22). Diver observations revealed a layer of brownish-grey flocculate material resting about the substrate along the south walls of both berthing basins, but as the figures show, this did not seem to drastically affect the percent organic matter figures.

The particle size analysis of the sediment samples was accomplished by dry sieve analysis with U.S. standard mesh sieves #5, 10, 18, 35, 60, 120, 230, and 325 which correspond to a grain diameter size of 4, 2, 1, 0.5, 0.25, 0.125, 0.063, and 0.044 mm respectively. According to the Wentworth classification, these diameter sizes define the particles as pebble, granule, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, and coarse silt, respectively. An analysis was conducted for particle size distribution according to Inman (1952). By this procedure, the mm grain size values are converted to phi units where $\phi = \log_2$ (diameter in mm). For the analysis done here, the above mm values

Table 1. Organic content of sediments at selected locations within Honokohau Harbor, Hawaii. Values given as percent. The locations of sediment collections are given in Figure 21.

SEDIMENT LOCATION	ORGANIC MATTER (%)	SEDIMENT LOCATION	ORGANIC MATTER (%)
1	2.14	11	1.01
2	1.01	12	1.20
3	2.10	14	1.08
4	1.09	16	1.44
5	0.97	17	0.90
6	0.86	20	1.15
8	1.04	21	1.73
9	2.81	25	1.01
10	0.79	26	1.36
10a	1.12	28	1.41
9a	1.60		

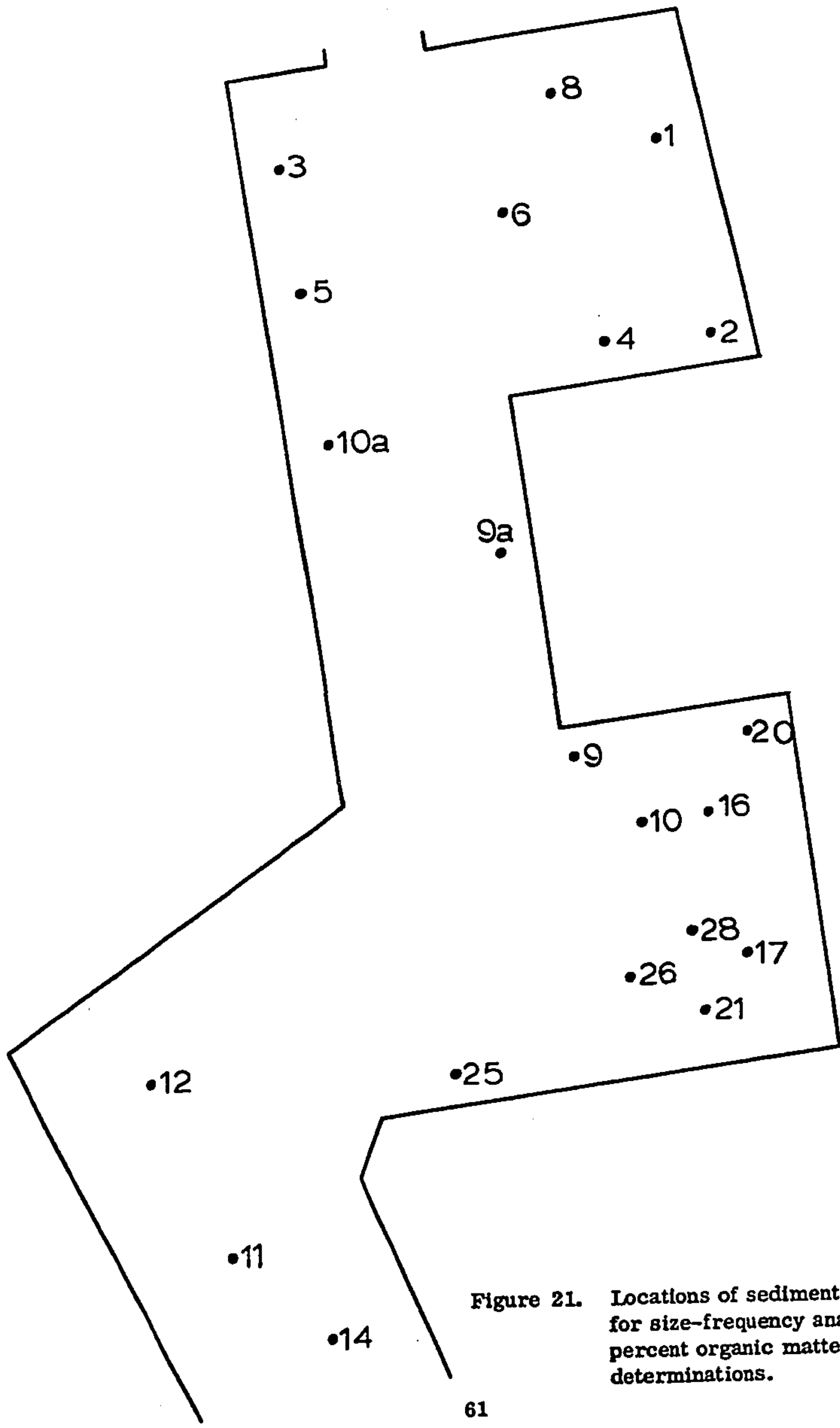


Figure 21. Locations of sediment samples for size-frequency analysis and percent organic matter determinations.

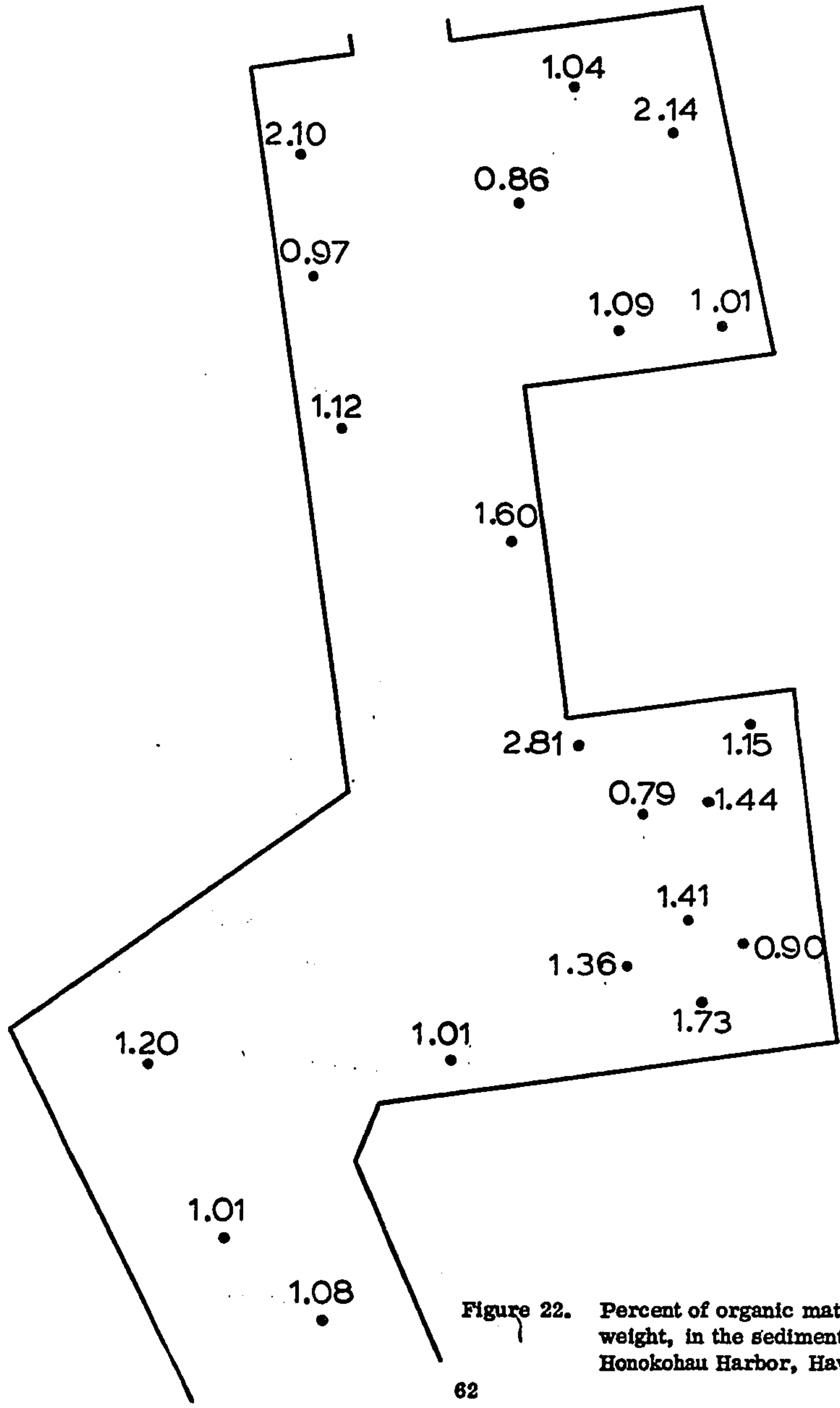
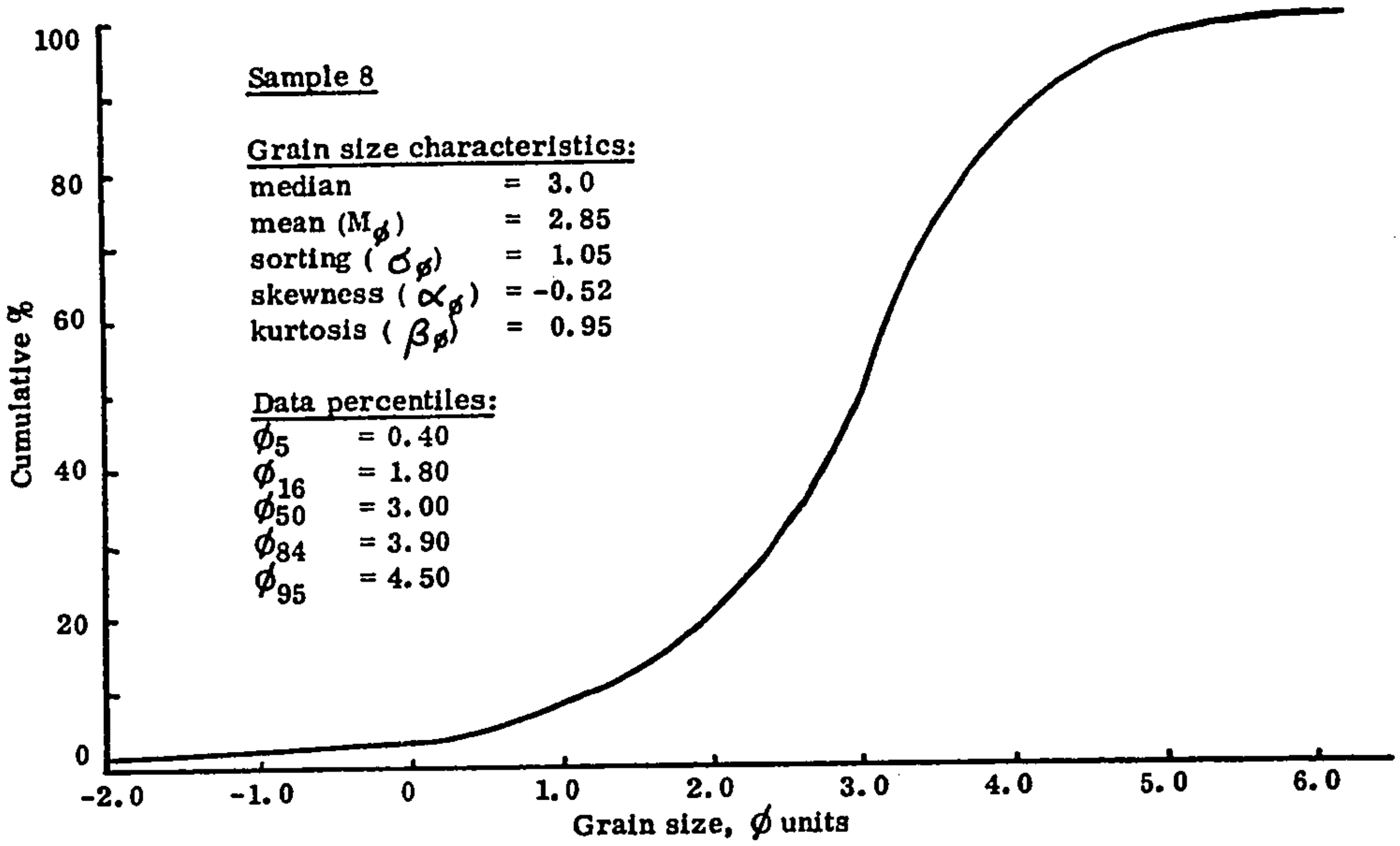


Figure 22. Percent of organic matter, by weight, in the sediments at Honokohau Harbor, Hawaii.

correspond to a grade scale of -2 to +4.5 phi units at 1 phi-size interval to +4 and 0.5 phi-size interval from +4 to +4.5. The cumulative size frequency curves in phi units of the samples were then plotted on probability paper to derive the Inman parameters of phi-median, phi-mean, phi-deviation (σ_ϕ: a measure of sorting), phi-skewness (α_ϕ), and phi-kurtosis (β_ϕ). Figure 23 (pages 50 to 60) presents the cumulative percent size distribution in phi units of the samples with the phi parameters as they were derived from the probability plots. Table 2 gives the pertinent results of the particle size analysis with the samples ordered by sampling location rather than number.

Table 2 reveals that most samples were composed of fine sand, very fine sand and silt. Exceptions are sample 6, collected from the center of the mauka basin, sample 10, collected from the center of the makai basin, and sample 11, collected in the outer channel. Samples 6 and 10 contained a fair amount of medium and coarser particles, while sample 11 was composed for almost 99% of medium to coarser sand.

The ordering of the samples by sampling location did not reveal any pattern so a reordering was attempted based on the shape of the cumulative frequency curve and the percentage of the sample that fell into the following particle size categories: 1) granule, pebble and coarser ($\phi \leq -1$), 2) very coarse and coarse sand ($-1 < \phi \leq +1$), 3) medium sand ($+1 < \phi \leq +2$),



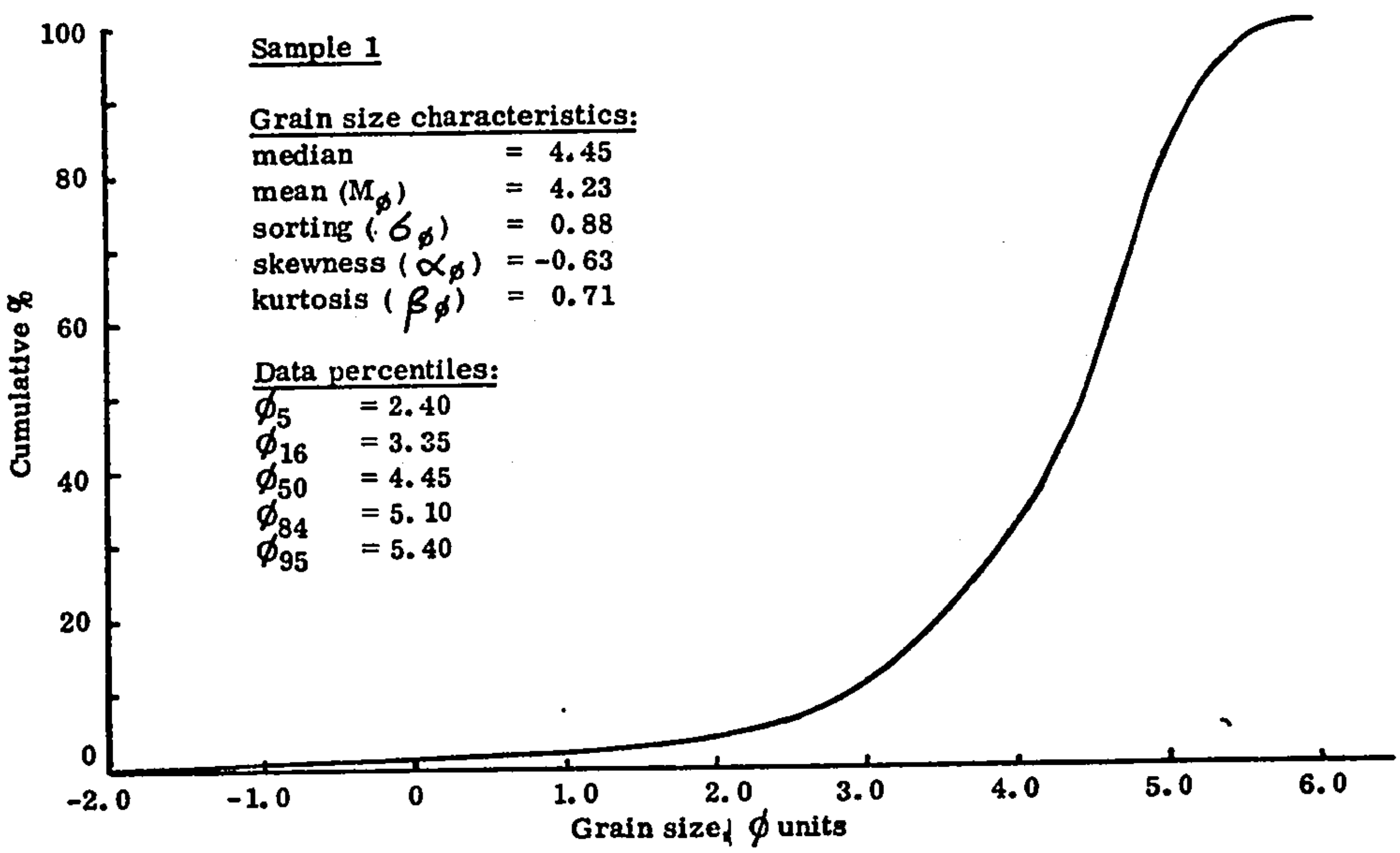
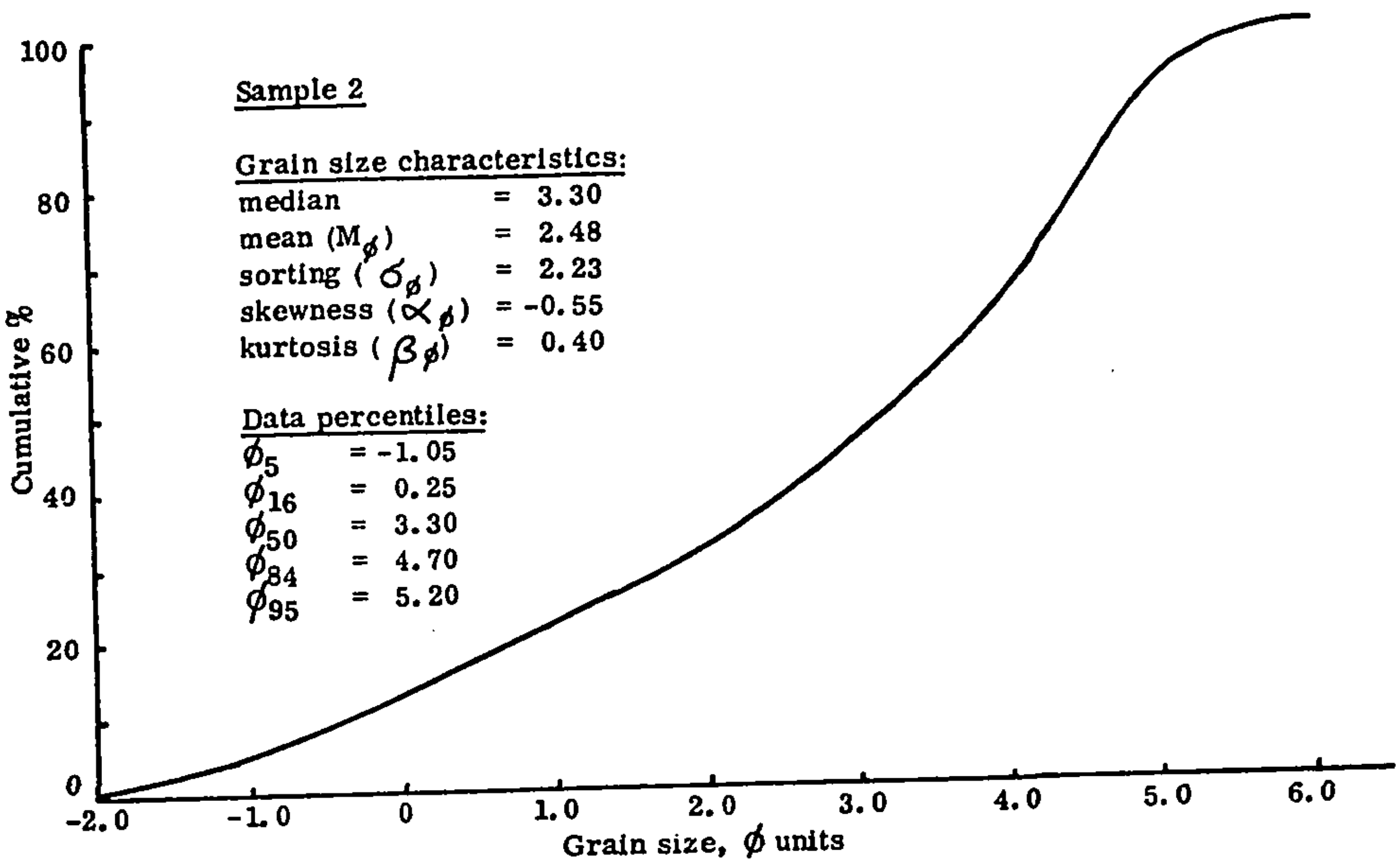


Figure 23. Cumulative percent size distribution in phi-units of sand samples collected in Honokohau Harbor, February 1975.



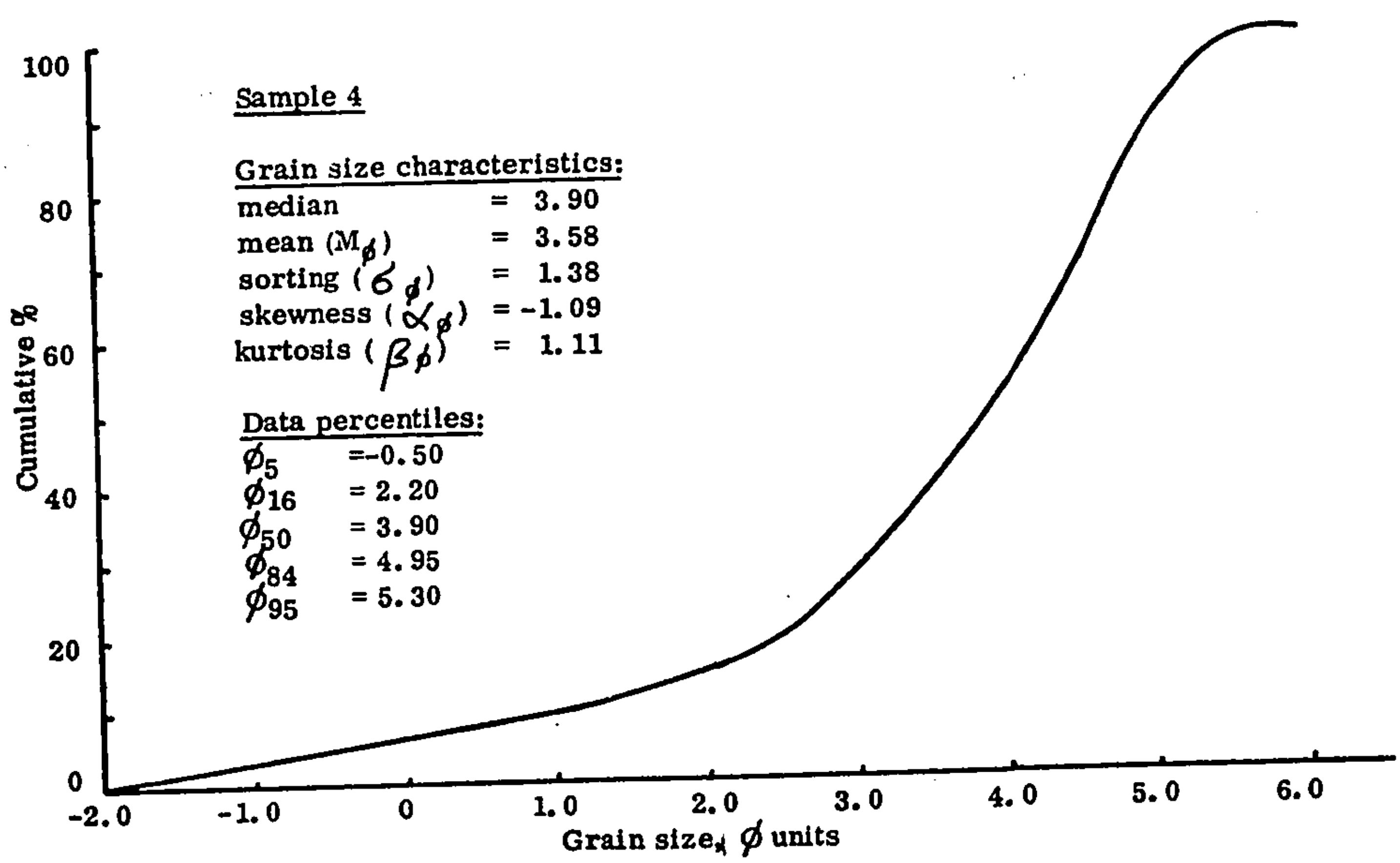
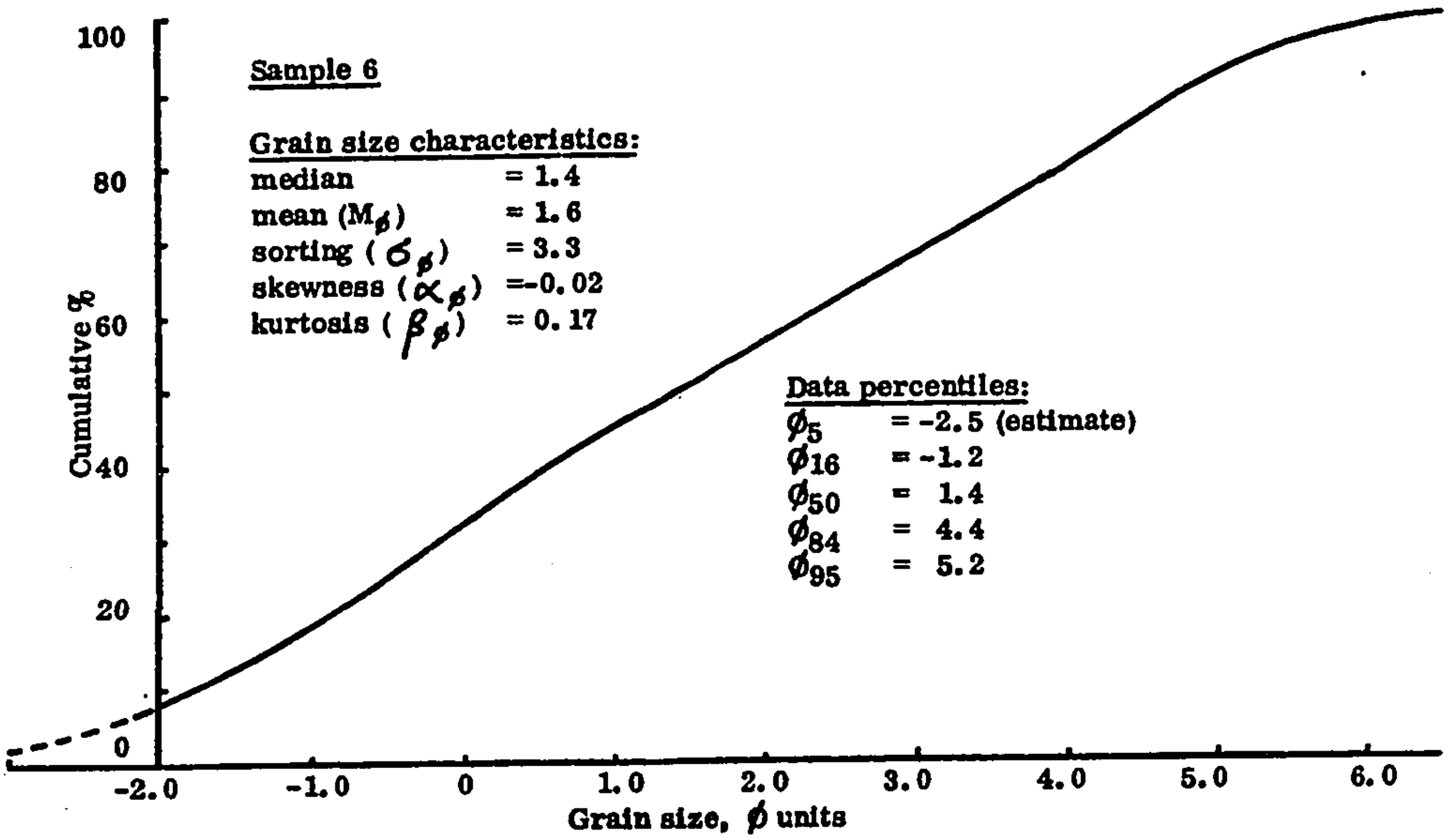


Figure 23 (ctd.)



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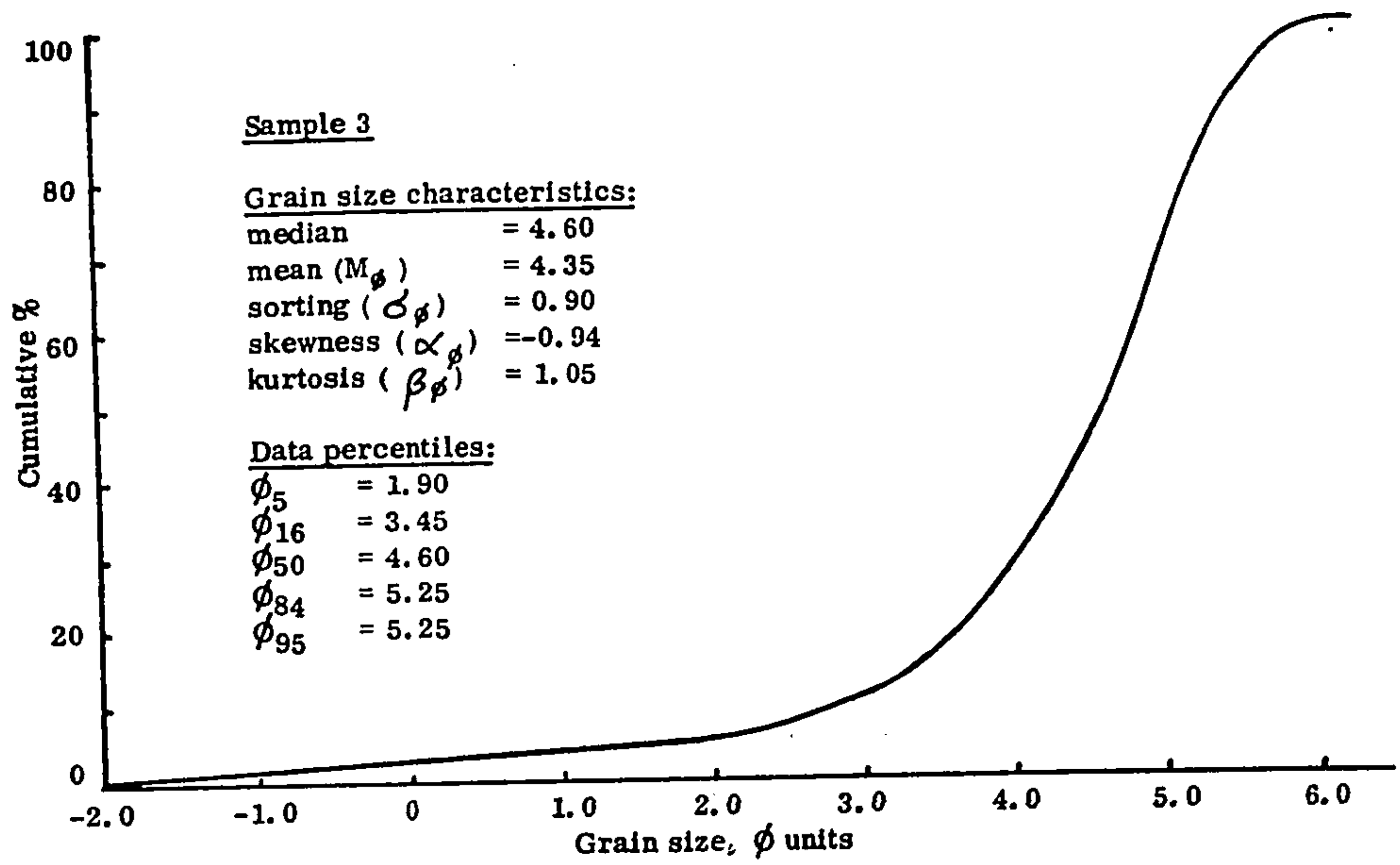

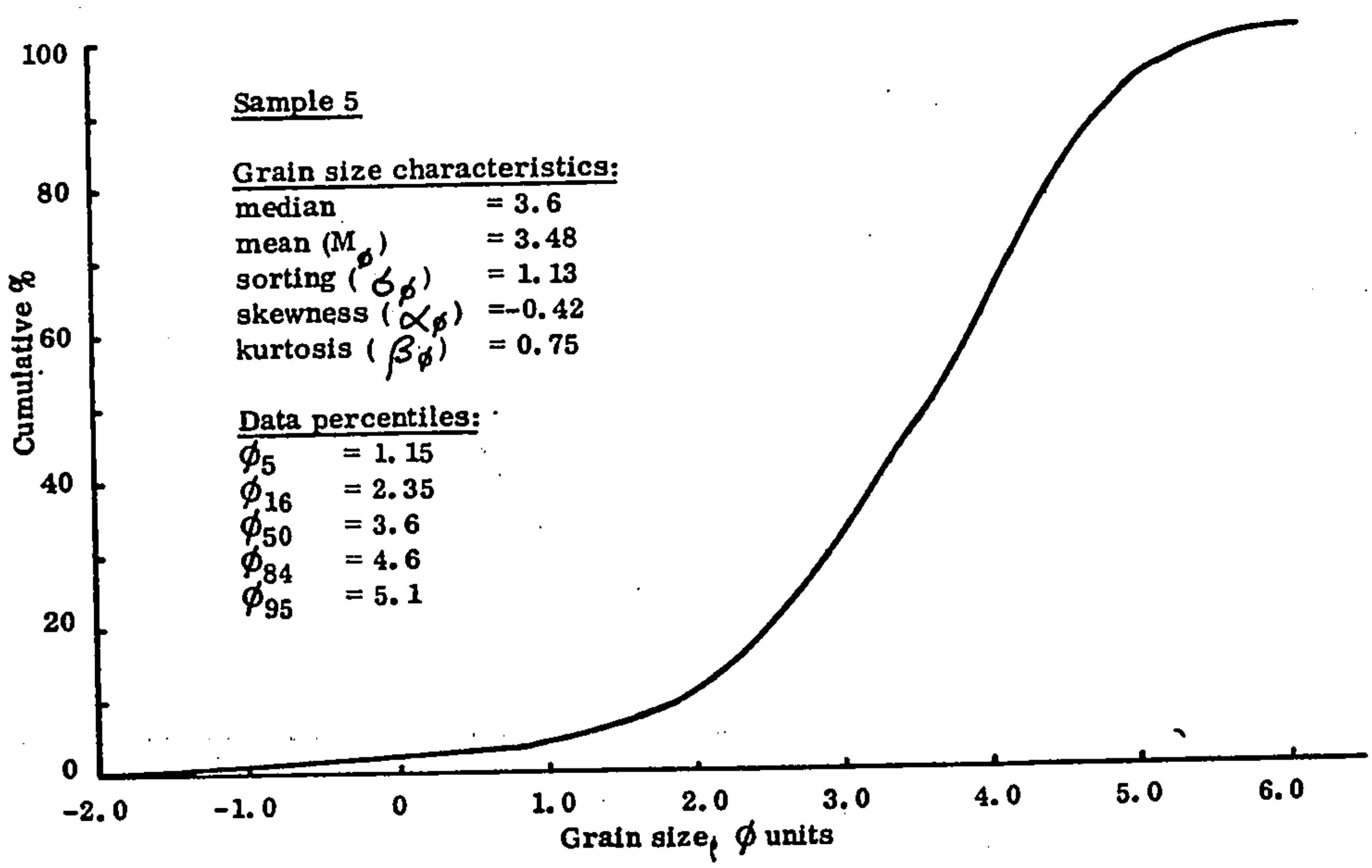

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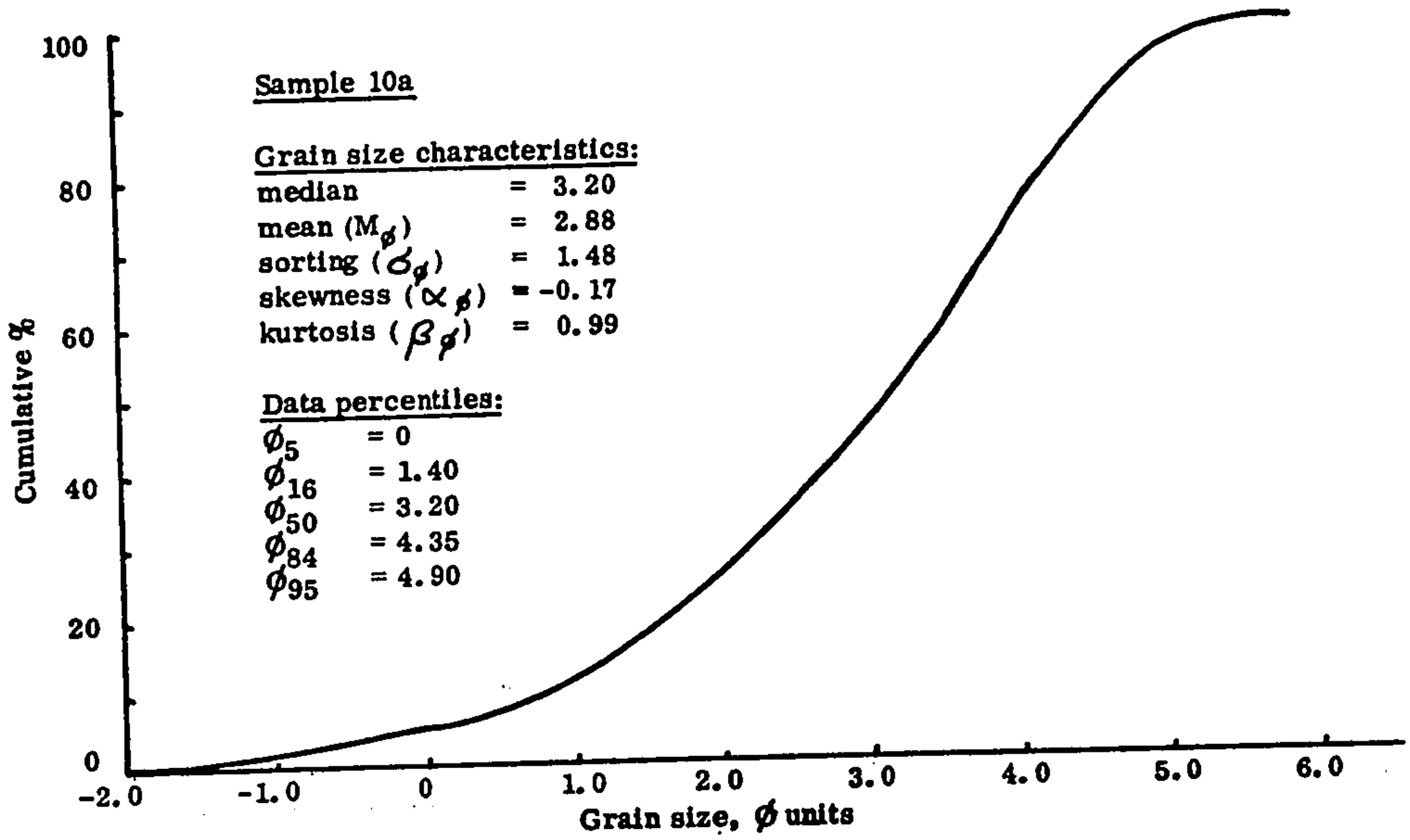

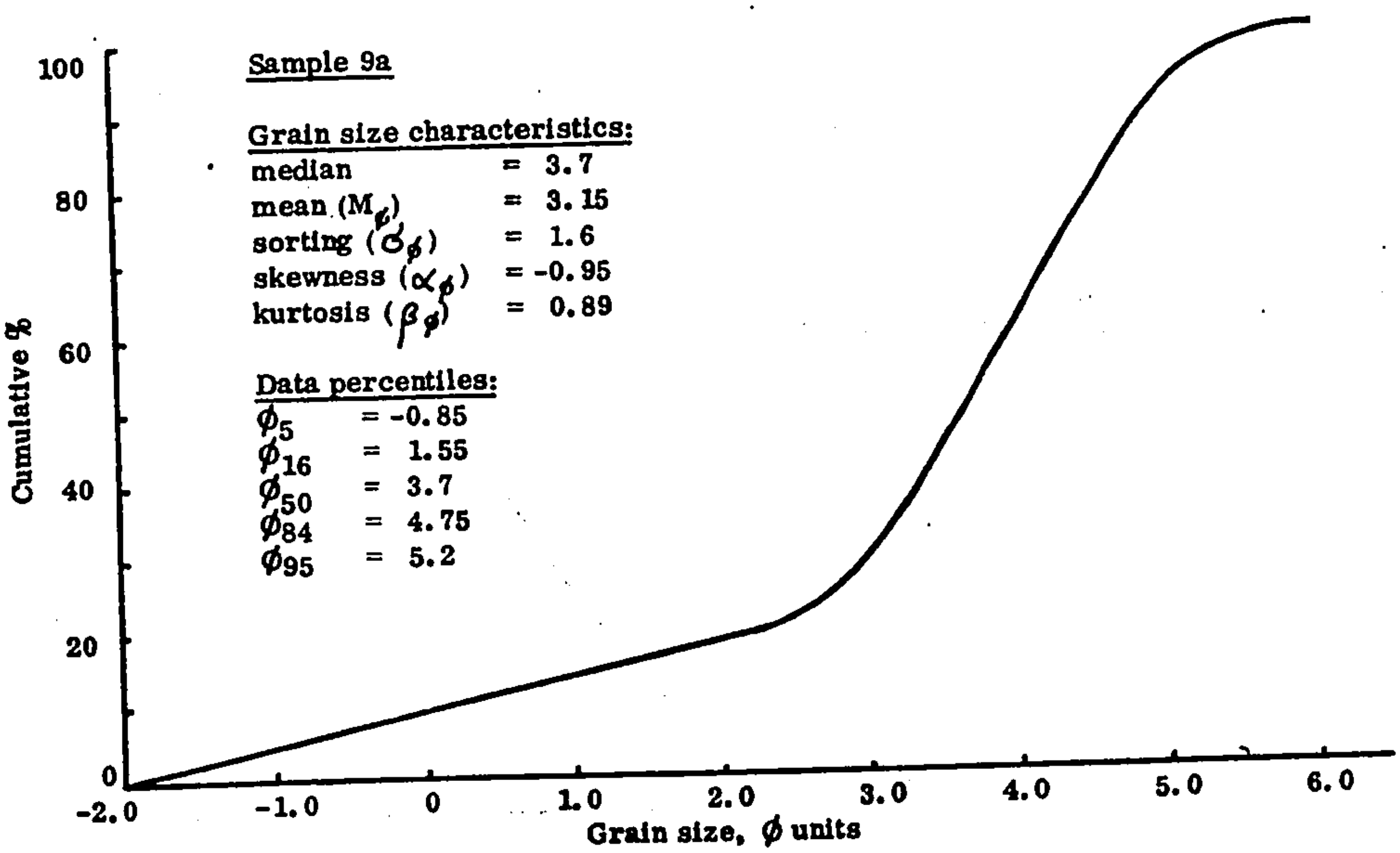

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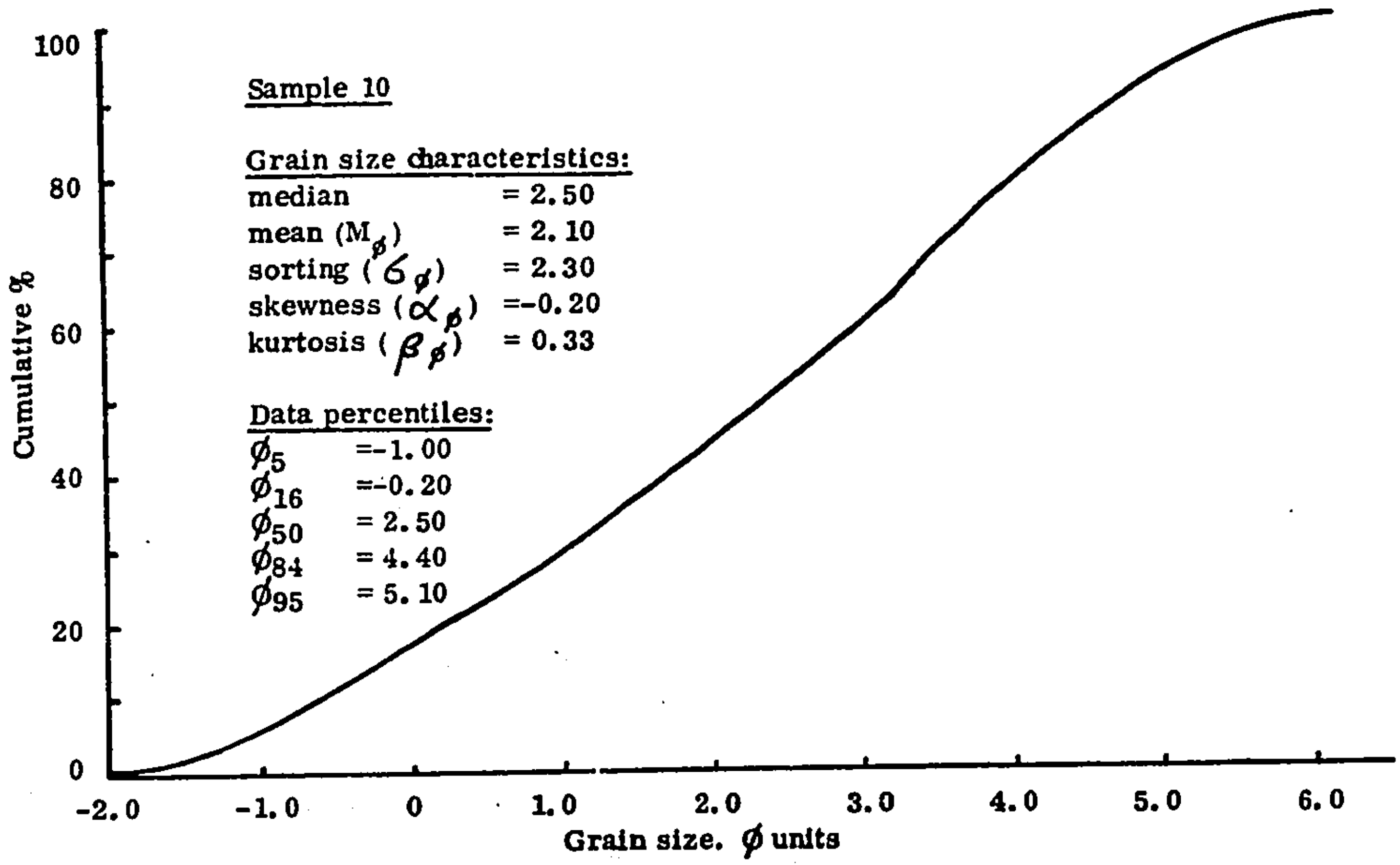

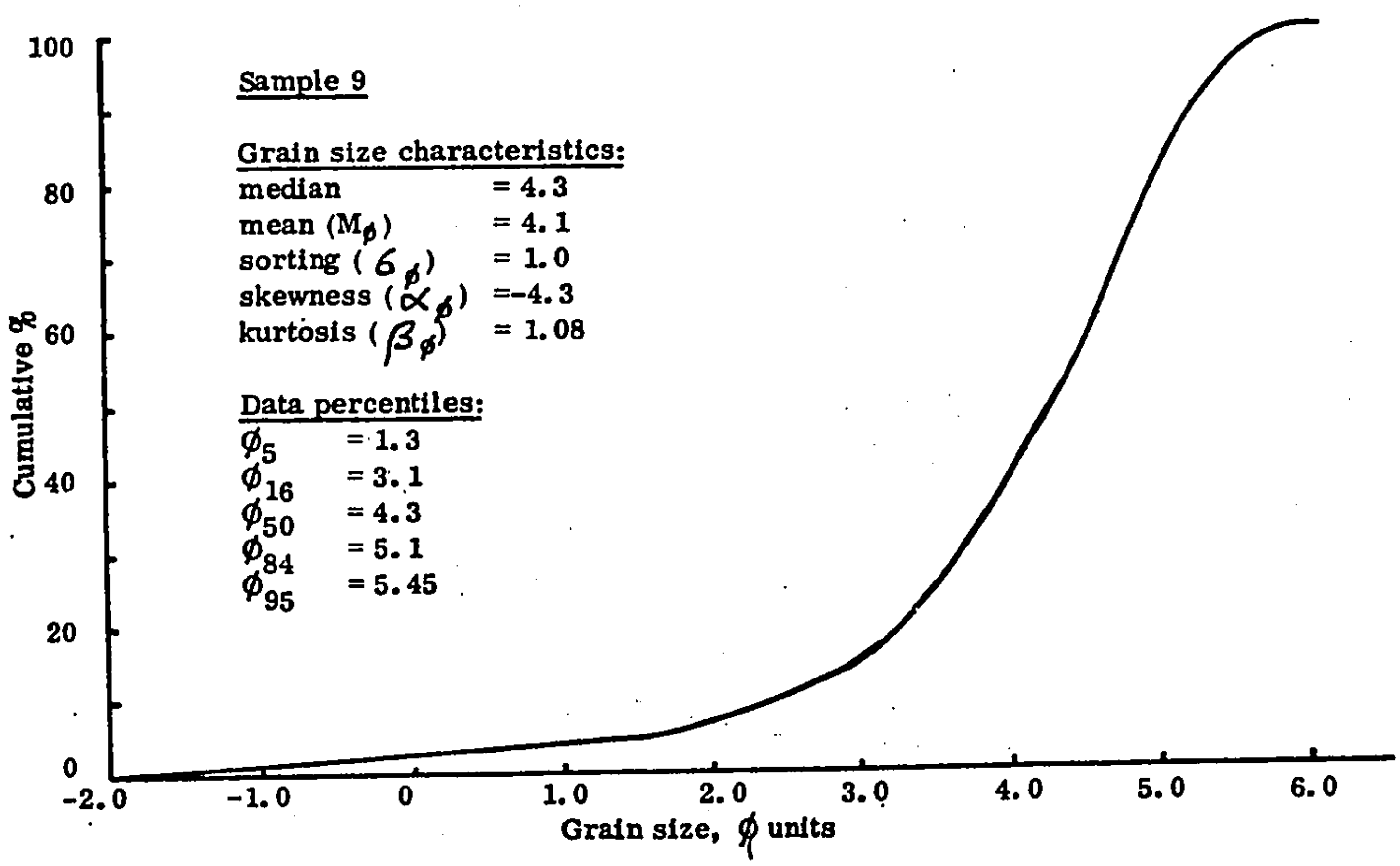

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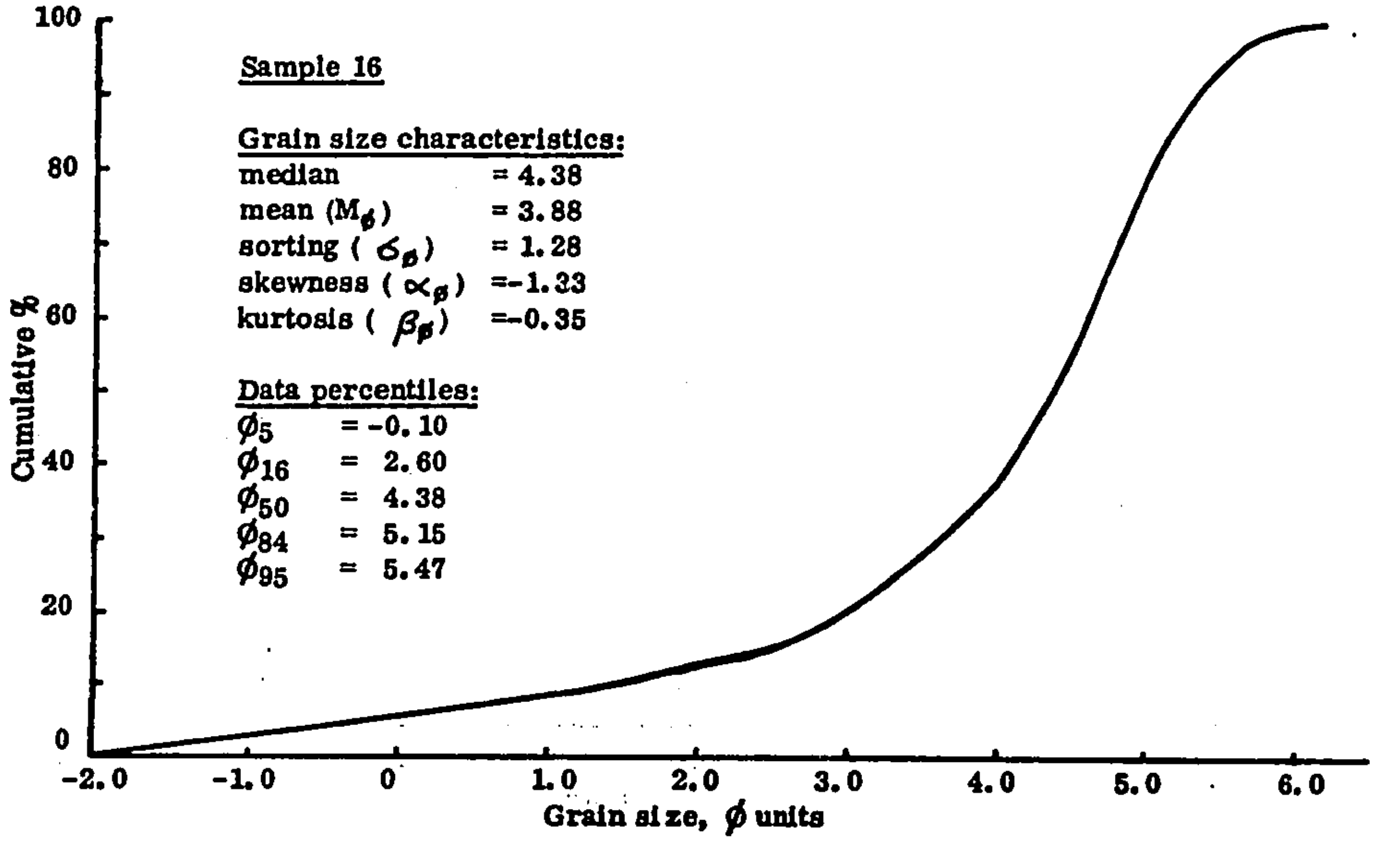

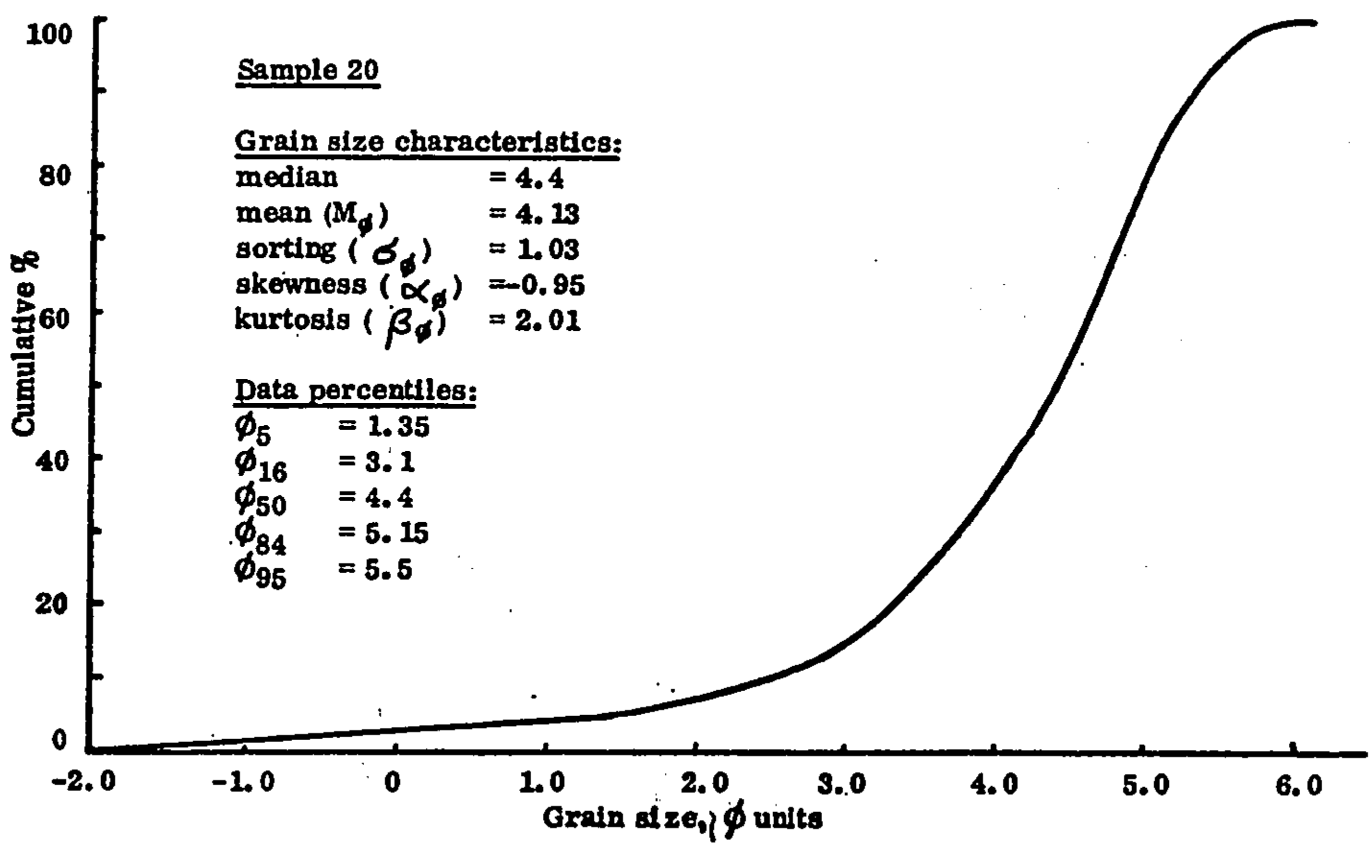

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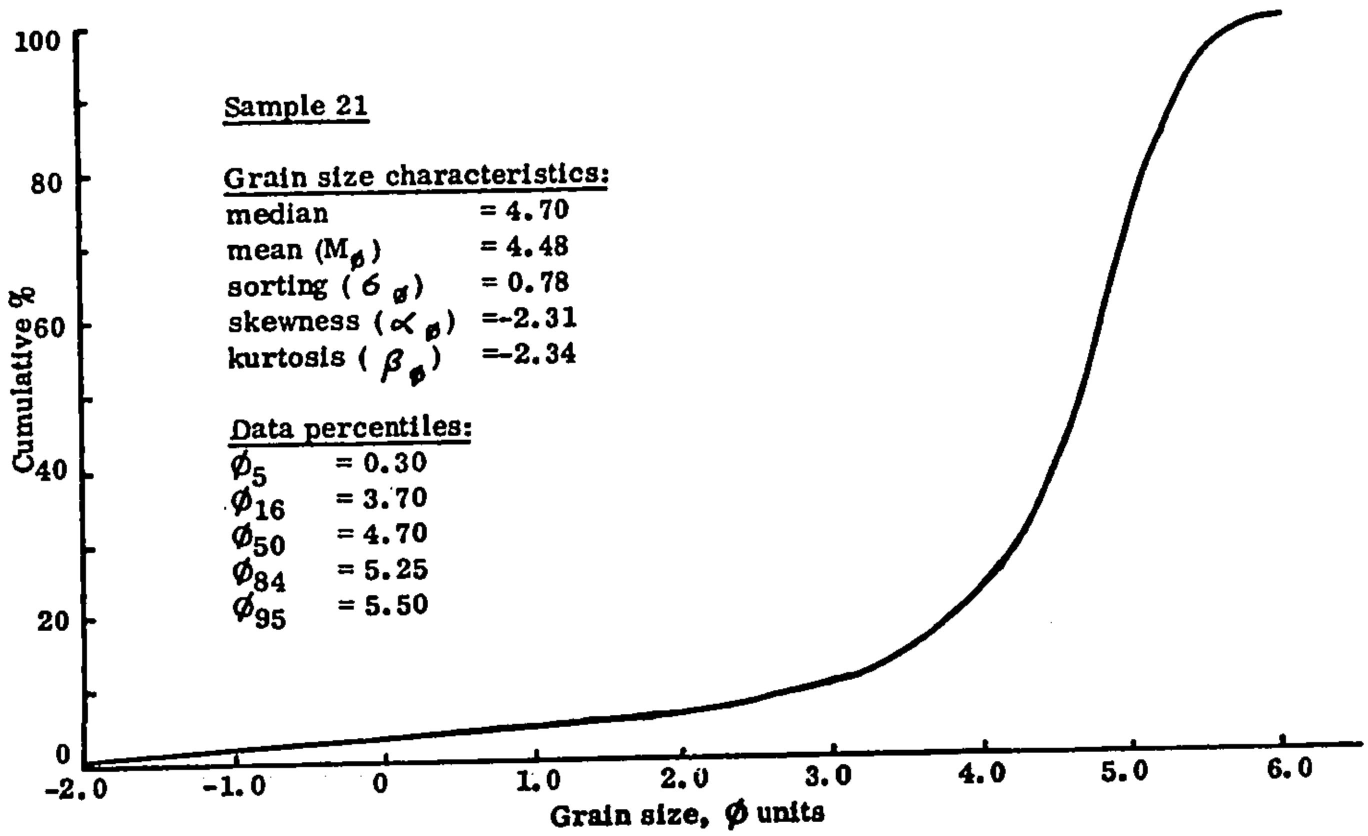

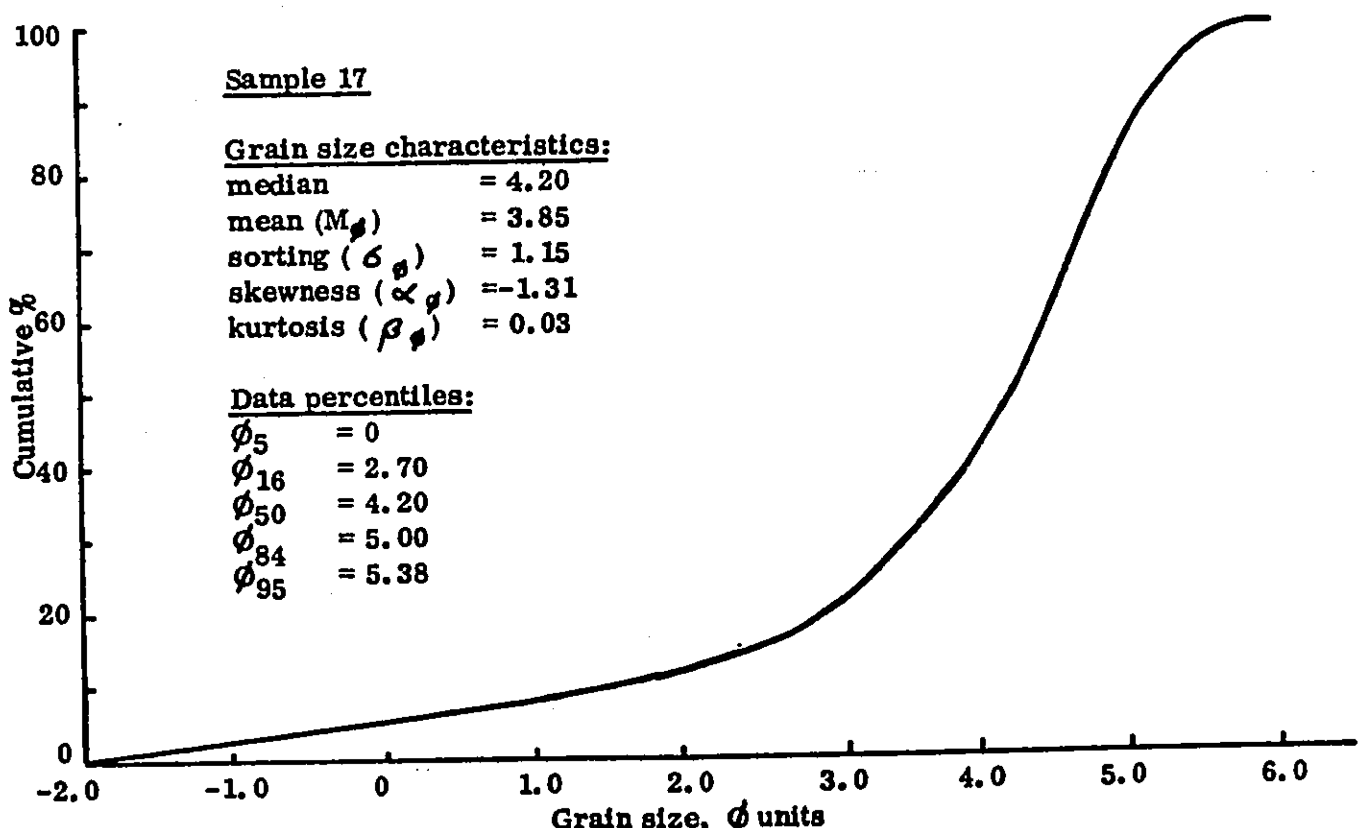

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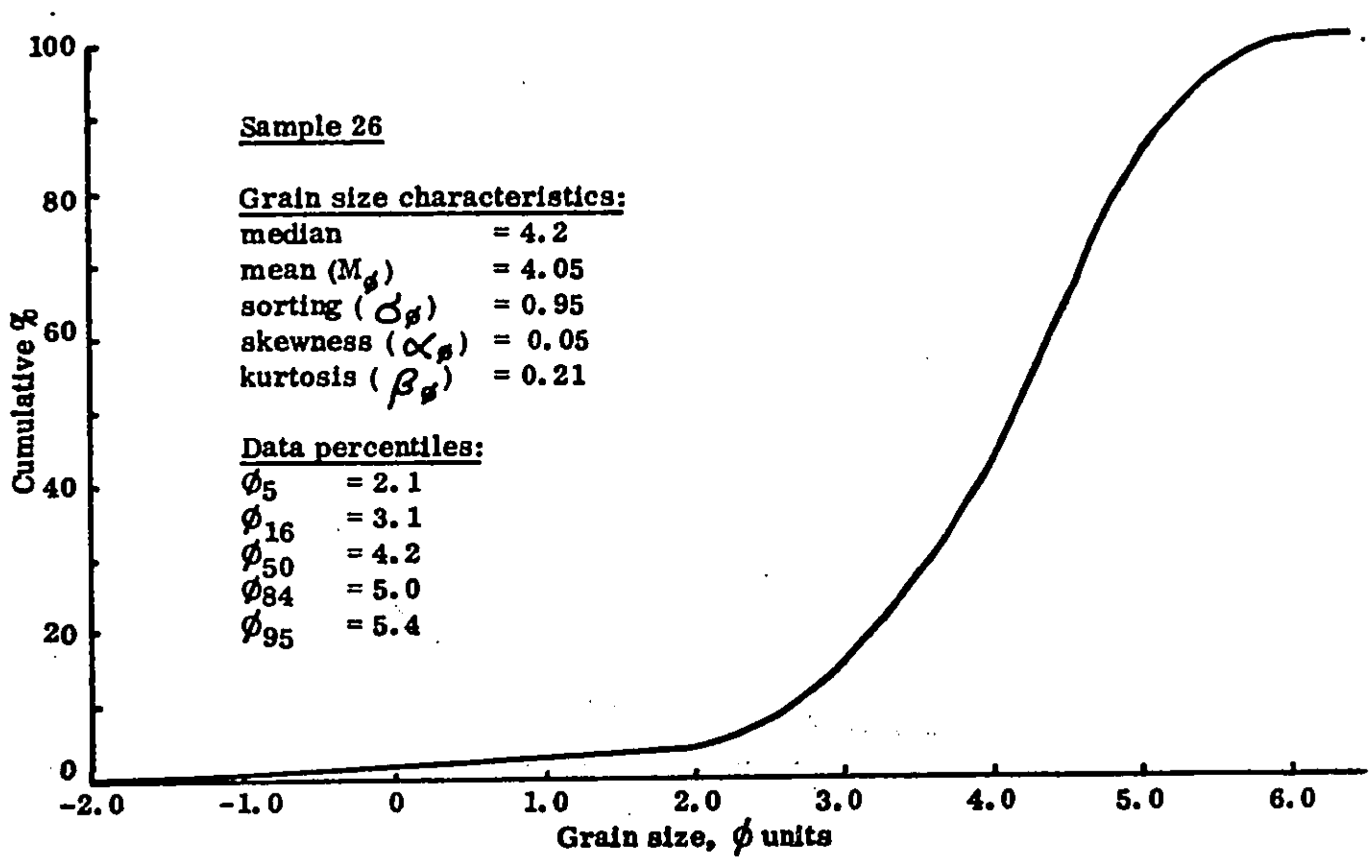

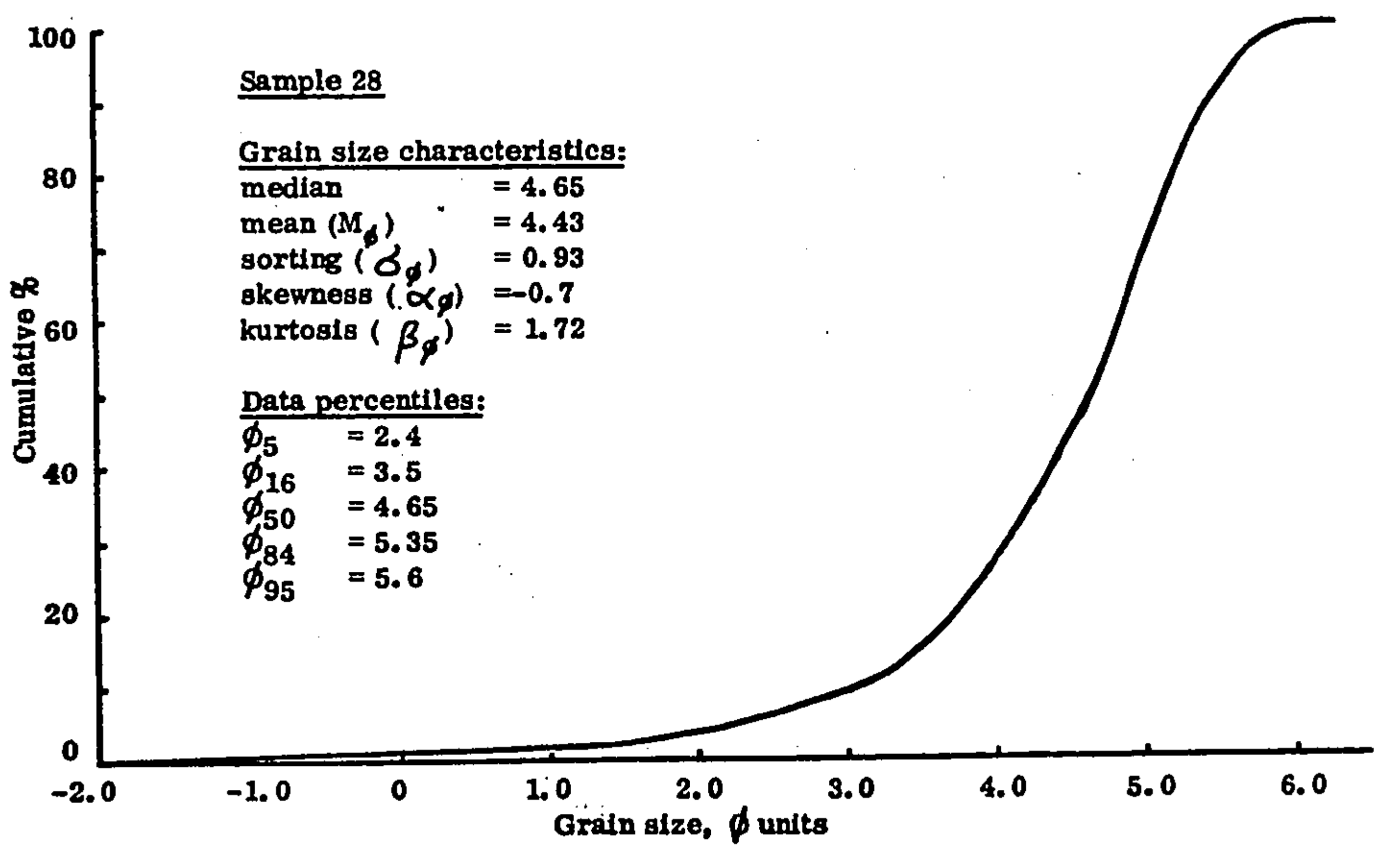

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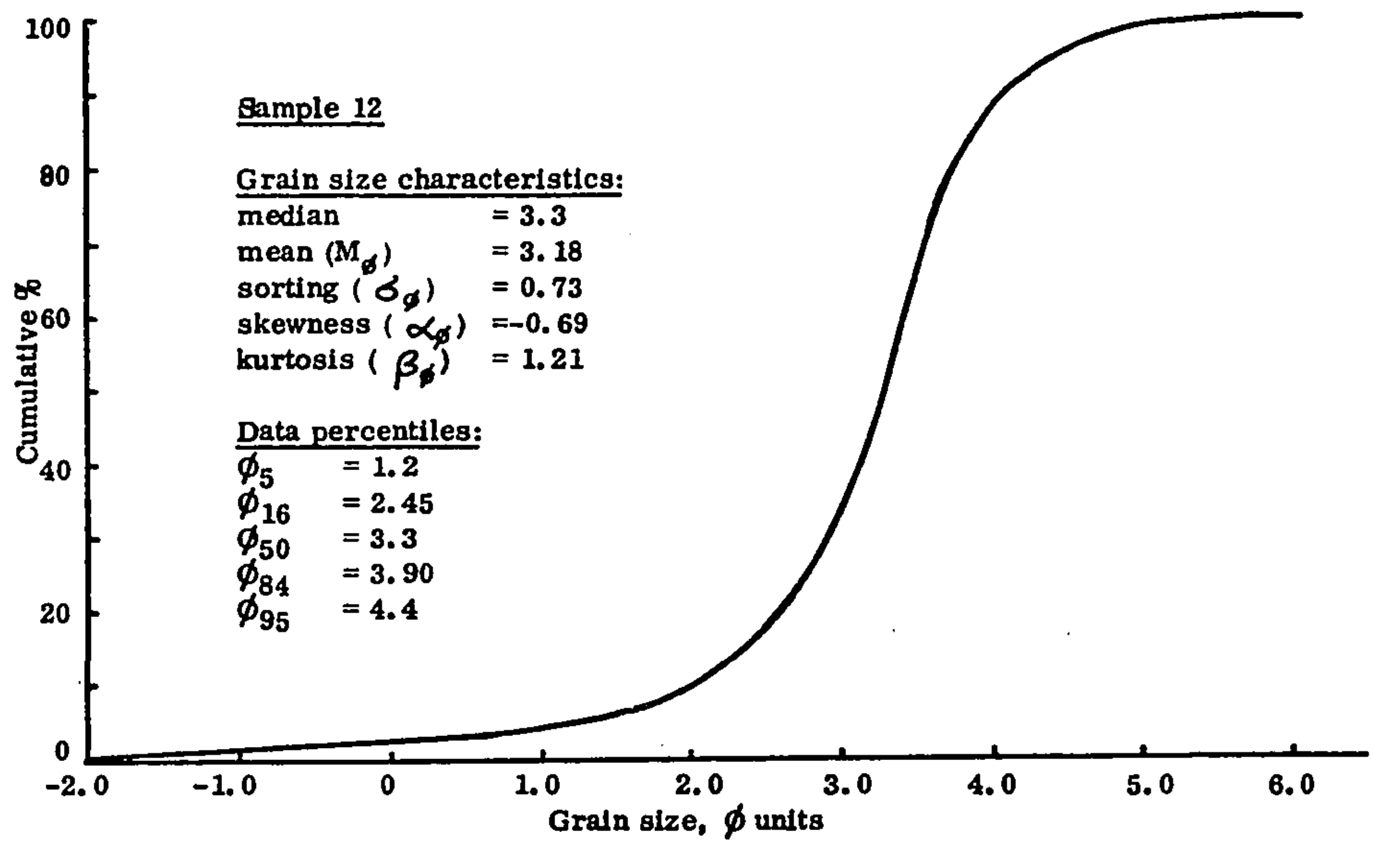


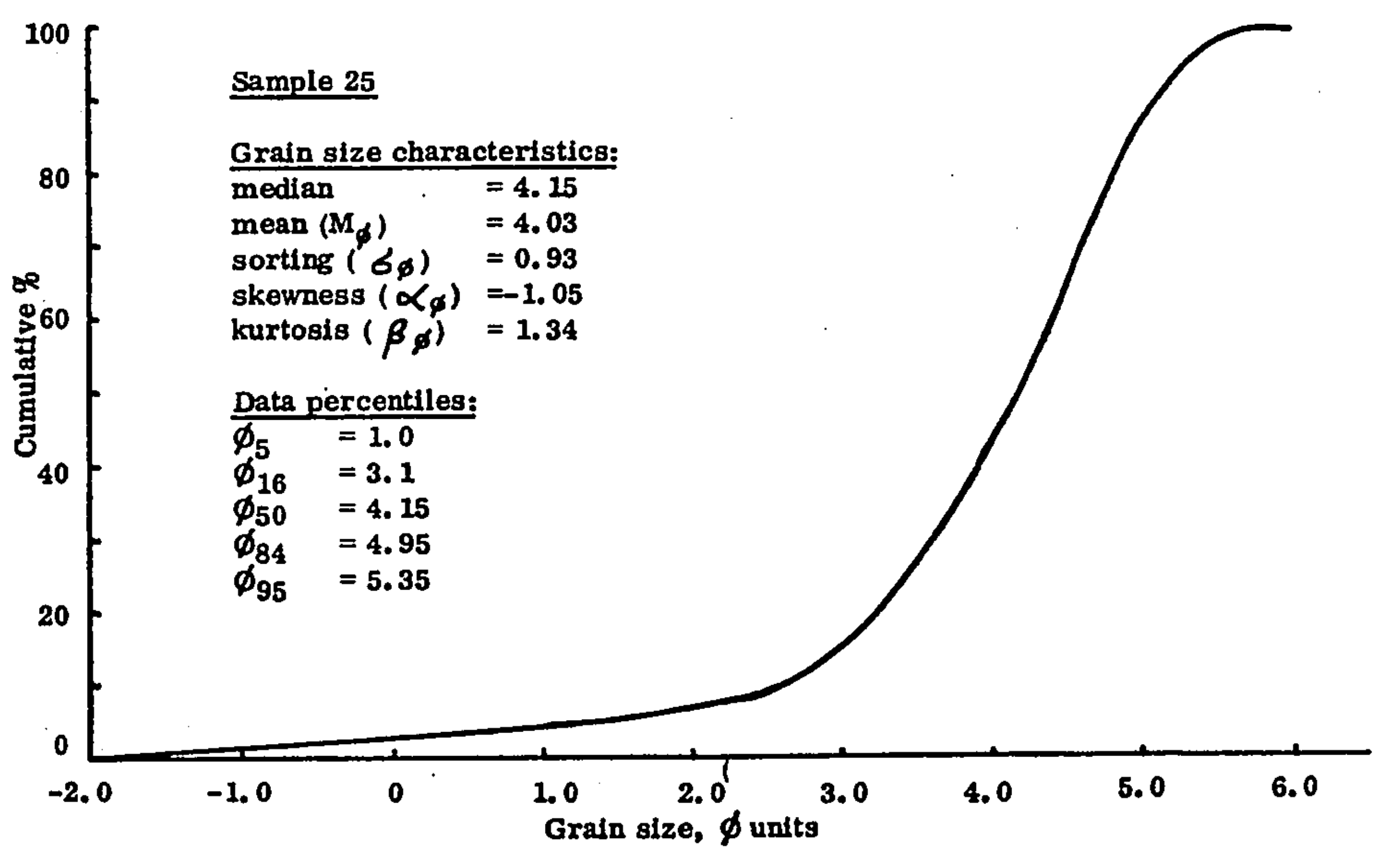
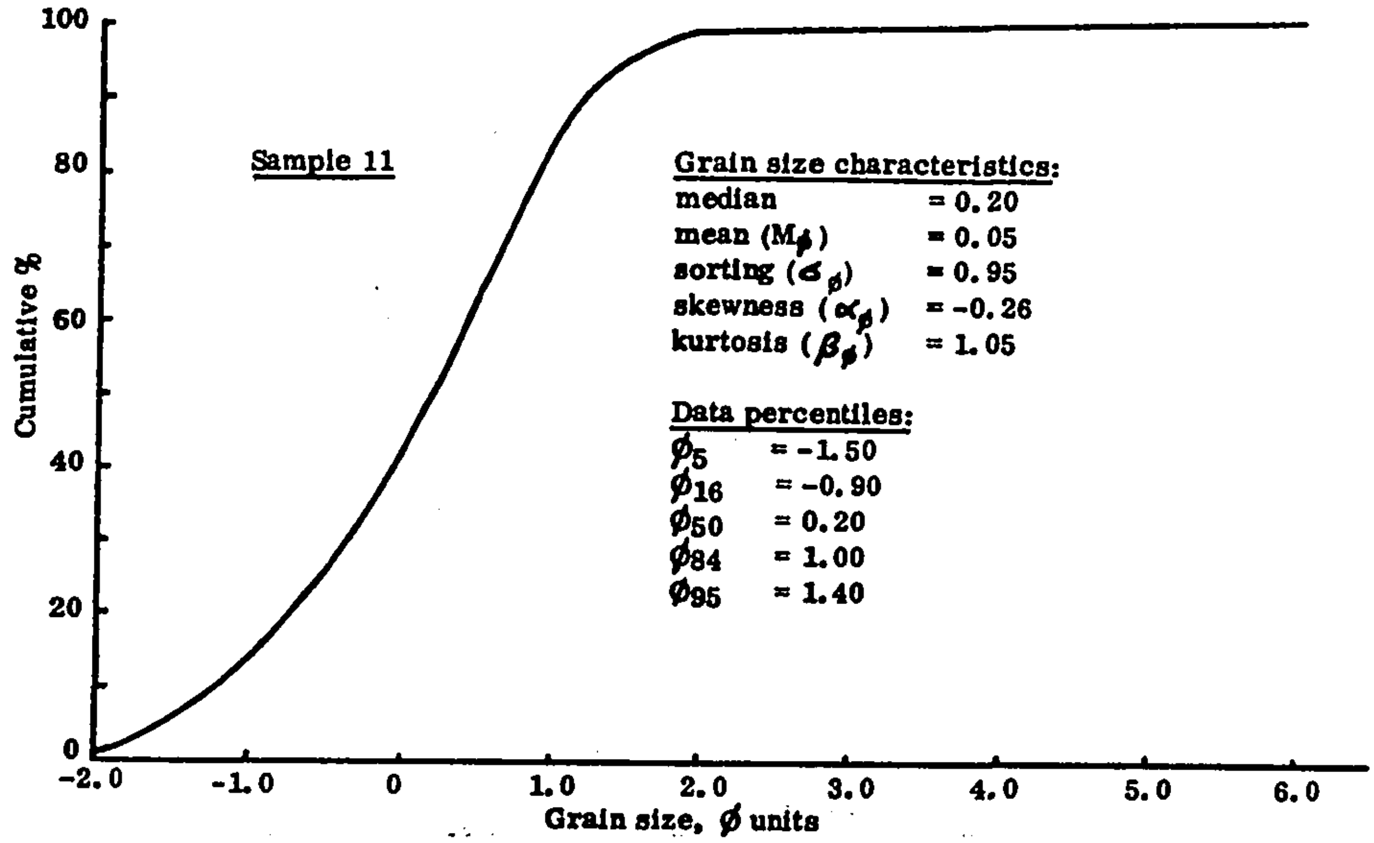


Figure 23 (ctd.)



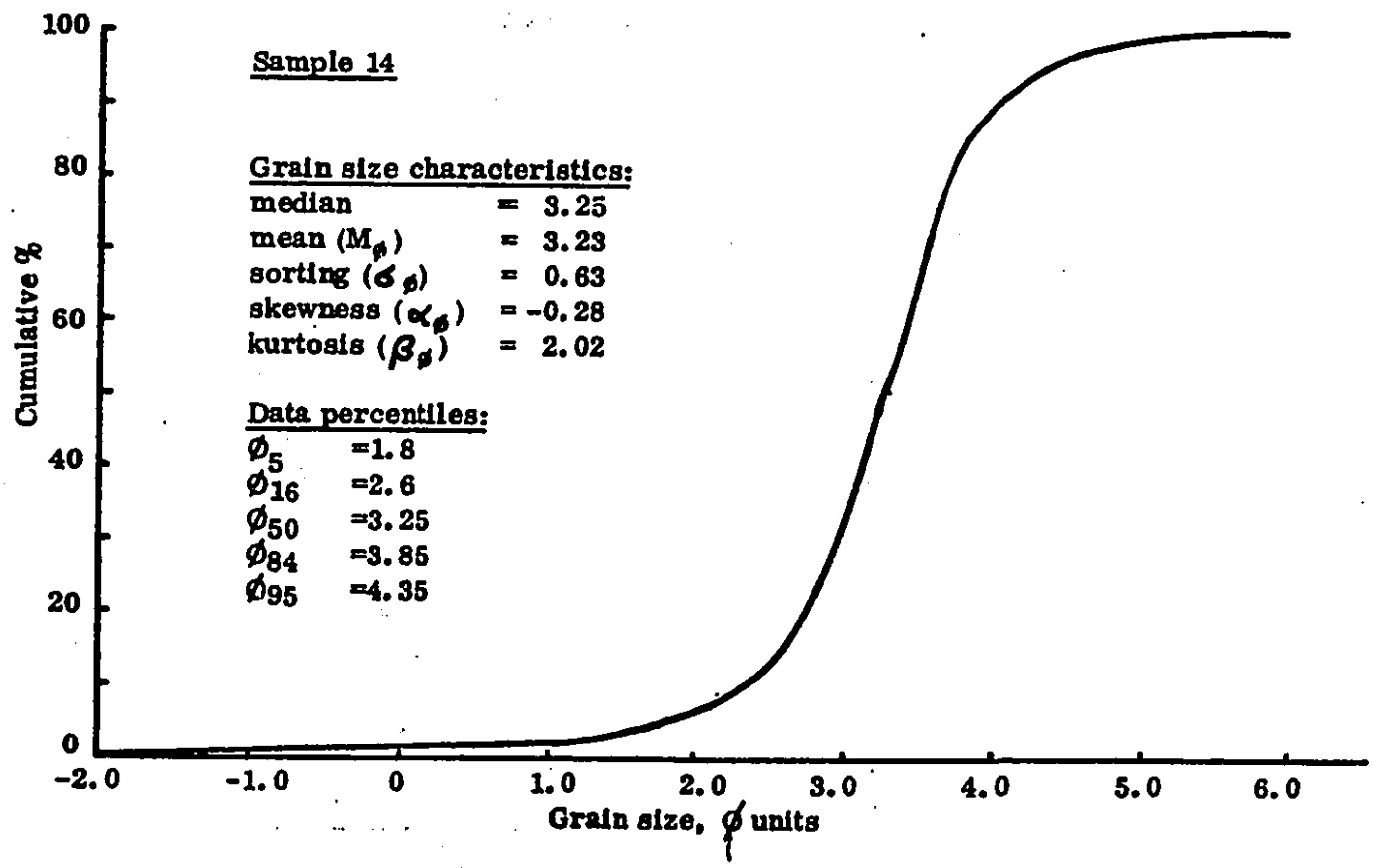


Figure 23 (ctd.)

	Sample no.	$\phi \le -2$ pebble	$-2 < \phi \le -1$ granule	$-1 < \phi \le 0$ very coarse sand	$0 < \phi \le 1$ coarse sand	$1 < \phi \le 2$ medium sand	$2 < \phi \le 3$ very fine sand	$3 < \phi \le 4$ fine sand	$4 < \phi \le 4.5$ coarse silt	$4.5 < \phi$ silt	σ_ϕ sorting
		% of particle size in sample									
mauka basin	8	0.81	1.00	1.86	4.41	11.26	32.25	35.15	8.09	5.15	1.05
	1	0	0.42	0.81	1.02	1.61	6.99	21.55	19.75	47.86	0.88
	2	0.55	4.66	8.75	8.24	8.05	13.14	22.79	12.33	21.50	2.23
	4	0.40	2.97	3.21	3.40	4.59	12.88	25.40	15.73	31.41	1.38
	6	8.71	9.35	14.23	12.87	10.96	10.74	11.81	6.77	14.56	3.30
	3	0.22	1.45	0.96	1.03	1.69	5.22	16.34	18.88	54.17	0.90
	5	0	0.63	1.24	2.50	6.38	19.99	33.67	15.71	19.88	1.13
inner channel	10a	0.46	1.32	3.23	7.82	11.47	20.13	30.48	13.02	12.08	1.48
	9a	0	3.88	5.42	4.44	4.23	9.29	29.54	18.21	24.96	1.90
makai basin	9	0	1.08	1.66	1.73	2.45	7.37	23.32	19.83	42.56	1.00
	10	0	4.54	13.90	12.95	11.54	16.28	17.97	8.63	14.28	2.30
	16	0	1.32	4.05	3.37	3.78	7.74	18.07	15.82	45.85	1.28
	20	0	0.18	1.77	1.39	2.22	8.02	22.41	15.61	47.41	1.03
	17	0	1.66	3.30	3.11	3.51	8.40	23.24	16.94	39.84	1.15
	21	0	2.20	2.14	1.39	0.90	2.57	13.25	15.73	61.82	0.78
	26	0	0.66	0.92	1.07	1.86	9.43	28.37	19.03	38.65	0.95
	28	0.18	0.28	0.70	0.87	1.50	5.65	18.71	15.59	56.53	0.93
	25	0	0.64	2.22	2.07	2.42	7.37	28.77	23.29	34.56	0.93
outer channel	12	0	0.69	1.72	2.18	4.16	27.09	51.63	8.40	4.12	0.73
	14	0	0.45	0.84	1.39	3.73	26.21	56.52	7.69	3.17	0.63
	11	1.05	12.75	29.16	40.72	15.35	0.55	0.27	0.12	0.03	0.95

Table 2. Particle size analysis results for sand samples collected at Honokohau Harbor, February 1975.

4) fine and very fine sand ($+2<\phi\leq+4$), and 5) silt or smaller ($+4<\phi$). This ordering is presented in Table 3 with the percentages rounded to the nearest 0.5%. Samples 1, 3, 21, 25, 26 and 28 compose group 1. They show quite similar cumulative phi frequency curves of fairly well-sorted sand for a harbor ($\sigma_\phi\approx0.9$) with over 50% silt and well over 90% of the samples composed of fine and very fine sand and silt (Moberly and Chamberlain, 1964). Samples 1 and 3 were taken in the back of the mauka basin while samples 21, 25, 26 and 28 were collected from the ocean side of the makai basin.

Samples 9, 20, 16 and 17 (group 2) also show over 50% silt and again a large percentage ($\approx$90%) of fine sand, very fine sand and silt. However, these samples contain slightly more medium to coarse particles and are less well sorted than group 1 with a sorting of $1<\sigma_\phi<1.3$. The samples of group 2 were all collected from the mauka side of the makai basin.

The samples collected in the inner channel (5, 9a and 10a) and those taken from the mauka side of the makai basin (2 and 4) compose group 3. They had between 70 - 80% fine sand to silt and a greater sorting coefficient ($1.13<\sigma_\phi\leq2.23$) indicating less well sorted sand than group 1 and 2. Samples 8 and 6 were both collected in the makai basin but they did not compare well with any of the other samples in that basin. Sample 8 was fairly well sorted ($\sigma_\phi=1.05$) but it contained 80% fine sand to silt, less

Sample no.	pebble & granule or larger $\phi \leq -1$	very coarse & coarse sand $-1 < \phi \leq +1$	medium sand $1 < \phi \leq 2$	fine & very fine sand $2 < \phi \leq 4$	coarse silt & silt $4 < \phi$	sorting σ_ϕ
1	0.50	2.00	1.50	28.50	67.50	0.88
3	1.50	2.00	1.50	21.50	73.50	0.90
21	2.00	3.50	1.00	16.00	77.50	0.78
28	0.50	1.50	1.50	24.50	72.00	0.93
26	0.50	2.00	2.00	38.00	57.50	0.95
25	0.50	4.00	2.50	36.00	57.00	0.93
9	1.00	3.50	2.50	30.50	62.50	1.00
20	0	3.00	2.00	30.50	64.50	1.03
16	1.50	7.50	4.00	26.00	61.00	1.28
17	1.50	6.50	3.50	31.50	60.00	1.15
2	5.00	17.00	8.00	36.00	34.00	2.23
4	3.50	6.50	4.50	38.00	47.50	1.38
5	0.50	3.50	6.50	53.50	36.00	1.13
9a	4.00	10.00	4.00	39.00	43.00	1.90
10a	2.00	11.00	11.50	50.50	25.00	1.48
8	2.00	6.00	11.00	67.50	13.50	1.05
6	18.00	27.00	11.00	22.50	21.50	3.30
10	4.5	27.00	11.50	34.00	23.00	2.30
12	0.50	4.00	4.00	78.50	13.00	0.73
14	0.50	2.00	3.50	82.50	11.50	0.63
11	14.00	70.00	15.00	1.00	0	0.95

Table 3. Particle size analysis results, ordered to indicate similarities in % composition and sorting coefficient.

than samples 1 and 3, but it was better sorted than samples 2 and 4. Sample 6 can perhaps be grouped with sample 10, collected in the center of the makai basin; they both contained a great deal more medium to coarse sand (over 40%) than the sample groups discussed so far and were not very well sorted with a $\sigma\phi$ of 3.3 and 2.3 respectively.

Samples 12 and 14, collected in the outer channel, compare with the samples of group 1 with well over 90% of the particles classified as fine sand, very fine sand and silt, but they contained relatively more medium and coarse sand particles and much less silt than the samples of group 1. Combined with a low sorting coefficient for these two samples, this indicates that in the outer channel the sand is being worked more than elsewhere in the harbor. This notion is supported by the particle composition of sample 11, also collected in the outer channel, which contained 15% medium sand and 84% coarse particles or larger and had a low sorting coefficient of 0.95.

Hydrology.

Figure 24 shows the location of the dominant groundwater inputs. On the basis of our observations there appear to be two types of input: a general percolation type inflow through the harbor walls and a more rapid flow type input originating from a distinct location in the harbor floor. Both types of inputs are most prevalent in the mauka berthing basin.

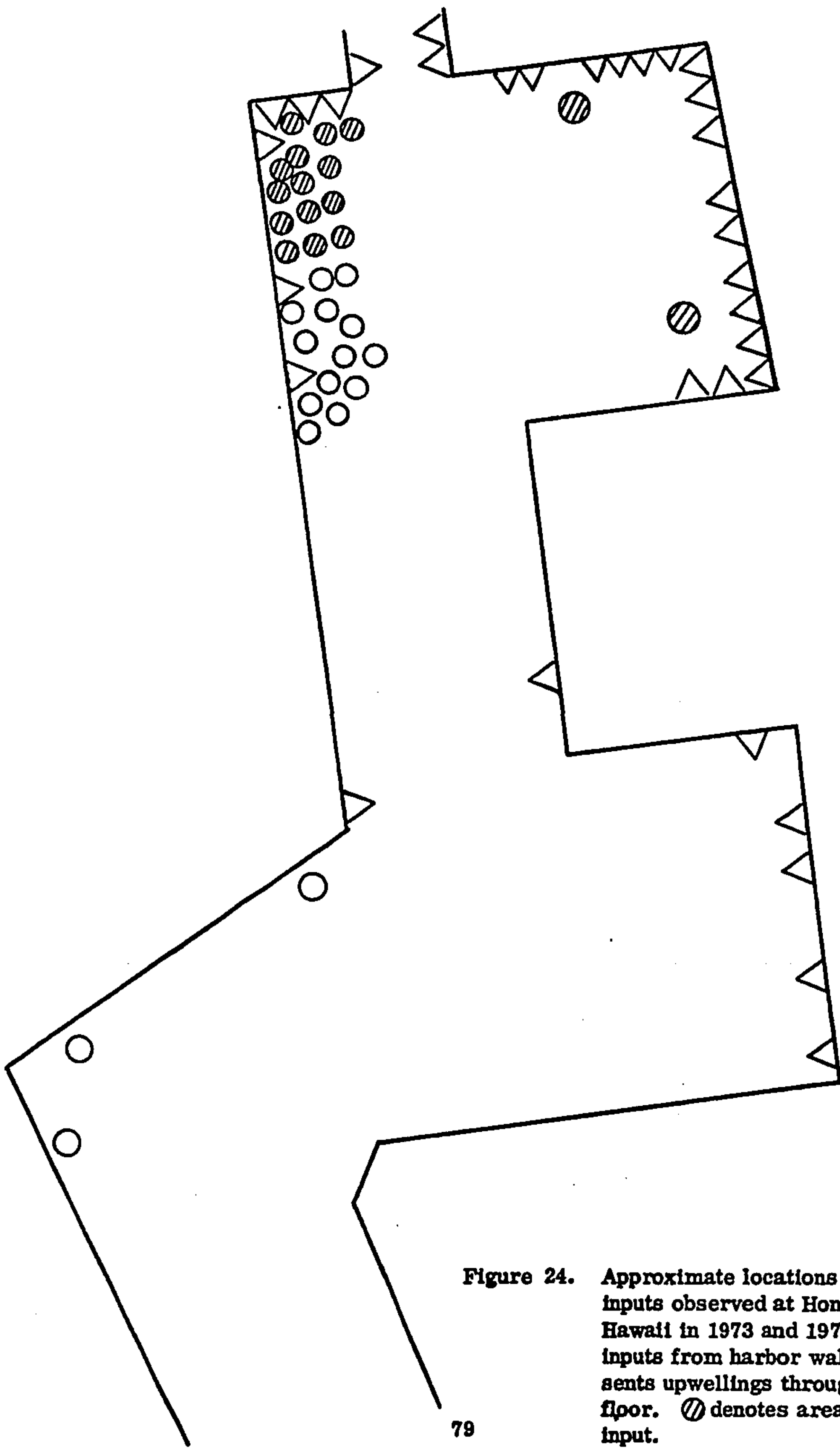


Figure 24. Approximate locations of groundwater inputs observed at Honokohau Harbor, Hawaii in 1973 and 1975. △ denotes inputs from harbor wall and ○ represents upwellings through the harbor floor. ⊘ denotes areas of greatest input.

Within this basin most of the inflow occurs along the northern end. Two discrete sources of input also occur along the eastern and southern sides.

Analysis of the chemical and physical data indicate that the incoming groundwater has the following properties: temperature $\triangleq$ 21 °C; salinity $\triangleq$ 24 ‰; nitrate $\triangleq$ 35.7 µg-at/l; phosphate $\triangleq$ 2.4 µg-at/l; N/P ratio $\triangleq$ 15; overall influx rate of ca. 71 $m^3 \cdot min^{-1}$.

CHEMICAL OCEANOGRAPHY

Nitrate.

The concentration of nitrate (NO_3^-) at various locations within Honokohau Harbor and adjacent coastal waters is shown in Table 4, and vertical distribution of the means of these results is shown in Figure 26. The outstanding feature of these values, which range from 0.13 - 35.72 µg-at/l, is the high nitrate content of the surface waters within the harbor. Similar distributions of nitrate were also found in previous investigations (Oceanic Institute, 1972, 1973, 1974) and are related to the influx of brackish groundwater through the walls and floor of the harbor, predominantly in the mauka berthing basin represented by station 1. The resulting configuration of nutrient-rich, low density, brackish water lying on top of nutrient-poor, higher density seawater accounts for the distribution of nitrate and phosphate within the harbor.

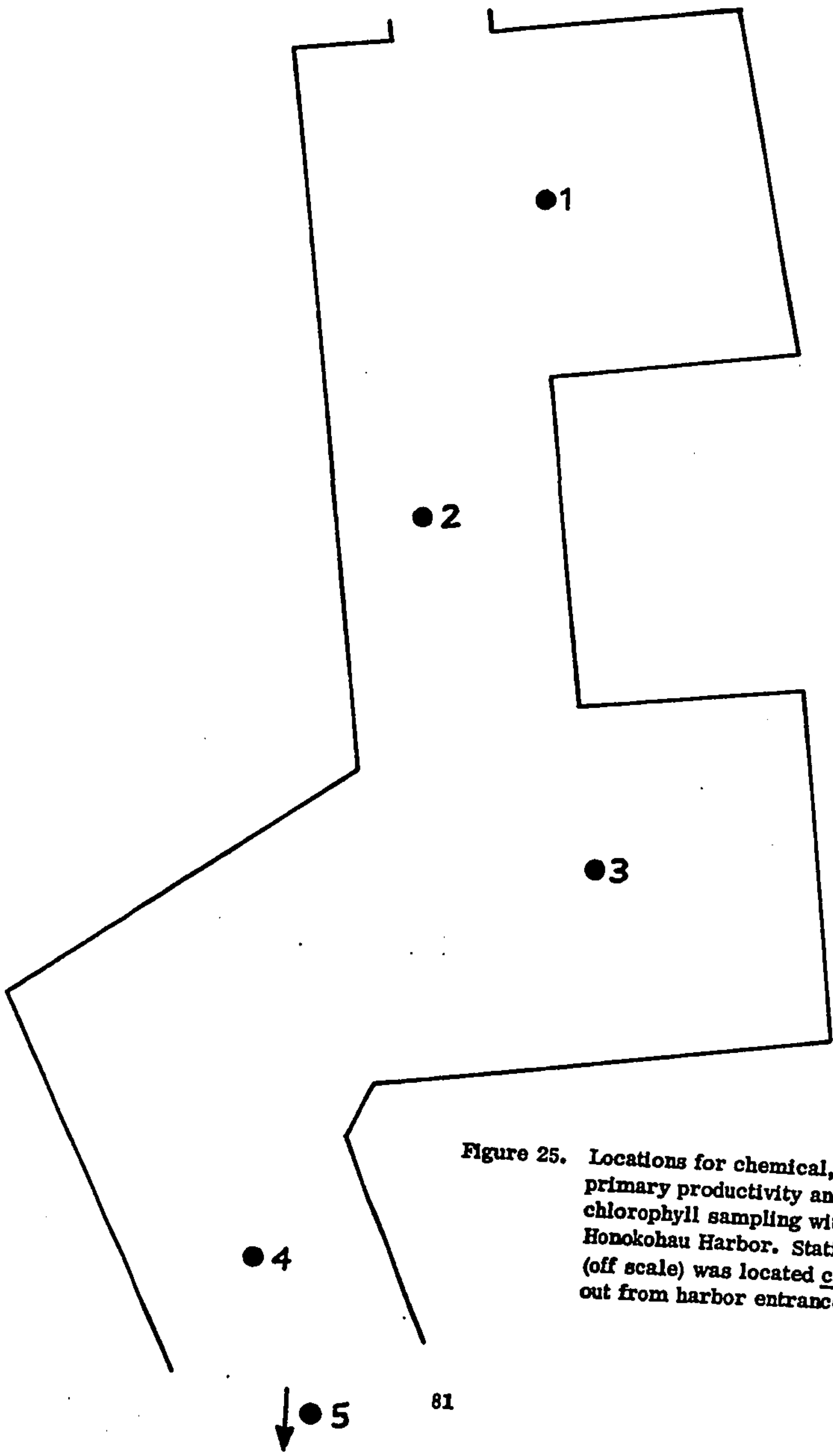


Figure 25. Locations for chemical, primary productivity and chlorophyll sampling within Honokohau Harbor. Station 5 (off scale) was located ca. 150 m out from harbor entrance.

STATION	DEPTH (m)	FALLING TIDE - AM 2/24/75	2/25/75	MEAN	RISING TIDE - PM 2/26/75	2/27/75	MEAN
1	0.5	30.64±0.08	23.89±0.00	27.27±3.90	35.72±3.42	31.60±1.44	33.66±3.20
	1.5	10.65±0.34	8.62±0.61	9.64±1.24	7.38±1.00	9.09±0.00	8.23±1.15
	3	5.01±0.33	2.36±0.10	3.80±1.69	2.95±0.59	4.75±0.85	3.85±1.20
2	1.5	5.67±0.59	7.50±0.16	6.58±1.11	12.04±0.32	10.93±0.33	11.48±0.69
	3	1.56±0.01	1.30±0.04	1.43±0.15	1.22±0.05	1.71±0.01	1.46±0.29
3	0.5	23.79±0.00	23.07±0.52	23.52±0.54	26.85±0.16	19.20±0.67	23.02±4.44
	1.5	5.60±0.17	3.24±0.17	4.42±1.37	2.94±0.34	12.46±0.17	7.70±5.50
	3	0.64±0.04	0.32±0.06	0.48±0.19	1.06±0.00	1.50±0.00	1.28±0.25
4	1.5	0.83±0.02	5.96±0.00	3.39±2.96	4.35±0.16	6.04±0.16	5.20±0.98
	3	0.84±0.09	0.37±0.05	0.60±0.28	0.27±0.00	0.52±0.02	0.40±0.15
5	1.5	0.58±0.06	0.59±0.07	0.58±0.06	1.25±0.05	0.16±0.02	0.70±0.63
	5	0.13±0.02	0.25±0.03	0.19±0.07	0.47±0.00	0.14±0.07	0.31±0.19

Table 4. Nitrate concentrations at selected locations at Honokohau Harbor, Hawaii. Values are listed in units of μg-at NO_3^-/l and represent the mean of duplicate analysis.

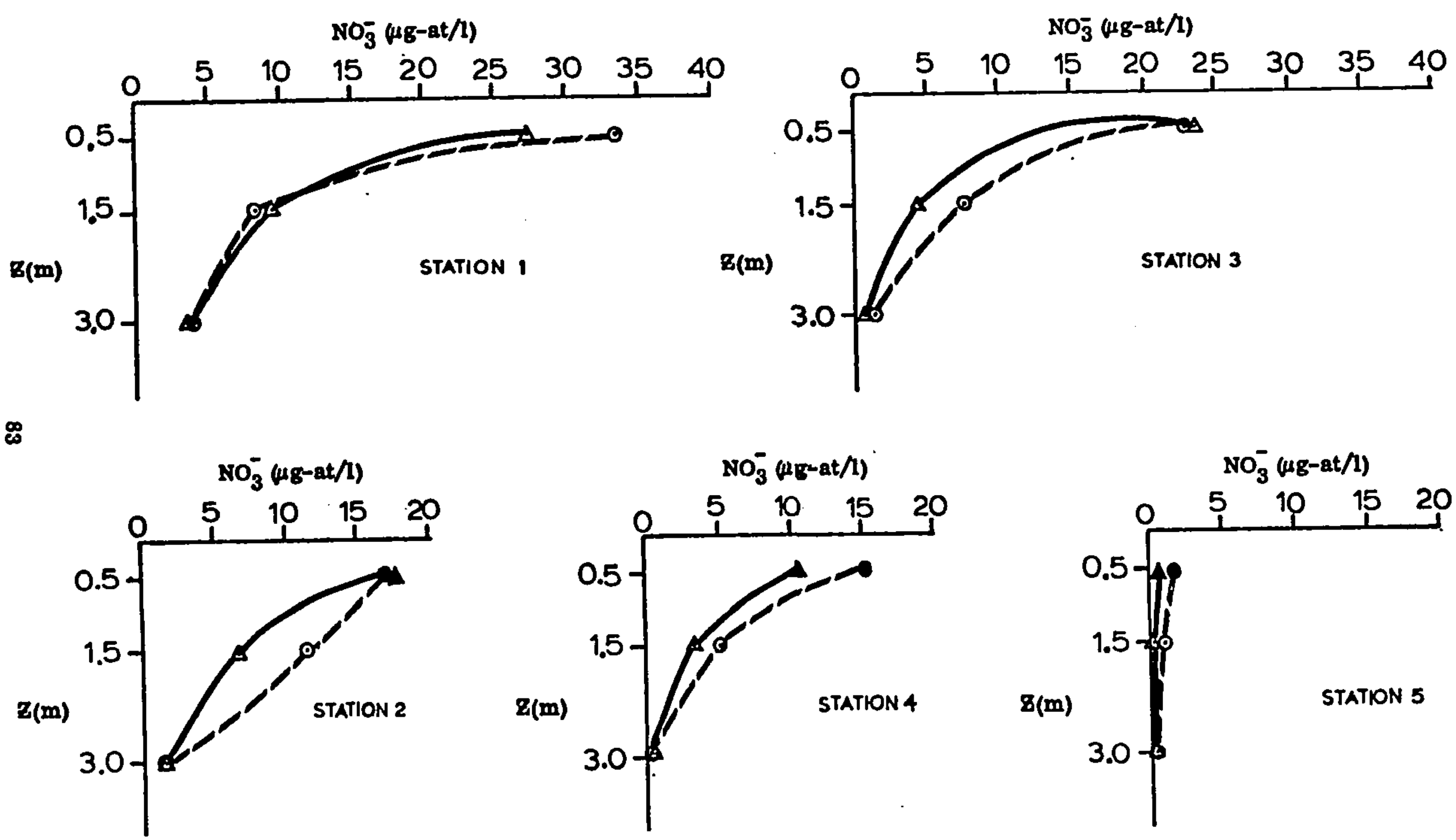


Figure 26. Vertical distribution of nitrate (NO_3^-) at selected locations within Honokohau Harbor. ——△ denotes data for falling tide (+0.6' ± 0.2'); — — ⊙ denotes data for rising tide (0.0' ± 0.2') conditions; and filled symbols (▲ and ●) represent complementary 0.5 m data from previous report (Oceanic Institute, 1973).

Actual sample collection at a given station varied somewhat from day to day; relative proximity to point sources of brackish water inputs (Figure 24) accounts, to a great extent, for the daily variation at a given tidal condition. The spatial distribution at 1.5 and 3.0 meters reveals a systematic decline of nitrate from high values at station 1, in the mauka province of the harbor, through stations 2, 3, 4 and finally to ambient levels at station 5 outside the harbor. Nitrate at 3.0 meters at station 4 was not significantly different from 1.5 meter levels at station 5. The concentration of nitrate at station 5 always showed that 1.5 meter values exceeded 5.0 meter values though the magnitude of change was considerably less than that expressed in the harbor itself. Drogue studies and other physical measurements showed that the direction of the harbor effluent, which occurs at all times regardless of the tidal cycle, was west in the direction of station 5. Previous data (Oceanic Institute, 1974) suggests that the surface nitrate concentration at station 5 is comparable to the 1.5 meter nitrate levels at station 5. Comparison of nitrate levels for stations 4 and 5 illustrate the magnitude of mixing and dilution occurring over this ca. 150 meter distance.

There was apparent variation of ambient nitrate in response to the prevailing tidal conditions. Nitrate concentrations at station 1 were ca. 6.3 μg-at/l higher under low tide conditions (0.0$\pm$0.2 feet) than under higher tide conditions (0.6 ± 0.2 feet). This undoubtedly results from the correspondingly greater relative contributions of brackish water inputs to the harbor waters at low tide. This general trend was apparent at stations 2, 3, 4 and 5—particularly at 1.5 meters.

Surface nutrients at stations 2, 4, and 5 represented in Figure 26 by the filled symbols are not contemporaneous with the other data but were taken from the 1973 investigation and are included only to illustrate the general trend of nitrate distribution at these locations.

A supplementary vertical profile, conducted at one meter intervals at station 3 (Figure 27 and Table 5), shows that nitrate levels decline rapidly to ambient levels at 2.5 meters and thus delimit the boundary of the nutrient-enhanced layer in this area. Mean nitrate levels are slightly higher than at the greater depths, suggesting vertical turbulence and diffusion input mechanisms; but overall the nitrate levels at depths in excess of 2.5 meters are not statistically different from one another.

Data from previous years' investigations demonstrate considerable annual variation in nitrate levels, apparently related to incident rainfall. Mean values from the 1971, 1972, 1973, and 1974 surveys showed nitrate concentrations at station 1 to be 30.63, 39.71, 21.55 and 30.47 µg-at/l, respectively. Similar variations were evident for other stations. Comparing the levels over the four-year period, the highest nitrate recorded was

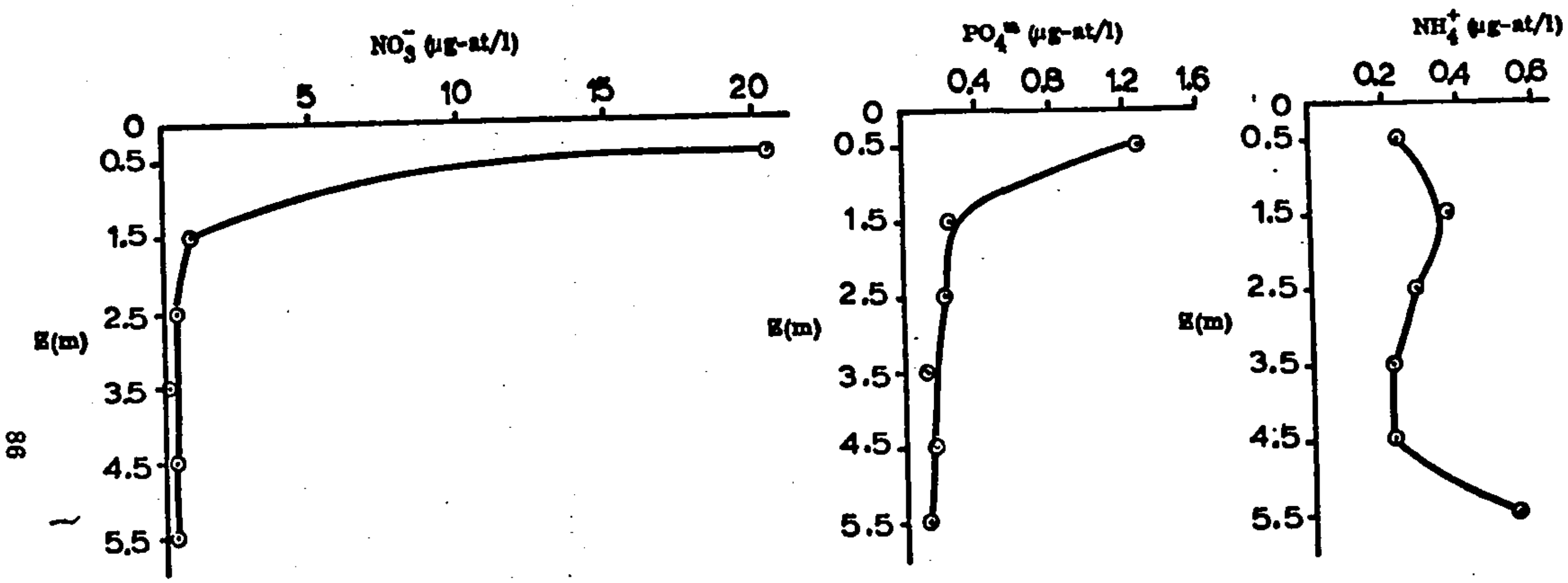


Figure 27. Vertical profiles of nitrate, phosphate, and ammonium concentrations at Station 3 in the Makai berthing basin at Honokohau Harbor, Hawaii.

DEPTH (m)	PRIMARY PRODUCTION mg C.m^{-3}.hr^{-1}	PI hr^{-1}	NO_3^- µg-at/l	NH_4^+ µg-at/l	PO_4 µg-at/l	Phaeo/ Chl-a AM	Phaeo/ Chl-a PM	AM Chl-a mg/m^3	PM Chl-a mg/m^3
0.5	0.58	5.80	20.50 ± 1.51	0.24 ± 0.11	1.27 ± 0.00	1.00	0.82	0.10	0.16
1.5	1.72 ± 0.33	10.75 ± 2.06	1.00 ± 0.04	0.38 ± 0.06	0.27 ± 0.01	0.68	0.31	0.16	0.26
2.5	2.90 ± 0.21	12.61 ± 0.91	0.34 ± 0.00	0.20 ± 0.06	0.21 ± 0.07	0.67	0.79	0.23	0.21
3.5	3.64 ± 0.74	15.17 ± 3.08	0.19 ± 0.01	0.21 ± 0.06	0.14 ± 0.02	0.48	1.08	0.24	0.19
4.5	2.12 ± 0.30	8.83 ± 1.25	0.25 ± 0.15	0.21 ± 0.06	0.16 ± 0.00	0.86	0.92	0.24	0.24
5.5	1.58 ± 0.08	9.29 ± 0.47	0.24 ± 0.11	0.55 ± 0.18	0.14 ± 0.00	0.95	0.36	0.17	0.79

Table 5. Vertical profiles of selected chemical and biological parameters taken at station 3 in the makai berthing basin of Honokohau Harbor.

43.9 μg-at/l (1972).

Nitrite (NO_2^-) analysis was conducted in the 1975 reconnaissance and NO_2^- levels were undetectable in all cases. The 1971 survey reported NO_2^- levels of 10^{-2} μg-at NO_2^-/l overall, and there appeared to be no systematic vertical or spatial distributional characteristics. This information shows that the nitrogen contained in the brackish water is probably represented solely by NO_3^- and not any reduced nitrogenous radicals. Thus results from 1972 and 1973 surveys (Oceanic Institute, 1973; 1974) which list $NO_3^- + NO_2^-$ values can therefore be taken to represent NO_3^- concentrations.

Phosphate.

The concentration of phosphate ($PO_4^{\equiv}$) at various locations within Honokohau Harbor and adjacent waters is shown in Table 6 and the vertical distribution of the means of these results is shown in Figure 28. Similar to the nitrate results, the outstanding feature of the phosphate data is the high surface values. Phosphate concentrations range from 0.13 μg-at/l in the subsurface waters at station 5 to 2.65 μg-at/l in the surface waters at station 1 under low tide conditions. The phosphate levels in the subsurface waters do not differ significantly from normal ambient concentrations expected in coastal areas. The surface values in μg-at/l are roughly an order of magnitude less than corresponding nitrate values; this

STATION	DEPTH (m)	FALLING TIDE - AM 2/24/75	2/25/75	MEAN	RISING TIDE - PM 2/26/75	2/27/75	MEAN
1	0.5	1.99±0.04	1.93±0.02	1.96±0.04	2.36±0.00	2.65±0.40	2.50±0.28
	1.5	0.73±0.00	0.51±0.00	0.62±0.13	0.68±0.00	0.58±0.00	0.63±0.06
	3	0.41±0.04	0.23±0.00	0.32±0.10	0.41±0.00	0.37±0.01	0.39±0.02
2	1.5	0.52±0.06	0.48±0.00	0.50±0.04	0.82±0.02	0.73±0.00	0.77±0.05
	3	0.32±0.01	0.31±0.04	0.31±0.02	0.25±0.02	0.30±0.02	0.27±0.03
3	0.5	1.72±0.04	1.81±0.02	1.76±0.06	1.58±0.01	1.58±0.13	1.58±0.07
	1.5	0.61±0.06	0.30±0.02	0.45±0.18	0.35±0.02	1.15±0.28	0.75±0.49
	3	0.20±0.01	0.21±0.03	0.21±0.02	0.21±0.00	0.42±0.20	0.32±0.17
4	1.5	0.25±0.02	0.67±0.02	0.46±0.24	0.46±0.04	0.53±0.00	0.49±0.05
	3	0.35±0.02	0.19±0.04	0.27±0.10	0.22±0.01	0.18±0.02	0.20±0.03
5	1.5	0.23±0.00	0.30±0.02	0.26±0.04	0.20±0.01	0.18±0.02	0.19±0.02
	5	0.18±0.02	0.26±0.04	0.22±0.05	0.16±0.00	0.13±0.02	0.14±0.02

Table 6. Phosphate concentrations at selected locations at Honokohau Harbor, Hawaii. Values are given in units of µg-at $PO_4^{\equiv}$/l and represent the mean of duplicate analysis.

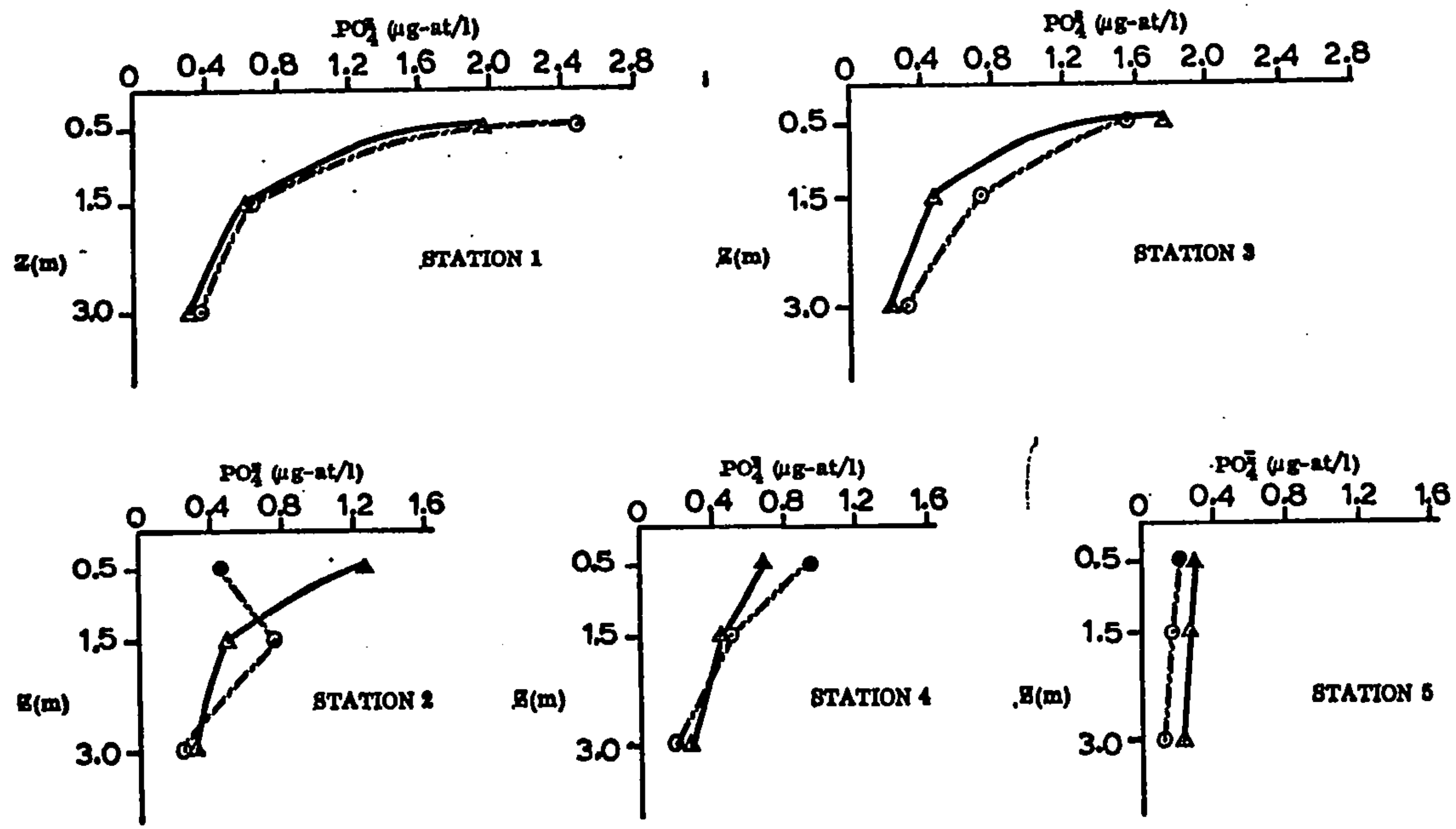


Figure 28. Vertical distribution of phosphate ($PO_4^{\equiv}$) at selected locations within Honokohau Harbor. ———△ denotes data for falling tide (+0.6' ± 0.2'); -----⊙ denotes data for rising tide (0.0' ± 0.2') conditions; and filled symbols (▲ and ●) represent complementary 0.5 m data from previous report (Oceanic Institute, 1973).

typical relationship of nitrogen-phosphorous availability is a result of the natural ground water processes affecting their distribution. Previous investigations (Oceanic Institute, 1972, 1973, 1974) have shown similar distribution of phosphate.

The vertical distribution shows that phosphate is highest in the surface waters, represented by the 0.5 meter samples. Previous studies (Oceanic Institute, 1972, 1973, 1974) show that the high phosphate surface concentrations, shown for stations 1 and 3, also apply to other provinces of the harbor. Phosphate levels at 1.5 meters are ca. 25 - 45 percent of the corresponding surface values, and for all 3.0 meter samples, except station 1, phosphate is very close to ambient levels in the adjacent coastal waters. Intermediate phosphate levels at 1.5 meters probably result from vertical mixing between the high-phosphate brackish water and the low-phosphate seawater layer.

Horizontal variation in phosphate levels was much less pronounced than vertical variation. Station 1 values at the surface tend to be greater than station 3 values, reflecting the proximity of groundwater inputs. A general trend of decreasing phosphate levels at locations more distant from the mauka provinces of the harbor seems to apply to data representing all depth and tidal conditions.

Phosphate levels appear to respond to the tidal conditions in much the same manner as do nitrate levels, phosphate being highest when the tide is low (0.0' ± 0.2'). This trend is most apparent in the mauka berthing area (station 1) which receives the groundwater inputs. No such tidal variation in phosphate is evident at the oceanic control station (5) outside the harbor. This tidal response of phosphate and nitrate points to the fact that hydraulic rather than biological processes predominate in affecting the ambient levels of these nutrients, particularly in the surface waters.

Comparison of the phosphate at 3.0 meters at station 4 with the levels at station 5 suggests that below 3.0 meters, the water within the harbor is essentially oceanic in nutrient character. This is also shown by the supplementary vertical profile, conducted at station 3 (Figure 27). At 2.5 meters, the phosphate concentration is essentially that of the adjacent coastal waters, and at 3.5 meters the phosphate is as low as the mean phosphate at 5.0 meters at station 5 (Table 6).

Supplementary data from previous surveys shows considerable variation in ambient phosphate as was apparent for nitrate. Data from 1971 through 1973 shows the range of variation at station 1 (0.5 meters) to be 0.96 - 3.15 μg-at/l with corresponding variations for other stations. The highest phosphate level recorded (3.23 μg-at/l) occurred in 1972 and corresponded to conditions of increased rainfall.

Ammonium.

The concentration of ammonium in Honokohau Harbor and adjacent waters is shown in Table 7 and Figure 29. Results show that the distribution of ammonium nitrogen does not follow the trend illustrated for nitrate and phosphate. Values in the surface waters did not show enhancement relative to subsurface waters, suggesting that ammonium, a reduced nitrogenous radical, is not present in the groundwater to any great extent. Further comparison of ammonium data for previous surveys (Oceanic Institute, 1973, 1974) shows similar concentrations in space and time and no dependence on rainfall conditions.

The range of ammonium figures, 0.04 - 2.00 μg-at NH_4^+/l, is not different from what might be encountered in an oligotrophic coastal system. No clear vertical, spatial or tidal variations in the ambient concentration of ammonium are apparent. Ammonium levels within the harbor, though showing isolated high values (1 - 2 μg-at/l), were not distinctly different from levels outside the harbor.

In contrast to the situation for nitrate and phosphate, biological rather than hydraulic processes are probably responsible for controlling the ammonium levels within the harbor. The grazing and excretion activities of zooplankton account to a large extent for the production of ammonium, and these processes are balanced by the rapid assimilation by phytoplankton.

STATION	DEPTH (m)	FALLING TIDE - AM			RISING TIDE - PM		
		2/24/75*	2/25/75*	MEAN	2/26/75	2/27/75	MEAN
1	0.50	0.67	2.00	1.34±0.94	0.58±0.06	0.54±0.06	0.55±0.05
	1.5	0.50	0.33	0.42±0.12	0.33±0.06	0.88±0.18	0.69±0.34
	3	0.83	0.33	0.58±0.35	0.33±0.06	0.25±0.00	0.28±0.05
2	1.5	0.67	0.33	0.50±0.24	0.21±0.06	0.29±0.06	0.25±0.07
	3	0.67	0.92	0.80±0.18	0.42±0.12	0.21±0.06	0.31±0.14
3	0.5	1.83	0.58	1.21±0.88	0.55±0.18	0.54±0.06	0.54±0.11
	1.5	0.42	1.42	0.92±0.71	0.33±0.00	0.13±0.06	0.23±0.12
	3	1.58	0.25	0.92±0.94	0.71±0.30	0.50±0.11	0.61±0.22
4	1.5	0.33	0.58	0.46±0.18	0.42±0.00	0.21±0.06	0.29±0.11
	3	0.25	1.25	0.75±0.71	0.29±0.06	0.25±0.00	0.27±0.04
5	1.5	0.25	0.17	0.21±0.06	0.25±0.24	0.04±0.06	0.15±0.19
	5	0.25	1.00	0.63±0.53	0.25±0.00	0.25±0.00	0.25±0.00

Table 7. Ammonium concentrations at selected locations within Honokohau Harbor, Hawaii. Values are given in units of μg-at NH_4^+/l and represent the mean of duplicate analysis except the two columns denoted by "*" which represent a single analysis of each sample.

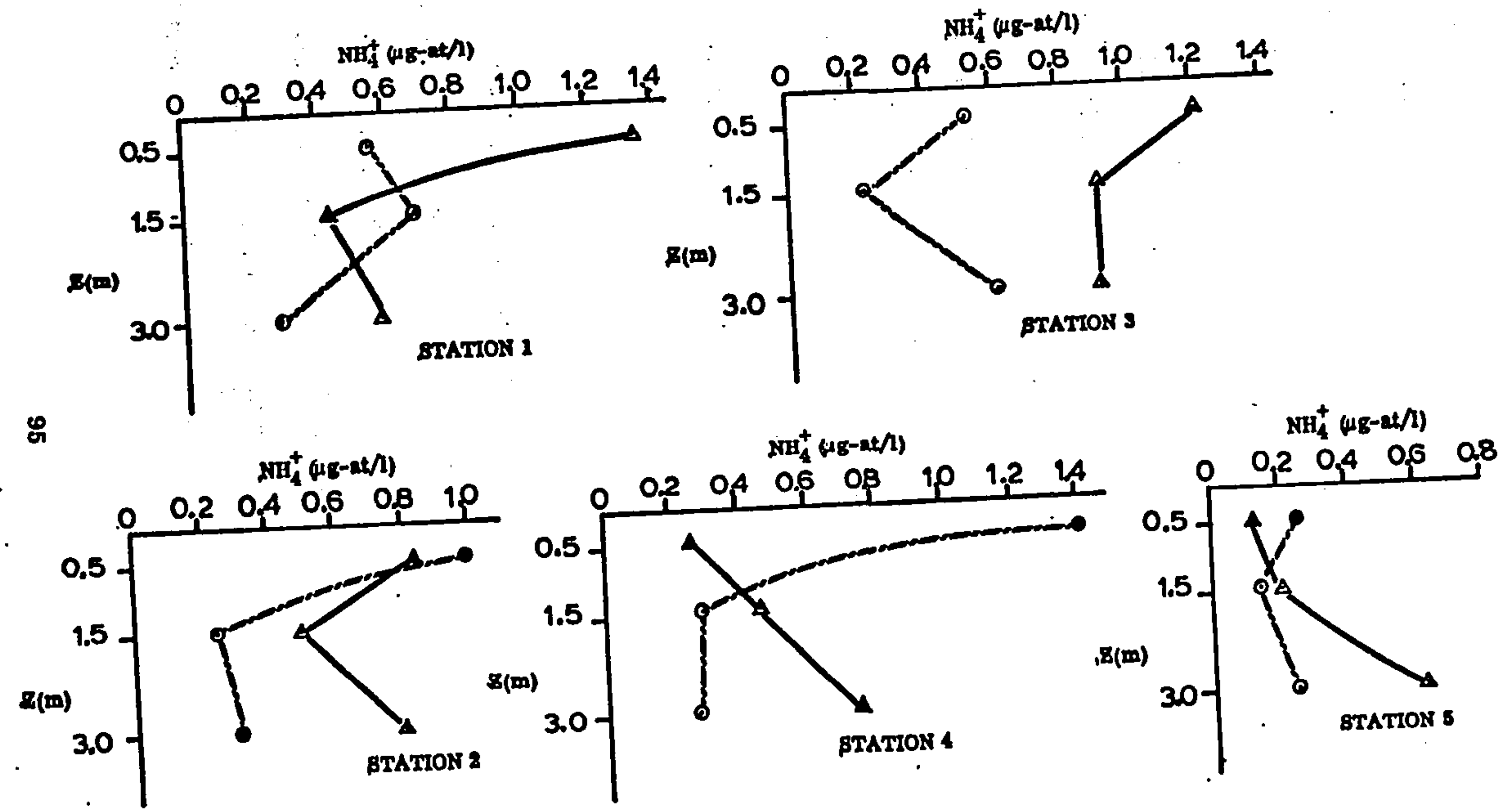


Figure 29. Vertical distribution of ammonium (NH_4^+) at selected locations within Honokohau Harbor. ——▲ denotes data for falling tide (+0.6' ± 0.2'); - - -⊙ denotes data for rising tide (0.0' ± 0.2') conditions; and filled symbols (▲ and ●) represent complementary 0.5 m data from previous report (Oceanic Institute, 1973).

This uptake is therefore responsible for maintaining the concentration below pernicious levels. The absence of distinctly different ammonium concentrations between station 1 and 3 where zooplankton biomass differed by a factor of ca. 8 points to environmental processes, occurring in situ, as the controlling mechanism.

The suggestion in Figure 29 that ammonium was higher at falling tide conditions may be an artifact of the analysis. A mishap during the analysis resulted in the invalidation of the replicate of the ammonium samples; thus figures listed in Table 7 are the result of only a single analysis. While it is true that reduced uptake of ammonium in the dark may be partially responsible for these somewhat higher values collected in the early morning, comparison with ammonium levels recorded during the complete vertical profile (Figure 27 and Table 5) does not show the enhanced levels described in Table 7.

pH, Total Alkalinity, Carbonate Alakalinity.

The pH of the waters within Honokohau ranged from 8.02 to 8.21 (Table 8). Lowest values were generally found in the upper 0.5 meters within the brackish layer, and pH values were highest in the 3.0 meter samples. Coastal waters adjacent to the harbor showed similar values as the subsurface waters within the harbor and averaged 8.18 $\pm$ .03.

Total alkalinity values showed a similar trend. Values were lowest in

STATION	DEPTH (m)	2/24/75 pH	2/24/75 A_t	2/24/75 A_c	2/25/75 pH	2/25/75 A_t	2/25/75 A_c	2/26/75 pH	2/26/75 A_t	2/26/75 A_c	2/27/75 pH	2/27/75 A_t	2/27/75 A_c
1	0.5	8.06	1.805	1.755	8.10	1.959	1.899	8.03	1.721	1.671	8.02	1.629	1.579
	1.5	8.14	2.114	2.024	8.16	2.154	2.064	8.15	2.114	2.024	8.13	2.114	2.024
	2.5	8.13	2.229	2.139	8.18	2.247	2.157	8.16	2.193	2.103	8.13	2.136	2.046
2	1.5	8.15	2.212	2.122	8.12	2.116	2.036	8.13	2.136	2.056	8.14	2.116	2.036
	3	8.15	2.264	2.164	8.18	2.247	2.147	8.16	2.229	2.129	8.16	2.174	2.074
3	0.5	8.16	1.805	1.745	8.03	1.776	1.726	8.07	1.748	1.698	8.08	1.833	1.783
	1.5	8.17	2.228	2.128	8.17	2.229	2.127	8.14	2.154	2.054	8.10	2.073	1.993
	3	8.15	2.263	2.163	8.21	2.281	2.181	8.18	2.212	2.112	8.15	2.264	2.174
4	1.5	8.14	2.117	2.027	8.17	2.174	2.074	8.15	2.193	2.093	8.15	2.155	2.065
	3	8.05	2.265	2.190	8.19	2.281	2.181	8.20	2.229	2.129	8.19	2.212	2.112
5	1.5	8.18	2.282	2.182	8.19	2.298	2.198	8.14	2.074	1.984	8.19	2.212	2.112
	5	8.19	2.265	2.165	8.17	2.265	2.165	8.20	2.229	2.129	8.13	2.264	2.174

Table 8. pH, total alkalinity (A_t) and carbonate alkalinity (A_c) for waters within Honokohau Harbor. Alkalinity values are given in units of milli-equivalents/l.

the 0.5 meter samples (1.79 ± .08 m equiv/l) and increased with depth to maximum recorded levels at 30 meters (2.24 ± .04 m equiv/l). Carbonate alkalinity ranged from 1.73 ± .09 m equiv/l at the surface to 2.14 ± .03 m equiv/l at 3.0 meters. Both total and carbonate alkalinity values (3.0 meter samples) were slightly lower inside the harbor, but these values were not significantly different from values recorded in the adjacent coastal waters.

BIOLOGICAL OCEANOGRAPHY

Phytoplankton Biomass.

Phytoplankton biomass, as measured by chlorophyll a density, is shown in Table 9. The figures presented are a quantitative index of the pristine conditions prevalent at Honokohau Harbor. The highest mean chlorophyll value, recorded at station 1 (3 meters), was only 0.70 mg/m^3 and represents only a 5-fold increase over the chlorophyll content of the adjacent oligotrophic coastal waters (0.14 mg/m^3). This enhancement results from the enriched nutrient conditions and the residence time of organisms within the harbor. The phytoplankton biomass in the harbor is undoubtedly maintained at these low levels in the face of abundant plant nutrients (NO_3^-, $PO_4^{=}$) by the processes of flushing and grazing by zooplankton.

Table 9. Phytoplankton biomass at various locations within Honokohau Harbor, Hawaii. Biomass measurements are given in units of mg chlorophyll-a/m^3 and are the result of a single 800ml sample.

STATION	DEPTH (m)	FALLING TIDE - AM 2/24/75	2/25/75	MEAN	RISING TIDE - PM 2/26/75	2/27/75	MEAN
1	0.5	0.09	0.10	0.10±0.01	0.07	0.05	0.06±0.01
	1.5	0.39	0.73	0.56± 0.24	0.48	0.72	0.60±0.17
	3	0.47	0.62	0.55±0.11	0.46	0.93	0.70±0.33
2	1.5	0.93	0.31	0.62±0.44	0.24	0.36	0.30±0.08
	3	0.57	0.37	0.47±0.14	0.40	0.43	0.42±0.02
3	0.5	0.11	0.08	0.10±0.02	0.13	0.14	0.14±0.01
	1.5	0.20	0.21	0.21±0.01	0.17	0.14	0.16±0.02
	3	0.22	0.25	0.24±0.02	0.45	0.40	0.43±0.04
4	1.5	0.14	0.18	0.16±0.03	0.16	0.19	0.18±0.02
	3	0.15	0.19	0.17±0.03	0.14	0.18	0.16±0.02
5	1.5	0.15	0.16	0.16±0.01	0.15	0.13	0.14±0.01
	5	0.14	0.15	0.15±0.01	0.14	0.13	0.14±0.01

Phytoplankton biomass is lowest at the surface (0.5 meters) within the brackish water layer. Though nutrients are abundant (Table 4, 6 and 7), these waters are colder and less saline than the seawater below and receive direct sunlight; these thermal, light and salinity differences may suppress the abundant growth of the phytoplankton. Further, the surface layer is constantly flowing out of the harbor--thus the residence time within the harbor of phytoplankton contained in the sea waters is short with respect to the underlying waters. Slightly below the brackish water interface (Figures 6 to 8), the chlorophyll a density shows a distinct increase. At stations 1 and 2 the 1.5 meter chlorophyll a levels were not distinctly different from the 3.0 meter levels; whereas at stations 3 and 4 the chlorophyll a continued to increase down to 3.0 meters. The variation with proximity to the open ocean may reflect the mixing processes occurring and the subsequent effects upon phytoplankton residence times and light penetration. The 1.0 meter interval profile conducted at station 3 shows the vertical distribution of phytoplankton in the makai berthing basin (Figure 30 and Table 5). The density is maximum in the 2.5 - 4.5 meter interval. Biomass levels at 5.5 meters are similar to levels in the adjacent open ocean. With the exception of station 1 at which the maximum depth is only 3 meters, these near-bottom chlorophyll levels are probably applicable for the entire harbor.

At both 1.5 and 3.0 meters there is a tendency for phytoplankton density to increase with greater distance from the ocean. This is probably an effect of internal flushing and the subsequent residence time of waters in the various regions. There was no regular variation in the chlorophyll a levels measured in the early morning as opposed to those measured at noon; nor is there a clear trend from the comparison of samples collected at sunrise and sunset (Table 5). In this case, even the effects of grazing in the evening hours are masked by the sampling and analytical variability. Comparison of the present biomass levels with those obtained during the September 1973 survey (Oceanic Institute, 1974) shows no apparent seasonal fluctuations in the phytoplankton biomass within the harbor.

Phaeophytin and its ratio to the chlorophyll a density is frequently used to indicate the grazing pressure of the zooplankton community. Phaeophytin is a degradation product of chlorophyll and is formed by the passage of chlorophyll through the acidic digestive tract of the herbivorous zooplankton. Levels of phaeophytin (Table 10) were generally higher in the mauka provinces of the harbor, corresponding to increased levels of chlorophyll a and zooplankton (Table 11 and 14). Levels in the back berthing area were roughly three times higher than levels in the makai berthing basin (station 3), whose values were similar to the coastal water values. Phaeophytin/chlorophyll a (P/C) ratios showed higher subsurface values at

STATION	DEPTH (m)	FALLING TIDE - AM 2/24/75	2/25/75	MEAN	RISING TIDE - PM 2/26/75	2/27/75	MEAN
1	0.5	0.08	0.14	0.11±0.04	0.07	0.06	0.07±0.01
	1.5	0.24	0.47	0.36±0.16	0.09	0.57	0.33±0.34
	3	0.26	0.64	0.45±0.27	0.22	0.81	0.52±0.42
2	1.5	0.59	0.23	0.41±0.25	0.21	0.26	0.24±0.04
	3	0.26	0.23	0.25±0.02	0.20	0.21	0.21±0.01
3	0.5	0.8	0.11	0.10±0.02	0.10	0.12	0.11±0.01
	1.5	0.13	0.18	0.16±0.04	0.19	0.09	0.14±0.07
	3	0.08	0.03	0.06±0.04	0.19	0.21	0.20±0.01
4	1.5	0.22	0.15	0.19±0.05	0.16	0.16	0.16±0
	3	0.17	0.22	0.20±0.04	0.15	0.19	0.17±0.03
5	1.5	0.17	0.15	0.16±0.01	0.15	0.13	0.14±0.01
	5	0.16	0.14	0.15±0.01	0.13	0.10	0.12±0.02

Table 10. Phaeophytin densities within Honokohau Harbor, Hawaii. Values are given in unites of mg phaeophytin/m^3.

STATION	DEPTH (m)	FALLING TIDE - AM 2/24/75	FALLING TIDE - AM 2/25/75	FALLING TIDE - AM MEAN	RISING TIDE - PM 2/26/75	RISING TIDE - PM 2/27/75	RISING TIDE - PM MEAN
1	0.5	0.92	1.44	1.18+0.37	1.10	1.10	1.10+0
	1.5	0.62	0.64	0.63+0.01	0.18	0.80	0.49+0.44
	3	0.56	1.03	0.80+0.33	0.49	0.87	0.68+0.27
2	1.5	0.64	0.74	0.69+0,07	0.86	0.72	0.79+0.10
	3	0.46	0.63	0.55+0.12	0.50	0.49	0.50+0.01
3	0.5	0.79	1.45	1.12+0.47	0.82	0.80	0.81+0.01
	1.5	0.65	0.89	0.77÷0.17	1.11	0.65	0.88+0.33
	3	0.38	0.13	0.26+0.18	0.43	0.54	0.49+0.08
4	1.5	1.50	0.86	1.18+0.45	0.99	0.86	0.93+0.09
	3	1.14	1.16	1.15+0.01	1.06	1.05	1.06+0.01
5	1.5	1.09	0.93	1.01+0.11	1.10	0.95	0.98+0.04
	5	1.17	0.97	1.07+0.14	0.96	0.81	0.89+0.11

Table 11. Phaeophytin/chlorophyll-a ratios at selected locations within Honokohau Harbor, Hawaii.

stations 3, 4 and 5 than at stations 1 and 2. Coastal P/C ratios were ca. 1 regardless of the time of day, while subsurface ratios in the back basin were roughly 0.65, indicating that the 5-fold change in chlorophyll between these two stations was more of a determinant on the P/C ratio than was the increased grazing pressure exerted by the considerably higher standing stocks of zooplankton (Table 14). Vertical profiles of P/C ratios at sunrise and sunset (Table 5) revealed high surface values but not consistent trend with depth or time of day.

The P/C ratios at 0.5 meters at stations 1 and 3 and for the sunrise - sunset vertical profiles showed consistently high values. This is unexpected because phaeophytin is rapidly degraded to immeasurable by-products when exposed to direct sunlight. Thus the continual presence of these high values must be the result of a persistent process, for although chlorophyll a levels were low, the concomitant phaeophytin reduction by light would make its density correspondingly lower, thus reducing the P/C ratio in these waters. Just the opposite is true. Since the dominantly oceanic zooplankton population would probably avoid the cold, brackish, brightly lighted surface waters, the implication is that the production of phaeophytin arises from the destruction of plant chlorophyll from non-grazing causes. A plausible explanation is the lysing of phytoplankton cells due to osmotic imbalance of cells entrained in subsurface waters which are mixed with the overlying brackish surface waters. This may arise from vertical mixing at the interface between the two water types and/or by the upwelling of the oceanic waters caused by the continual outflow of the brackish waters from the harbor (see physical oceanography section) which would entrain an amount of the seawater layer below. Regardless of the mechanism, the effect is that of control on the phytoplankton standing stock and a reduction of turbidity within the harbor waters.

Phytoplankton Productivity.

The rates of primary production, given in units of milligrams of plant carbon produced per cubic meter per hour for the harbor and adjacent coastal waters, are shown in Table 12. The mean values range from 1.38 mg $C \cdot m^{-3} \cdot hr^{-1}$ outside the harbor to 5.24 mg $C \cdot m^{-3} \cdot hr^{-1}$ in the mauka berthing basin (station 1). These values describe a trend of decreasing productivity rates with greater proximity to the ocean. A similar distribution phytoplankton biomass is apparent. The primary productivity rates within the harbor are low and compare favorably with values from the open coastal environment of Waianae, Oahu (Oceanic Institute, 1975). These low values are maintained largely by the harbor's rapid flushing capacity.

Mean values of the morning and afternoon measurements show that productivity rates are higher in the morning than in the afternoon. The

STATION	DEPTH (m)	FALLING TIDE - AM 2/24/75	2/25/75	MEAN	RISING TIDE - PM 2/26/75	2/27/75	MEAN
1	0.5	0.33		0.33	0.58±0.11	0.37	0.51±0.14
	1.5	3.43±0.06	6.19±1.55	4.81±1.82	2.33±0.46	4.18±1.10	3.25±1.27
	3	2.65±0.18	6.09±0.12	4.37±1.99	3.85±0.25	6.63±0.68	5.24±1.66
2	1.5	5.09±0.39	5.33±1.52	5.21±0.92	2.44±0.16	3.31±1.01	3.12±0.82
	3	4.93±0.83	4.90±2.53	4.91±1.54	2.44±0.64	7.24±0.62	4.84±2.82
3	0.5	0.28	0.41±0.13	0.37±0.12	0.39±0.28		0.39±0.28
	1.5	2.68±0.86	3.11±0.84	2.89±0.74	1.83±0.90	1.09±0.18	1.46±0.68
	3	3.77±0.23	3.07	3.54±0.43	3.53±0.17	5.15±0.95	4.34±1.09
4	1.5	1.31±0.48	2.68±0.34	2.00±0.86	0.79±0.10	2.01±0.52	1.40±0.77
	3	2.60±0.55	2.96	2.72±0.44	1.06±0.30	1.66±0.07	1.36±0.39
5	1.5	1.47±0.06	1.68±0.14	1.58±0.15	0.53±0.05	2.35±1.75	1.44±1.46
	5	1.72±0.08	1.47	1.63±0.15	1.63±0.31	1.12±0.07	1.38±0.35

Table 12. Primary Production rates at Honokohau Harbor, Hawaii. Values are given in units of mg $C.m^{-3}.hr^{-1}$ and represent the average of two light and one dark sample.

daily variation at a given tide cycle reflects both spatial and analytical variability within the berthing basins. Daily sampling took place at various locations in the area designated as a given station (Figure 25). Resultant variability was noted for primary productivity, phytoplankton biomass and nutrient values. Nutrient levels were lower on those occasions when biomass and productivity were higher and suggest that a variation in residence times in the different regions may be responsible for the spatial variability.

Production in the upper 0.5 meters is very low due to the low levels of phytoplankton biomass contained therein and to the less favorable growth conditions (e.g., low temperature and salinity and extremely high light intensity). Productivity rates at 1.5 meters, lying below the brackish water interface, were considerably higher than at 0.5 meters. At stations 1 and 2 the productivity values at 1.5 meters were generally the same as those at 3.0 meters, whereas at stations 3 and 4 rates showed continuing increase down to 3.0 meters. Figure 30 and Table 5 describe a complete vertical profile of primary production in the makai berthing basin, conducted over the entire day. Figure 30 shows increasing production rates with increasing depth down to 3.5 meters where maximum photosynthesis occurs; below this depth, rates decline. It is interesting to note that the production rates at 1.5 meters and 5 meters within the harbor are comparable to values attained at station 5 outside the harbor. The accompanying productivity index (PI) distribution (Figure 30), which yields an expression of specific growth rate, displays features similar to the production rate data. The PI values at station 3 are comparable at 1.5 meters and 5 meters with PI values from station 5, implying that comparable growth conditions (e.g., light intensity) apply to both locations (Table 13). PI values for other stations suggest that the phytoplankton population within the harbor is healthy and growing at near maximum rates. An exception to this is station 1, which consistently showed slightly lower PI values. Nutrient additions through vertical mixing to the nutrient-poor subsurface waters result in the higher productivity, biomass and PI values between 1.5 and 4.5 meters.

Zooplankton Biomass.

Two measures of zooplankton biomass (dry weight and numbers of individuals) in and near Honokohau Harbor are shown in Table 14. The results describe an enhancement of zooplankton standing stock in the harbor relative to the adjacent coastal waters, particularly so in the mauka berthing basin. This higher zooplankton standing stock is due to higher densities of herbivorous species such as Acartia sp.

Comparison of the two biomass measures with the species abundance data (Table 15) shows a change in the species composition relative to the coastal waters. These responses are undoubtedly due to the amount of

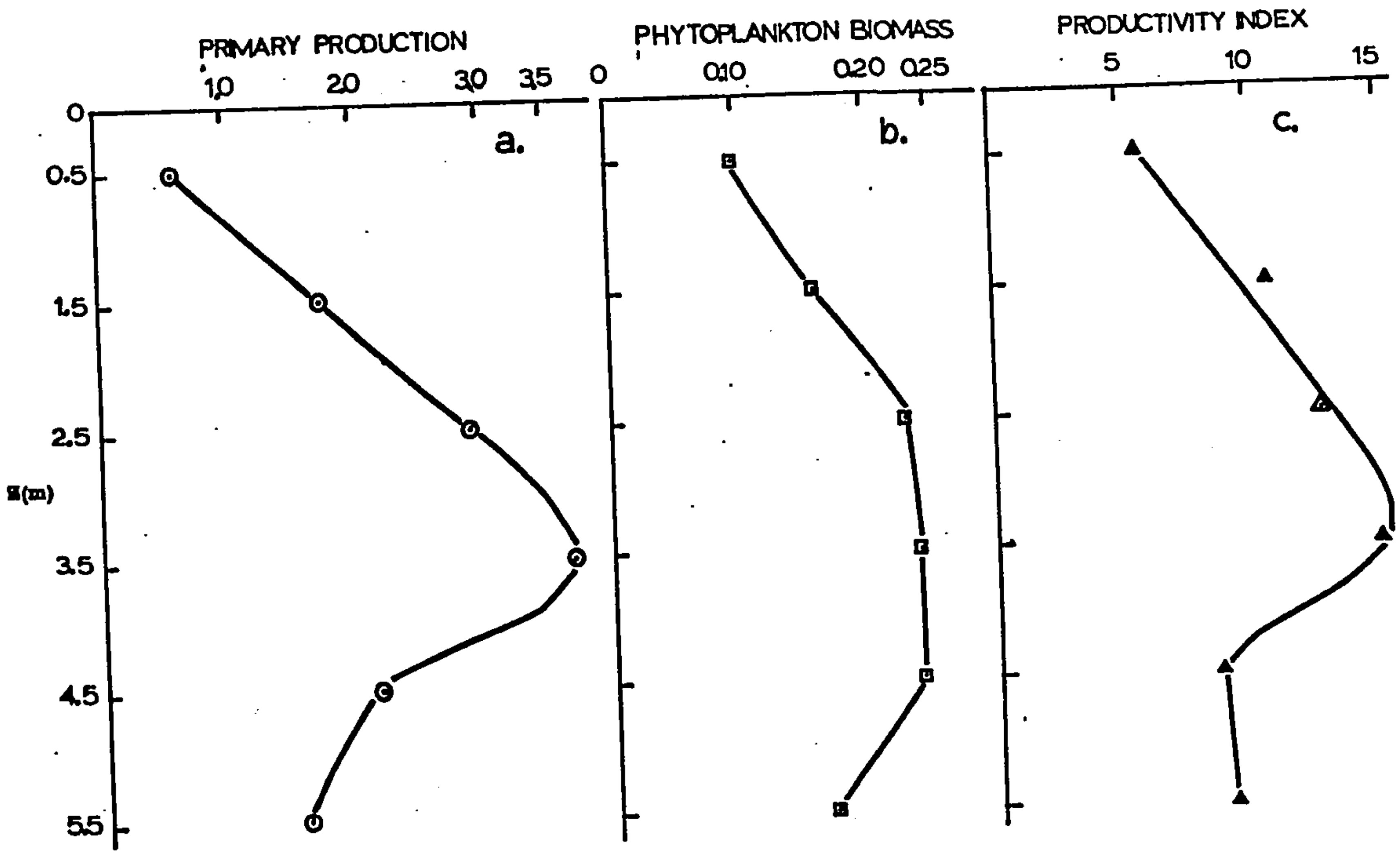


Figure 30. Vertical profiles of: a) primary productivity rates, given in units of $mgC \cdot m^{-3} \cdot hr^{-1}$; b) phytoplankton biomass, given in units of mg chlorophyll-a$\cdot m^{-3}$; and productivity index, given in units of hr^{-1}. Location is the makai berthing basin of Honokohau Harbor, Hawaii.

STATION	DEPTH (m)	FALLING TIDE - AM			RISING TIDE - PM		
		2/24/75	2/25/75	MEAN	2/26/75	2/27/75	MEAN
1	0.5	3.67		3.67	8.29		8.29
	1.5	8.79	8.48	8.64±0.22	4.85	5.81	5.33±0.68
	3	5.64	9.82	7.73±2.96	8.37	7.13	7.75±0.88
2	1.5	5.47	17.19	11.33±8.29	10.17	9.19	9.68±0.69
	3	8.65	13.24	10.95±3.25	6.10	16.84	11.47±7.59
3	0.5	2.55	5.13	3.84±1.82	3.00		3.00
	1.5	13.40	14.81	14.11±1.00	10.76	7.79	9.28±2.10
	3	17.40	22.12	19.76±3.34	7.84	12.88	10.36±3.56
4	1.5	9.36	14.89	12.13±3.91	4.94	10.58	7.76±3.99
	3	17.33	37.58	27.46±14.32	7.57	9.22	8.40±1.17
5	1.5	9.80	10.50	10.15±0.49	3.53	18.08	10.81±10.29
	5	12.29	23.47	17.88±7.91	11.64	8.62	10.13±2.14

Table 13. Productivity Indices (PI) at selected locations within Honokohau Harbor, Hawaii. PI values are the ratio of primary production rates to phytoplankton biomass (mg C. m^{-3}. hr^{-1}/mg chl-a. m^{-3}) and have units of hr^{-1}.

food (phytoplankton) available in the various provinces of the harbor. The density of zooplankton dry weight (mg· m^{-3}) in the makai berthing basin is similar to that found in the adjacent coastal ocean, while the dry weight density in the mauka basin is 5.8 times larger than in the coastal waters. Phytoplankton biomass was higher in the mauka and makai basins than in the coastal waters by factors of ca. 4 and 2, respectively. Organism density (numbers · m^{-3}) in the makai basin was 2.5-fold greater than outside the harbor, and suggests a shift in species composition toward smaller organisms, e.g., Acartia sp. Organism density in the mauka basin showed a 28-fold increase over levels outside the harbor. Thus the second trophic level (zooplankton) shows a biomass distribution commensurate with that of the primary trophic level.

Zooplankton Species Composition.

Analysis of species composition and abundance (Table 15) shows that diversity is highest in the open coastline and gradually declines in toward the mauka province of the harbor. Copepods dominated the samples in all locations. Outside the harbor, many species of copepods were represented and cyclopoids were predominant. At both locations within the harbor, however, the large number of copepods present are represented almost entirely by one species of Acartia. The greater organism density in the makai basin over the open coastal waters is due to increases in numbers of Acartia sp.

Table 14. **Zooplankton biomass at Honokohau Harbor, Hawaii. Tow #1 is from the oceanic waters outside the harbor, ca. 150 meters from the harbor channel; tow #2 is from the outer (makai) berthing basin; tow #3 is from the inner (mauka) berthing basin. All tows conducted for ca. 10 minutes, using a 212μ mesh, 0.5 meter net.**

TOW #	zooplankton dry weight (mg/m^3)	mean zooplankton dry weight (mg/m^3)	zooplankton density (individuals/m^3)	mean zooplankton density (individuals/m^3)
1a	4.20	5.62 ± 2.00	203.67	206.09 ± 2.43
1b	7.03		208.51	
2a	4.81	5.54 ± 1.03	492.99	500.75 ± 7.76
2b	6.27		508.50	
3a	31.82	32.63 ± 1.15	5279.65	5744 ± 464.66
3b	33.44		6208.96	

Table 15. Composition and abundance of zooplankton at Honokohau Harbor, Hawaii. Data represent average numbers per cubic meter from duplicate tows at each location.

TAXONOMIC GROUP	TOW # 1	2	3
Copepods	195.12 ± 2.95	496.72 ± 7.4	4,807.89 ± 404.11
Mysids	-	0.66 ± 0.03	2.65 ± 0.65
Euphausids	0.04 ± 0.04	0.02 ± 0.02	-
Shrimp zoea	0.08 ± 0.08	0.02 ± 0.02	-
Shrimp larvae	0.32 ± 0.14	0.46 ± 0.13	0.26 ± 0.26
Crab zoea	1.06 ± 0.16	1.50 ± 0.42	1.01 ± 0.01
Amphipods	0.03 ± 0.03	-	-
Chaetognaths	2.69 ± 0.68	0.04 ± 0.04	-
Polychaetes	-	0.02 ± 0.02	0.20 ± 0.20
Oikopleura sp	0.23 ± 0.01	-	-
Doliolids	0.14 ± 0.02	-	-
Siphonophores	0.07 ± 0.01	-	-
Ctenophores	-	-	-
Ostracods	0.17 ± 0.05	0.02 ± 0.02	-
Bivalve larvae	0.78 ± 0.35	0.04 ± 0.04	392.88 ± 59.98
Gastropod larvae	2.00 ± 0.24	0.84 ± 0.21	518.05 ± 0.51
Fish eggs	3.28 ± 0.60	0.02 ± 0.02	-
Fish larvae	-	0.32 ± 0.10	1.39 ± 0.39
Total organisms/m^3	206.09 ± 2.43	500.75 ± 7.76	5,744.31 ± 464.66

Several of the carnivorous species found at low density in the coastal waters were not present within the harbor. Bivalve and gastropod larvae also showed considerably higher density in the mauka berthing basin.

Bacteriology.

The presence of coliforms in water indicates possible fecal contamination. Total coliform (TC) bacteria are widely distributed in nature and many species are native to the gut of warm-blooded animals and man, and leave the gut via fecal discharge. They may enter waters directly or they may be transmitted by storm water run-off, raw sewage discharge, or inadequate sewage treatment. Fecal coliforms (FC) and fecal *strepto-coccus* (FS) in the water specifically indicate fecal waste contamination by warm-blooded animals via fecal discharge. Both are native to the gut of warm-blooded animals especially, but also to man. All three bacterial indicators are in themselves nonpathogenic, but their presence in the water is indicative of a potential health hazard since both coliforms and waterborne pathogens may exist under similar conditions. The FC/FS ratio is employed to distinguish between bacterial contributions from human and nonhuman fecal wastes.

These three bacterial indicators were assessed over two days on two separate occasions, once in February, and again in May, 1975. At the times of investigation 51 boats, including no live-aboards, were moored

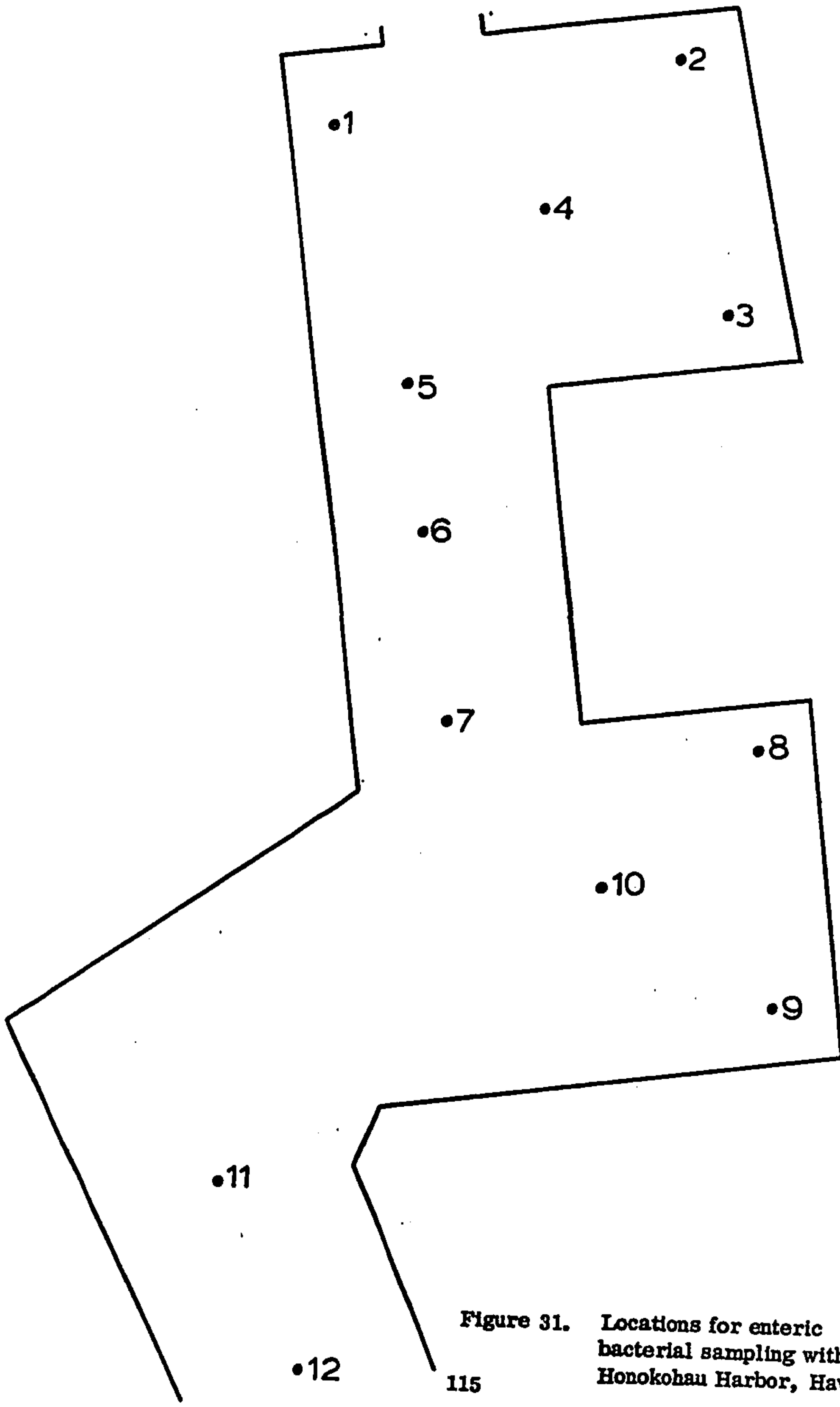


Figure 31. Locations for enteric bacterial sampling within Honokohau Harbor, Hawaii.

within the harbor. Analytical difficulties involving the TC plates of the February survey were not encountered during the May investigation, making the latter TC data easier to interpret.

Total Coliforms. TC densities within Honokohau Harbor are generally low and easily correspond to criteria established for class A waters (1000/100 ml). The February data (Table 16) shows TC levels ranging from 0 - 348 TC/100 ml. The majority of these values are below the limits set for AA waters (70 TC/100 ml.). The May data (Table 17) shows a similar range (0 - 553 TC/100 ml). It is clear from this data that TC levels are generally highest in the surface waters. This may be due to slower die-off rates due to lower salinity, to proximity to bacterial inputs or a combination of the two. The higher levels recorded on 5/5/75 over the previous day are the result of considerable rainfall which occurred between the two samplings. It is interesting to note that even after the rainfall the waters immediately outside the harbor show rather low values. Since TC levels rise considerably after precipitation, it is probable that these values (stations A and B) represent high levels; meaning that the adjacent coastal waters probably conform to Class AA microbial standards.

Fecal Coliforms. Fecal coliform levels were much lower than TC levels during both surveys. FC densities ranged from 0 - 165 FC/100 ml (February) and 0 - 22.2 FC/100 ml (May). On each investigation, the high

LOCATION	DEPTH (m)	TOTAL COLIFORMS #/100 ml 2/25/75	TOTAL COLIFORMS #/100 ml 2/27/75	FECAL COLIFORMS #/100 ml 2/25/75	FECAL COLIFORMS #/100 ml 2/27/75	FECAL STREPTOCOCCI #/100 ml 2/27/75(am)	FECAL STREPTOCOCCI #/100 ml 2/27/75(pm)	$\overline{FC}$ #/100 ml	$\overline{FS}$ #/100 ml	$\overline{FC}$ / $\overline{FS}$
1	0	*	*, 24.5	0	0, 0	1.3	0.33, 0.67	0	0.8	0
	3	*	*, *	0	0, 0	0.25	---	0	0.25	0
2	0	30	148, *	0	165, 0	0.5	1.33, 0.33	55	0.7	78.6
	3	4	*, *	0	150, 12.5	5.5	2, 0	54.2	2.5	21.7
3	0	---	25, *	---	0, 1.5	3.6	1.67, 1.33	0.75	2.3	0.3
	3	---	*, 36	---	0, 0	3.5	0.33, 0.33	0	1.4	0
4	0	---	3, *	---	1, 2	0.5	---	1.5	0.5	3
	3	---	*, *	---	1, 0	3	---	0.5	3	0.2
5	0	---	97, 7.5	---	2, 7	3	4.75	4.5	3.9	1.2
	3	---	0	---	0, 1	2.5	---	0.5	2.5	0.2
6	0	28	*, 30	0	6, 4	9, 7.8	0.33, 3.17	3.3	5.1	0.7
	3	13	214, *	26.4	0, 0	9	0.0, 0.33	8.8	3.1	2.8
7	0	---	44, 12.5	---	7, 0.5	11	---	3.8	11	0.4
	3	---	40, 18	---	0, 1.5	3.5	---	0.8	3.5	0.2
8	0	16	26	4.8	1, 4.5	4.3	9.67, 10.33	3.5	8.1	0.4
	3	29	348, 2.5	0	0, 0	3.8	6, 2.33	0	4.1	0
9	0	---	16, *	---	1, 1	9	---	1	9	0.1
	3	---	*	---	0, 0	7	---	0	7	0
10	0	*	*, *	0	3, 19	4.3	---	7.3	4.3	1.7
	3	*	*	0	2, 1.5	4.5	---	1.2	4.5	0.3
11	0	22	*	0.2	0, 0	1.3	7, 2.83	0.1	3.7	0.1
	3	1.4	30, *	0	4, 1	2.3	66, 0	1.7	12.1	0.1
12	0	---	*, *	---	0, 0	5.5	---	0	5.5	0
	3	---	2, 0.5	---	0, 2.5	7.25	---	1.3	7.3	0.2

Table 16. Enteric bacterial levels within Honokohau Harbor, Hawaii. Locations of the bacterial sampling are shown in Figure , "---" indicates no sample was taken on that day; "*" indicates bacterial density was not determinable under given analytical conditions.

STATION	Z	TOTAL COLIFORMS' (Numbers / 100 ml)			FECAL COLIFORMS (FC) (Numbers / 100 ml)			FECAL STREPTOCOCCI (FS) (Numbers / 100 ml)			FC/FS RATIO		
		5/4/75	5/5/75	Mean	5/4/75	5/5/75	Mean	5/4/75	5/5/75	Mean	5/4/75	5/5/75	Mean
3	S	189.7	--	189.7	0	--	0	0.3	--	0.3	0	--	0
	B	28.9	--	28.9	1.7	--	1.7	2	--	2	0.85	--	0.9
4	S	33.2	553	293.1	1.7	0.4	1.1	0.3	0	.2	5.67	u	5.5
	B	10.0	12	11	0.4	0.5	.5	0.3	0	.2	1.33	u	2.5
6	S	75.3	266	170.7	2.1	3.5	2.8	39.5	1	20	0.05	3.5	0.14
	B	33.2	303	168.1	0	0.3	.2	0.8	0	.4	0	u	0.5
8	S	34.0	--	34.0	0	--	0	0.5	--	0.5	0	--	0
	B	19.1	--	19.1	0.9	--	0.9	0.3	--	0.3	3.0	--	3.0
10	S	73.9	153	113.5	0.4	22.2	11.3	2.5	10.5	6.5	0.16	2.14	1.74
	B	14.2	6	10.4	0	0	0	1.5	0	0.8	0	u	0
12	S	16.6	237	126.8	0.9	2.5	1.7	1	3.5	2.3	0.9	0.71	0.73
	B	0	5	2.5	0	0.4	0.2	1	0	.5	0	u	0.4
A	S	--	66	66	--	4.4	4.4	--	2.5	2.5	--	1.76	1.76
	B	--	1	1	--	0	0	--	1	1	--	0	0
B	S	--	76	76	--	0.5	0.5	--	1.5	1.5	--	0.33	0.3
	B	--	7	7	--	0	0	--	0.5	0.5	---	0	0

Table 17. Enteric bacterial levels in Honokohau Harbor, Hawaii, in May 1973. Station "A" is located ca. 150 m NE of entrance channel off Maliu Point. Station "B" is located off sandy pocket beach to the SE. "--" indicates no sample was taken on that day. "u" indicates undefined quotient resulting from division by zero.

end of the range is represented by a single sample. The location of the isolated high value was different in the two cases. With the exception of station 10S, the daily variability expressed by the FC data was not as pronounced in the TC levels, though the low levels of the latter make direct comparison hazardous. The mean FC levels within the harbor were 7.4 FC/100 ml for the February data and 1.9 FC/100 ml for the May data. The median FC levels were 0 FC/100 ml and 0.4 FC/100 ml, respectively. FC standards applicable to class A waters state that the "fecal coliform content shall not exceed air arithmetic average of 200 per 100 ml during any 30-day period nor shall more than 10 percent of the samples exceed 400 per 100 ml in the same time period" (Public Health Regulations, State of Hawaii, Chapter 37-A).

Fecal Streptococci. Fecal streptococcus (FS) levels were also low during both investigations. Mean values are 3.3 FS/100 ml for the May survey and 5 FS/100 ml for the February survey. While no water quality standards exist for FS levels, they are taken to calculate the FC/FS ratio gain information regarding the probable nature of the bacterial input. FC/FS ratios significantly greater than 2 are most likely to contain wastes of human origin and ratios markedly less than 1 reflect a bacterial origin of animal wastes. However, the predictive ability of these values may be hindered somewhat as a result of the overall low values of both determinants. The majority of FC/FS ratios from both data sets (Tables 16 and 17) show that the measured bacterial levels are attributable to nonhuman sources. Overall, there were two instances, both occurring in the mauka berthing basin, in which the mean FC/FS ratios connote fecal bacteria of predominantly human origin (Station 2, Table 16 and Station 4, Table 17). An additional 12 percent of the samples had FC/FS ratios suggesting a predominance of human wastes in mixed pollution.

Heavy Metals.

Samples were taken to determine if the present harbor waters showed evidence of heavy metal pollution which might adversely affect the aquatic ecosystem. Samples were taken from the surface waters of the mauka basin and from the oligotrophic waters outside the harbor, and were analyzed to determine the concentration of seventeen metals. The results (Table 18) show there is no evidence of heavy metal pollution in the harbor. The figures, when detectable, show low values for all metals and no significant differences between the harbor and coastal waters. Comparison of these values with published values detailing the composition of seawater (Goldberg, 1966) also indicates normal metal levels prevail.

	Mauka Berthing Basin	Outside Coastal Ocean
	(concentrations in mg/l)	
Antimony	ND (0.001)	ND (0.001)
Arsenic	ND (0.1)	ND (0.1)
Cadmium	ND (0.01)	ND (0.01)
Cobalt	ND (0.001)	ND (0.001)
Copper	0.006	0.007
Chromium	ND (0.001)	ND (0.001)
Iron	0.014	0.010
Lead	ND (0.01)	ND (0.01)
Manganese	ND (0.01)	ND (0.01)
Mercury	ND (0.001)	ND (0.001)
Molybdenum	0.005	0.006
Nickel	0.001	0.001
Silver	ND (0.001)	ND (0.001)
Tin	ND (0.01)	ND (0.01)
Titanium	ND (0.1)	ND (0.1)
Vanadium	ND (0.1)	ND (0.1)
Zinc	ND (0.01)	ND (0.01)

NOTE: ND means not detected at the concentration indicated in parenthesis.

Table 18: Heavy metal levels in Honokohau Harbor and adjacent coastal waters.

Molluscs and Echinoids.

The species composition, distribution and abundance of molluscs and echinoids were studied over a three year period (Kay, 1971; 1972; 1973). The following information is taken from the final report (Kay, 1973) summarizing these investigations.

The outer basin is characterized by the greatest faunal diversity of both molluscs and echinoids, and the greatest density of urchins which occurs primarily at one to two meters depth. Eighty-five species of molluscs and urchins were recorded from the outer basin in 1973. Of these, sixty species of micromolluscs were found in the outer basin sediments (Table 19). The micromolluscan fauna is predominantly herbivorous and rubble-associated. The distribution and density of two dominant macromolluscs, the sessile, suspension feeding vermetid (Serpulorbis alii) and the oyster (Ostrea sandvicensis), is shown in Figure 32. The channel assemblages resemble those of the outer basin in species composition but contain fewer species of molluscs and echinoids. Thirty-three species of micromolluscs were recorded from the sediments and ledges of the connecting channel walls. The south channel wall supports almost 100% oyster cover in contrast to the north wall where oyster cover is about 20%. The south wall also has a greater variety of micromolluscs and sea urchins. In the inner basin a single vermetid was recorded on the walls and fine small molluscs were found in the sediments. A total of eight species of echinoids were found within the harbor. This distribution and density is shown in

TABLE 19 ABUNDANCE AND COMPOSITION OF MICROMOLLUSKS FROM SEDIMENT SAMPLES

	OUTER HARBOR			CHANNEL			INNER HARBOR			35-40 FT. OUTSIDE		
	71	72	73	71	72	73	71	72	73	71	72	73
No. samples	10	12	6	3[1/]	4	10	1	5	4	1	1	1
Numbers/cm^3	1	1	2.1	+	+	.40	+	+	+	9.4	9.6	13.4
Number species	32	37	59	7	11	33	-	-	1	50	42	56
Species diversity (H')	3.6	2.9		4.1	3.7	4.5	-	-	-	4.3	3.9	4.2
Relative Abundance (%)												
Brackish water species	33	40	5	72	50	47	100	90	99	-	-	-
Infaunal species	15	8	5							3	3	<1
Gastropod Composition[2/]												
Archaeogastropods	18	12	16							23	16	31
Mesogastropods	52	67	55							66	69	59
Neogastropods	3	6	10							8	10	6
Opisthobranchs	27	14	19							3	5	4
Bivalves	11	12	8							<1	2	<1
Dominant Groups												
Tricolia	-	2	1							9	11	16
Leptothyra	-	-	1							9	5	13
Rissoidae	7	11	26							34	35	47
Rissoina miltzona[3/]	+	100	58							48	41	43
Vitricithna[3/]	+	-	3									
Cerithiidae	19	36	10							13	16	12
Bittium impendens[3/]	-	2	12							55	47	29
B. parcum[3/]	80	12	4							-	1	<1
B. zebrum[3/]	12	86	58							-	3	4
Turridae	-	2	2							5	5	2
Pyradmidellidae	7	7	13							-	2	3

1/ Number of shells not sufficient for meaningful analysis
2/ Based on marine species only
3/ per cent of Rissoidae or Cerithiidae

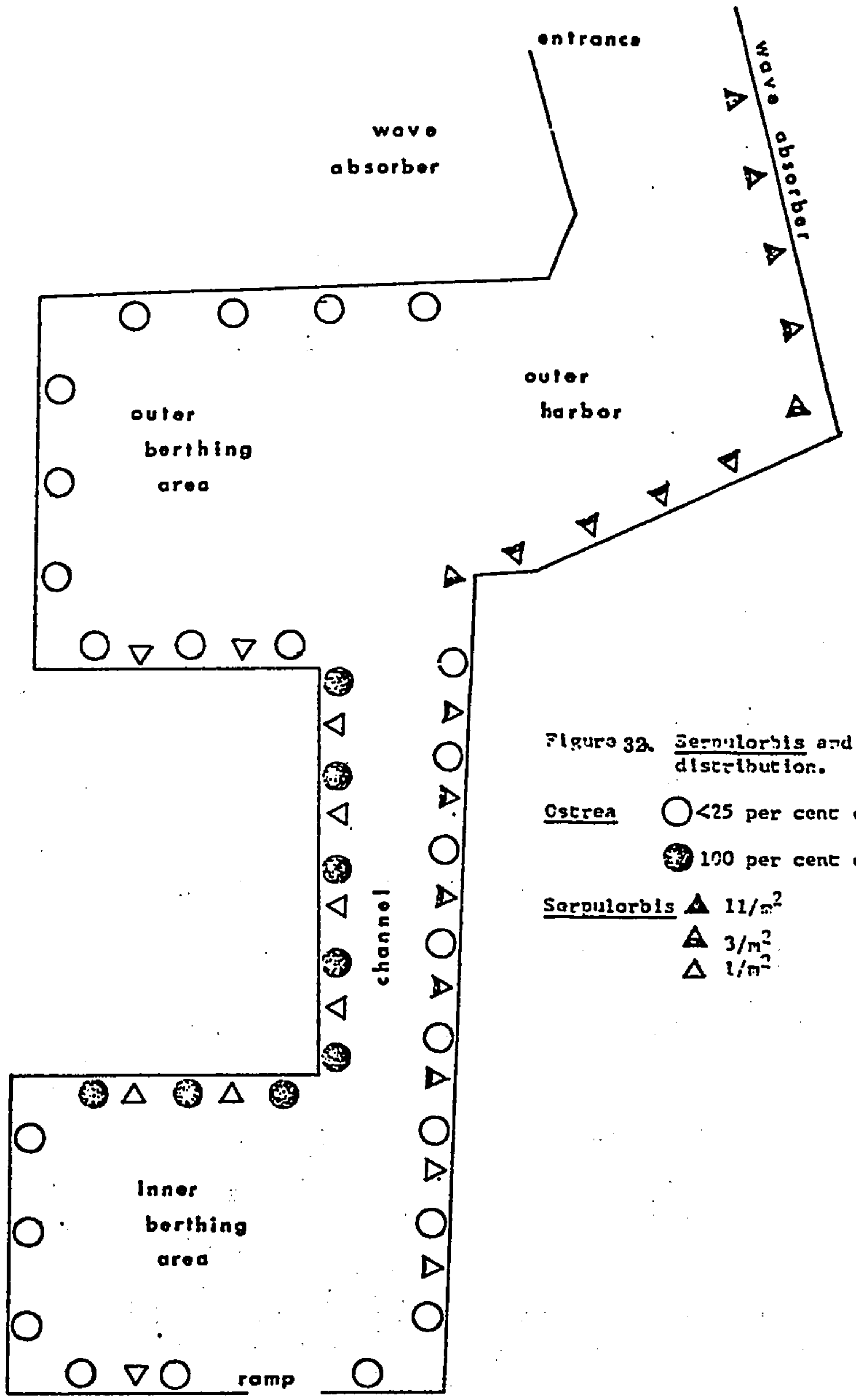


Figure 32. *Serpulorbis* and *Ostrea* distribution.

Ostrea ○ <25 per cent cover
● 100 per cent cover

Serpulorbis ▲ $11/m^2$
▲ $3/m^2$
△ $1/m^2$

Figure 33 and Tables 20 and 21 . Echinoid density decreases from the outer basin to the inner basin; a trend which was also apparent in 1971 and 1972 (Table 20).

Fish Populations.

The species composition, distribution and abundance of fishes were studied over a three year period (Wass, 1971; Brock, 1972; 1973). The following information is taken from the final report (Brock, 1973) summarizing these investigations.

The results of the three year study have yielded four important generalizations regarding the harbor fish population. An upward trend in the numbers of species and diversity is apparent within the harbor (Figures 34 and 36). Annual changes in species composition suggest that succession of fish species is still occurring. Recruitment of fishes to the outer harbor is primarily by sub-adults and adults rather than by juveniles. Increasing species diversity is apparent with greater proximity to the ocean (Figure 35).

In the inner basin during the 1971 survey 19 species (116 individuals) were seen; in 1972, 33 species (245 individuals) were encountered and in 1973, 25 species comprised of 142 individuals were enumerated. The majority of the fishes seen in this area over the three-year period were juveniles or sub-adults. The hierarchy of dominant species (those species with more than 10 individuals counted) are given below in Table 22 . The outer basin site had

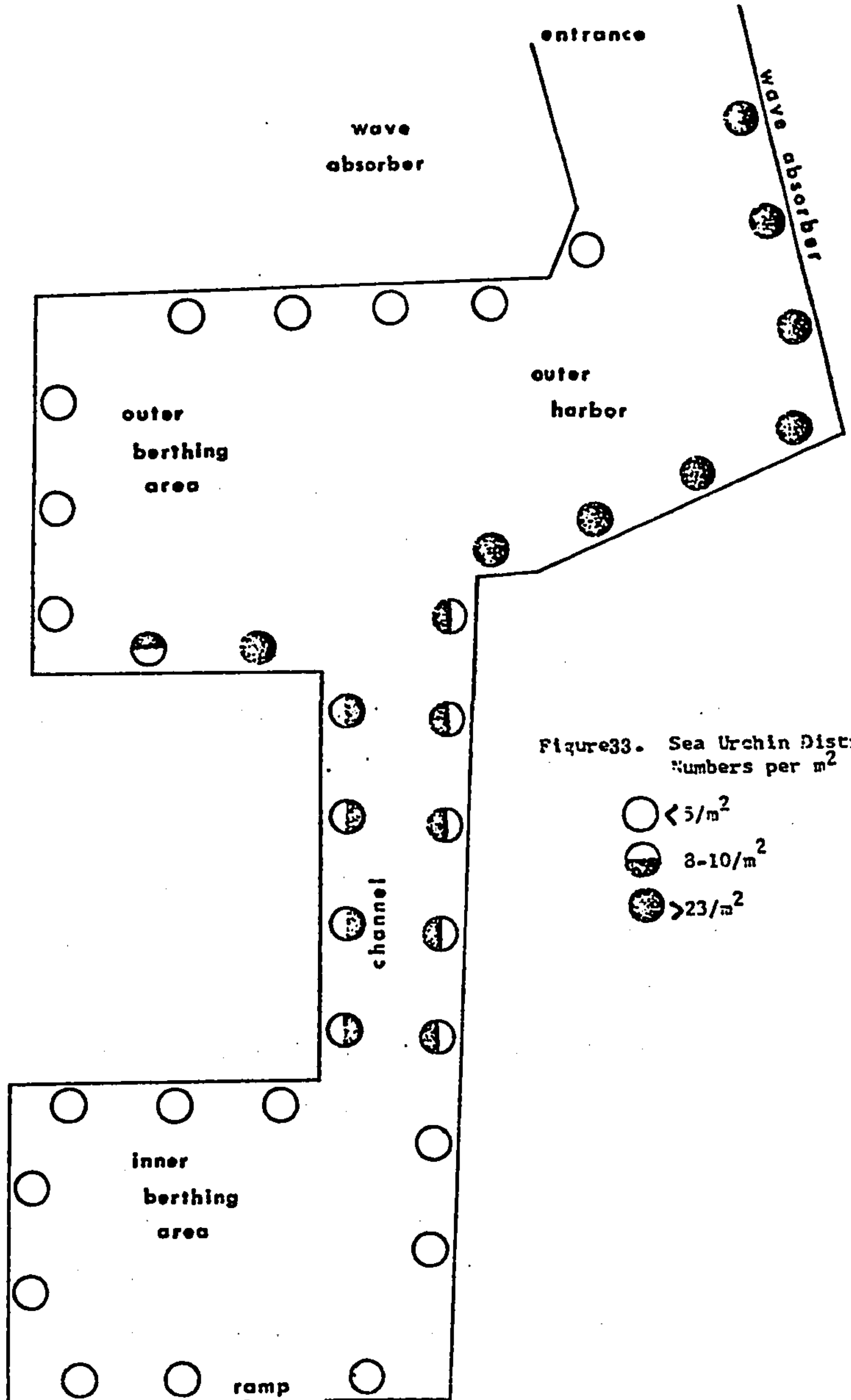


Figure33. Sea Urchin Distribution Numbers per m^2

Table 20 Distribution of Echinoids in Terms of Relative Frequency

	Outer Basin	Outer Berthing Area	Channel	Inner Berthing Area	Wave Absorber Walls
Colobocentrotus atratus					+
Diadema paucispina	23%	60%	51%	36%	
Echinometra mathaei	29	20	21		
Echinothrix calamaris	+	12	27		
Echinothrix diadema	82	32	70	71	
Eucidaris sp.	+				
Heterocentrotus mamillatus	71	8	34		
Psudoboletia sp.	+				
Tripneustes gratilla	96	80	93	28	

+ means present

that density decreases from the outer basin to the inner berthing area, as was found in 1971 and 1972 (Table).

Table 21 Density and Numers of Echinoids

	All urchins			Tripneustes			Echinothrix			Diadema		
	1971	1972	1973	1971	1972	1973	1971	1972	1973	1971	1972	1973
	(mean densities in numbers/m²)											
outer basin												
north wall	14.7	33.4	23.7	8.4	26.3	17.8	6.0	6.6	5.4	-	2.2	1.9
berthing area	10.3	5.9	5.5	9.7	5.2	3.8	1	2	3.1	1	3.8	2.0
base of wall	-	4.9	10.0	-	1.0	9.7	-	1.7	-	-	2.2	.23
channel												
north wall	4.7	8.2	7.0	5.4	6.7	8.8	1.2	2.8	2.0	-	-	1.7
south wall	5.4	8.7	10.3	3.4	7.2	4.8	2	2.0	4.3	-	-	1.5
inner basin	0.5	2.3	2.0	-	1.7	1	0.5	1.8	3.5	-	1	1

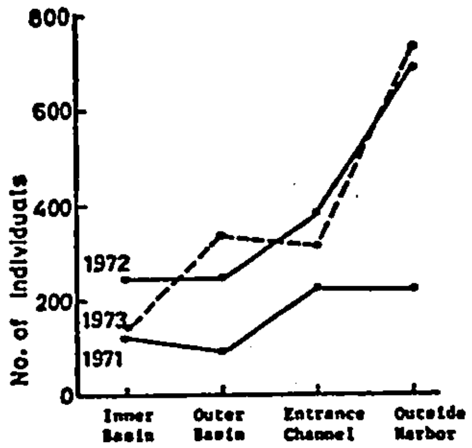


Figure 34 Plot of the total number of individuals encountered at each of the four transect areas at Honokohau Harbor over the three year study period.

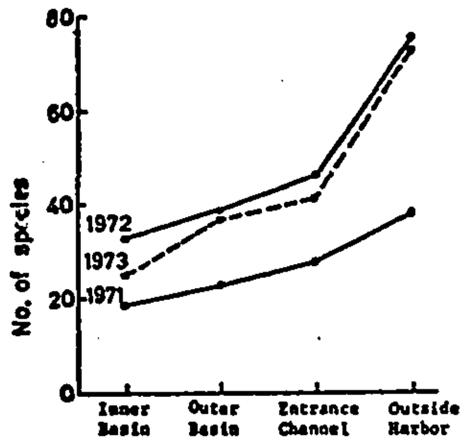


Figure 35 Number of species found within each study area at Honokohau Harbor over the three year study period.

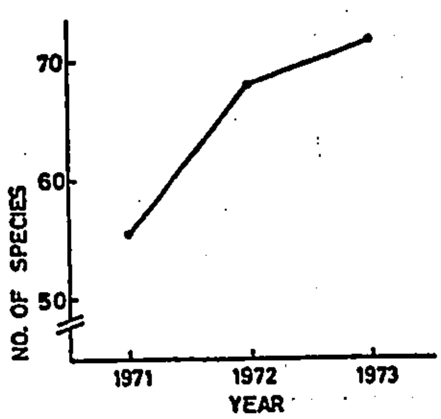


Figure 36 Total number of species seen within Honokohau Harbor each year of the three year study period.

23 species (93 individuals) in 1971, increasing to 38 species (244 individuals) in 1972 and 37 species (337 individuals) in 1973. This is a loss of 1 species from 1972 to 1973. The dominant species seen in this area are given in Table 23. The numbers of species and individuals in the entrance channel area over the three-year period have changed accordingly: 28 species, 225 individuals in 1971; 46 species, 381 individuals in 1972; and 41 species with 311 individuals in 1973 (Table 24). In 1972 and 1973 fish census taken outside the harbor to the north of the entrance channel yielded 75 species (689 individuals) and 73 species (729 individuals), respectively.

Coral Communities.

The species composition, distribution and abundance of corals were studied over a three-year period (Maragos, 1971; 1972; 1973). The following information is taken from the final report (Maragos, 1973) summarizing these investigations.

Results of the coral surveys reveal a continuation of the trends of increasing coral density, average size, community diversity and zonation. The average density of corals (2.66 colonies/M^2 in 1973) has risen markedly since the earlier surveys and practically all areas show increases (Table 25). Corals are most numerous on the harbor walls adjacent to the entrance channel. The average and maximum size of corals increased dramatically between 1972 and 1973 (Table 25); largest colonies of the common species showed maximum

1971	1972	1973
Acanthurus triostegus sandvicensis ([illegible])	Acanthurus triostegus sandvicensis ([illegible])	Gobiidae (associated with a shrimp) ([illegible])
Ctenochaetus strigosus (15)	Mulloidichthys samoensis (49)	Kelloggella oligolepis (22)
Mulloidichthys samoensis (14)	Ctenochaetus strigosus ([illegible])	Ctenochaetus strigosus ([illegible])
Aulostomus chinensis (10)	Abudefduf abdominalis (24)	Mulloidichthys samoensis (14)
	Juvenile scarids (23)	Acanthurus triostegus sandvicensis ([illegible])
	Apogon maculiferus (19)	Asterropteryx semipunctatus (11)
	Mulloidichthys auriflamma (11)	

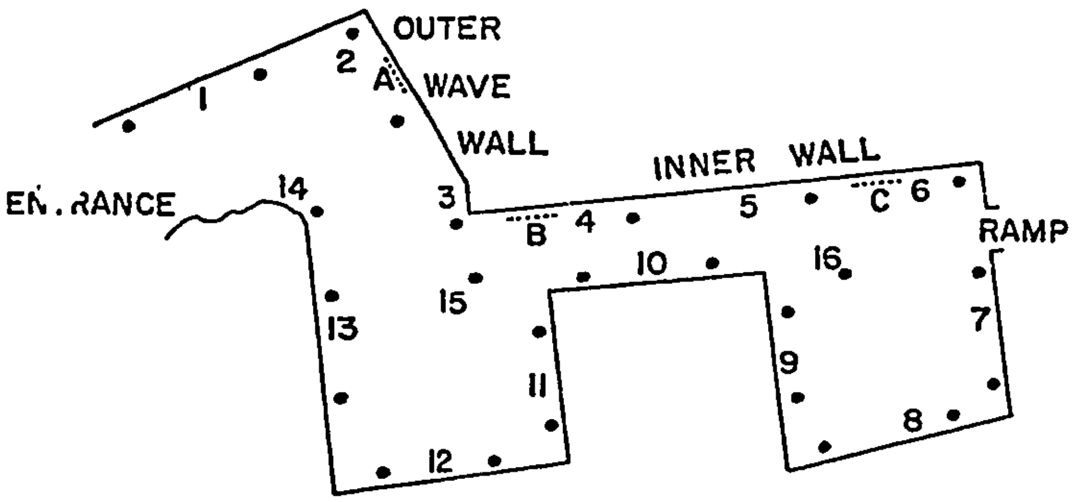
Table 22 Hierarchy of dominant fish species recorded in the inner basin of Honokohau Harbor. Actual numbers of individuals are given in parentheses.

1971	1972	1973
Acanthurus triostegus sandvicensis (19)	Ctenochaetus strigosus (45)	Stolephorus purpureus ([illegible])
Apogon maculiferus (12)	Mulloidichthys samoensis (34)	Ctenochaetus strigosus (45)
Abudefduf abdominalis (12)	Acanthurus triostegus sandvicensis (26)	Gobiidae sp. (associated with a shrimp) (21)
Ctenochaetus strigosus (12)	Mulloidichthys auriflamma (24)	Acanthurus olivaceus ([illegible])
	Acanthurus olivaceus (15)	Apogon snyderi (19)
	Apogon maculiferus (14)	Acanthurus triostegus sandvicensis ([illegible])
	Abudefduf abdominalis (10)	Juvenile scarids ([illegible])
		Asterropteryx semipunctatus (12)
		Kelloggella oligolepis (12)
		[illegible] ([illegible])
		[illegible] (10)

Table 23 Dominant species of fishes seen in the outer basin of Honokohau Harbor. Actual numbers of individuals are given in parentheses.

1971	1972	1973
Pomacentrus jenkinsi (36)	Pomacentrus jenkinsi (52)	Pomacentrus jenkinsi (52)
Acanthurus nigrofuscus (26)	Mulloidichthys samoensis ([illegible])	Ctenochaetus strigosus (50)
Acanthurus triostegus sandvicensis ([illegible])	Ctenochaetus strigosus (31)	Acanthurus nigrofuscus (37)
Mulloidichthys samoensis (24)	Acanthurus nigrofuscus (29)	Stethojulis balteata (37)
Kuhlia sandvicensis (20)	Thalassoma duperreyi (22)	Thalassoma duperreyi (29)
Abudefduf abdominalis (19)	Mulloidichthys auriflamma (22)	Acanthurus triostegus sandvicensis (15)
Thalassoma duperreyi (16)	Acanthurus triostegus sandvicensis (21)	Juvenile scarids (12)
Ctenochaetus strigosus (11)	Chromis vanderbilti (16)	
	Kuhlia sandvicensis (16)	
	Stethojulis balteata (13)	
	Acanthurus olivaceus (12)	
	Abudefduf abdominalis (11)	

Table 24 Dominant species of fish seen in the Honokohau Harbor entrance channel. Actual numbers of individuals are given in parentheses.



Density $\#/m^2$

Station	3-1970	9-1971	10-1972	10-1973
1	0	0.24	3.00	5.10
2	0	0.28	4.83	5.82
3	0	0.05	3.67	8.08
4	0	0.05	2.56	3.29
5	0	0.02	2.13	3.07
6	0	0	0.33	0.62
7	0	0	0.01	0.27
8	0	0	0.01	0.23
9	0	0	0.01	0.20
10	0	0.01	0.33	2.17
11	0	0.02	2.44	2.00
12	0	0.04	1.67	1.67
13	0	0.02	0.20	2.00
14	0	0.02	1.00	1.67
15	0	0.01	0.44	4.22
16	0	0.01	0.30	2.22
Mean	0.00	0.05	1.43	2.66

Table The density of coral colonies at 16 locations (above) within Honokohau Harbor at four intervals between 1970 and 1973.

Species	Maximum Diameter - cm 1971	1972	1973
Cyphastrea ocellina	1	2	4
Leptastrea bottae	2	4	6
Leptastrea purpurea	2	4	7
Leptoseris incrustans	-	-	4
Montipora patula	6	11	20
Montipora verrilli	-	11	16
Montipora verrucosa	2	8	11
Pavona varians	6	13	18
Pocillopora damicornis	4	7	10
Pocillopora ligulata	5	8	11
Pocillopora meandrina	8	12	16
Porites compressa	4	11	16
Porites lobata	4	11	16
Mean	4.0	8.5	12.5

Table 26 The maximum dimension of the largest colonies of each species of reef coral observed in Honokohau Boat Harbor during the 3 surveys conducted between 1971-1973.

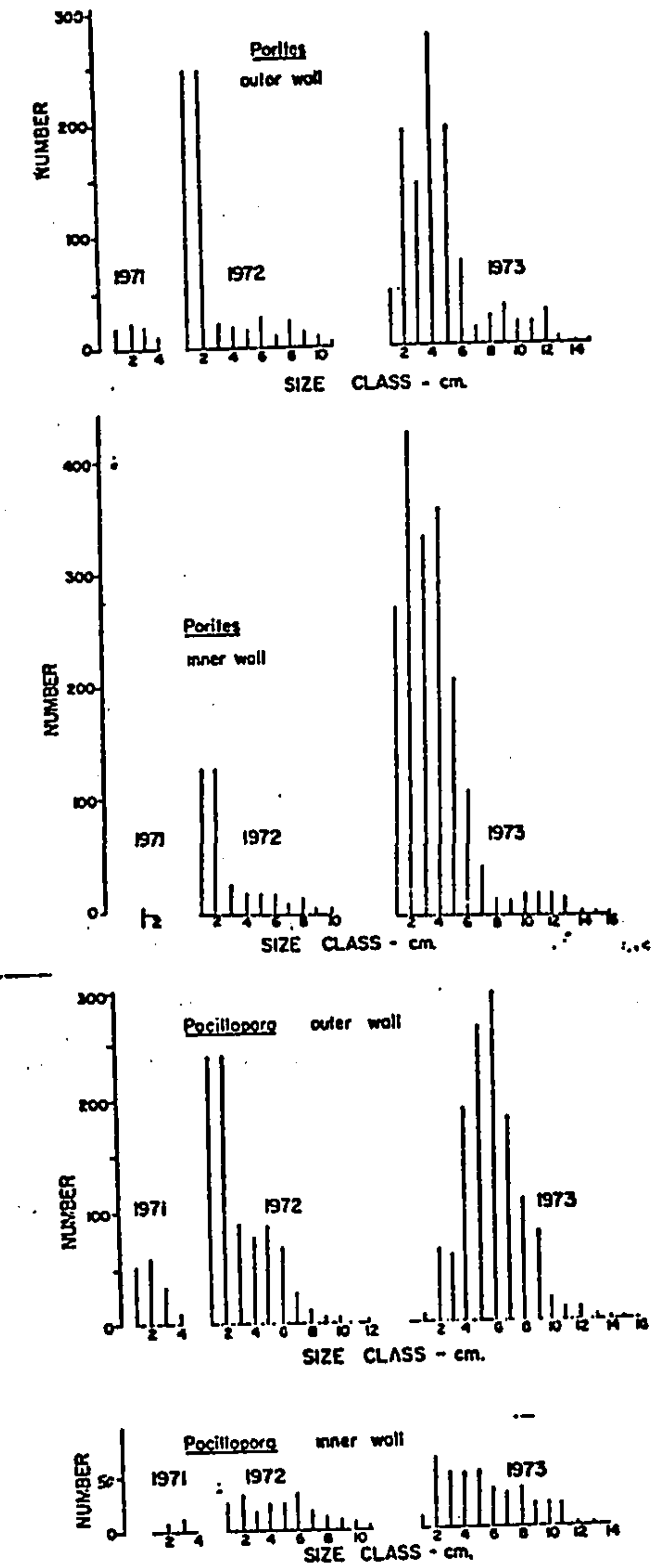


Figure 37 Size frequency distribution of Porites and Pocillopora on two harbor walls at 3 different times during the past 3 years. 1973 data derived from surveys of partitioned walls and from maximum size data.

diameters between 16 and 20 cm. Growth and recruitment rates by corals during 1972–1973 and comparable with those of 1971–1972. The corals Montipora patula, Pavona varians, Pocillopora meandrina and all Porites species showed diameter increases of 4–6 cm/year; other species appear to be growing more slowly (1–3 cm/year). The average recruitment rate of 1.23 colonies/M^2/yr computed for 1973 compares favorably with the 1.39 colonies/M^2/yr value estimated for 1972. Corals have failed to colonize substrates at shallow depth where the cold, low salinity layer is well developed (Figure 38). The 1973 survey showed a shift in dominance from Pocillopora to Porites colonies and other corals (e.g. Montipora and Pavona) are also increasing in relative abundance. This is consistent with the speculation (Maragos, 1972) that the harbor coral community should continue to grow and develop into a mature mixed Porites assemblage similar to the community outside the harbor, provided that conditions within the harbor remain satisfactory for coral growth and survival.

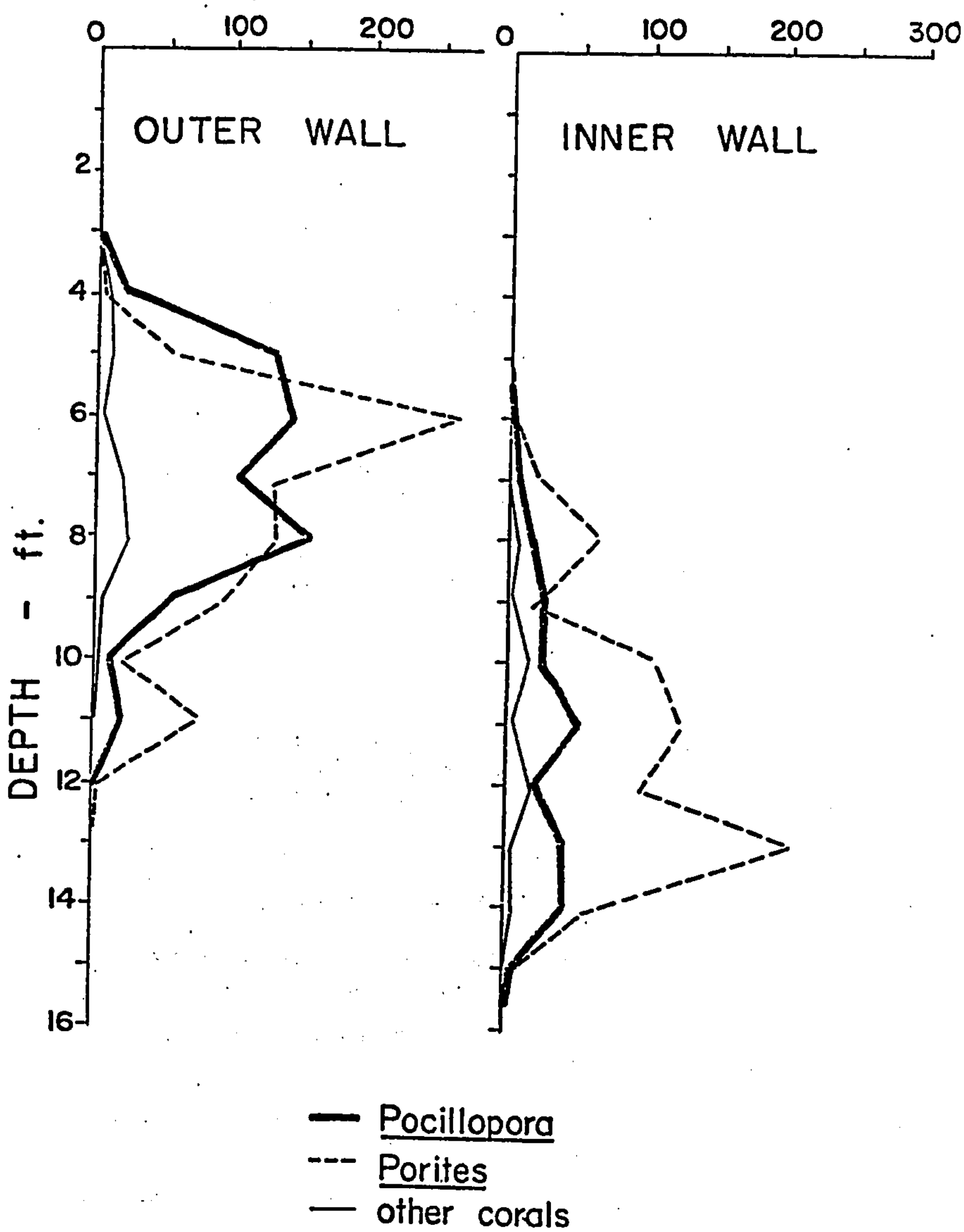


Figure 38 Vertical abundance distribution of Porites, Pocillopora, and other corals on two separate locations on the north wall. A - outer wave absorber wall B - inner channel wall. Data derived from surveys of partitioned walls (see methods).

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APPENDIX "C"

APPENDIX C

NOAA-JTRE-137 CONTRIBUTION

A STUDY OF THE NORMAL MODES OF OSCILLATION OF HONOKOHAU HARBOR, HAWAII

By

Harold G. Loomis

Joint Tsunami Research Effort
National Oceanic and Atmospheric Administration

June 13, 1975

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LIST OF FIGURES

A STUDY OF THE NORMAL MODES OF OSCILLATION OF HONOKOHAU HARBOR, HAWAII

I. INTRODUCTION

In connection with a proposed expansion of the small boat harbor at Honokohau, north of Kailua, Kona on the island of Hawaii, it was thought desirable to calculate the normal modes of oscillation of the harbor as it presently stands and also for each of the proposed modifications. This work is readily accomplished with the aid of computer programs previously worked out and reported in Loomis (1970, 1973). Having once gotten the ideas in mind and the computer program working successfully on one case, it was a simple matter to examine the effect of each proposed modification by changing a few cards in the program and resubmitting it to the computer. Each such calculation takes from one to two minutes of processing time on the IBM 370 model--and costs between $5 and $10.

II. THEORY

The theory and programming considerations are described in detail in Loomis (1973). In short, the shallow water, long wave equation for variable depth, namely,

$$\frac{\partial}{\partial x}\left(h\,\frac{\partial\phi}{\partial x}\right) + \frac{\partial}{\partial y}\left(h\,\frac{\partial\phi}{\partial y}\right) = \frac{1}{g}\,\frac{\partial^2\phi}{\partial t^2} \qquad (1)$$

is solved for steady state solutions of the form $\phi = e^{-i\omega t}\phi_1(x,y)$ with boundary conditions that the velocity normal to a reflecting boundary is zero, i.e., $\partial\phi/\partial n = 0$ and, the velocity potential $\phi = 0$ at a great distance from the harbor entrance in the open ocean.

Taking the time derivative (1) becomes

$$\frac{\partial}{\partial x}\left(h\frac{\partial \phi_1}{\partial x}\right) + \frac{\partial}{\partial y}\left(h\frac{\partial \phi_1}{\partial y}\right) = -\frac{\omega^2}{g}\phi_1 \qquad (2)$$

where ω and ϕ_1 are the unknowns to be solved for as eigenvalue and eigenvector, respectively.

Equation (2) has been rendered into a symmetric difference form and the resultant frequencies and amplitudes of the normal modes are found.

III. RESULTS

The accuracy of the calculations far exceeds the input data which was a number of sketches on 8-1/2 inch by 11 inch paper of the various proposals. Nevertheless, the general picture is not too sensitive to minor changes or alterations. In every case, normal modes of oscillation fall into the frequency range easily excitable by energies in the open ocean, namely, periods of 30 to 600 sec. During high surf conditions, individual wave sets, as well as surf beat can be expected to excite various normal modes of oscillation in the harbor.

Figures 1-5 show the plan views used in calculating normal modes for the present harbor for various modifications. The results are summarized in Table 1.

In the appendices are a listing of the computer program and detailed outputs of the normal modes for each case.

Every configuration considered here has natural periods of oscillation that can be excited by high surf directly or through the resultant surf beat. This effect is reported in the present harbor during conditions of heavy surf when (from all descriptions) the fourth mode with period 52 sec. is set to oscillating in the first basin along a north-south axis.

Table 1. Periods (in seconds) of normal modes of oscillation of Honokohan Harbor and proposed modifications

PERIODS IN SECONDS										
Mode No.	1	2	3	4	5	6	7	8	9	10
Present	348	150	58	52	47	40	33	32	29	27
Mod. B	688	194	142	96	72	57	56	52	52	50
Mod. C1	634	194	115	98	74	67	60	58	52	50
Mod. C3	461	109	99	76	55	51	48	46	43	37

Figure 1. Present harbor at Honokohau showing the coupling of the harbor to the open ocean with variable grid spacing (plan A).

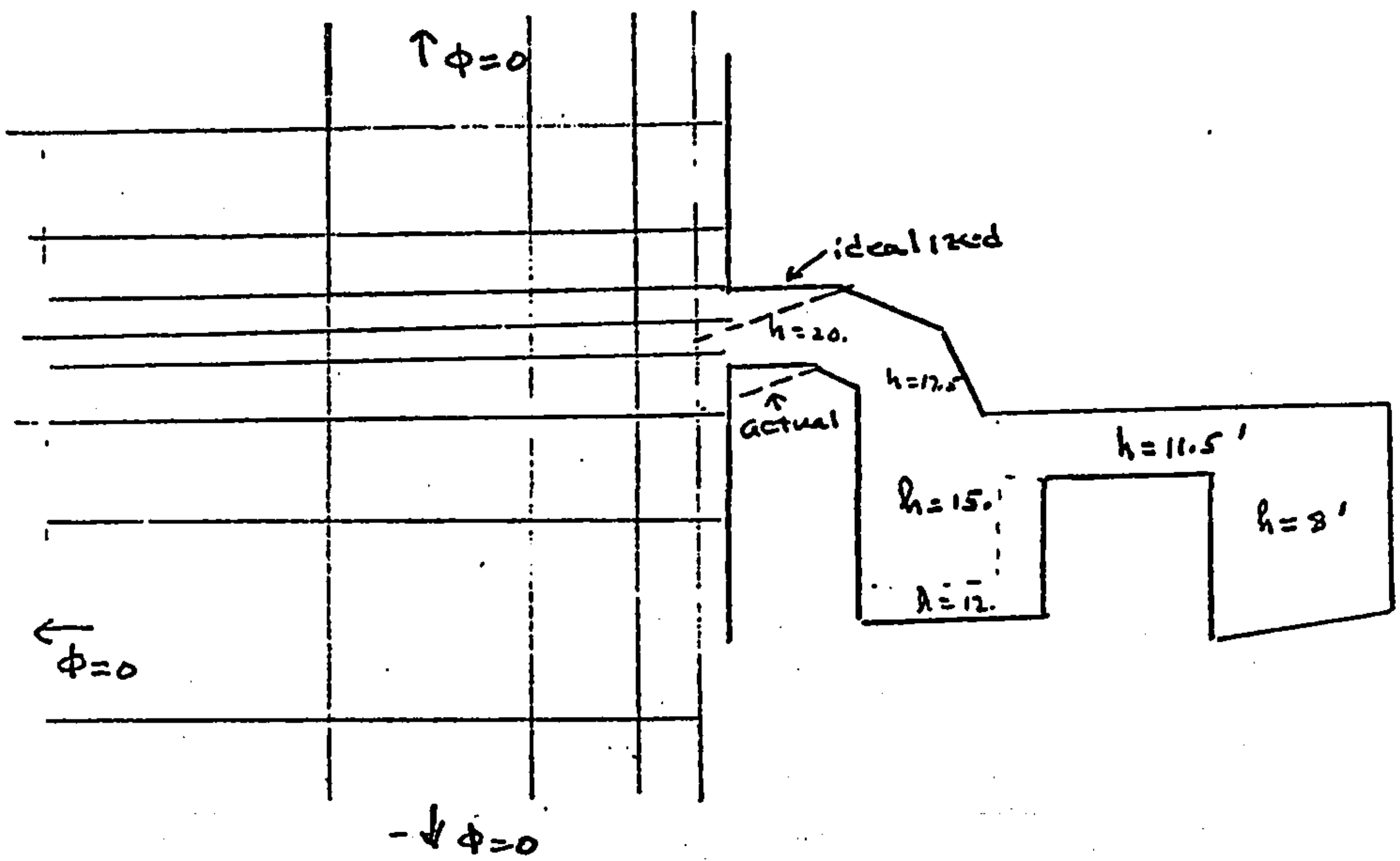
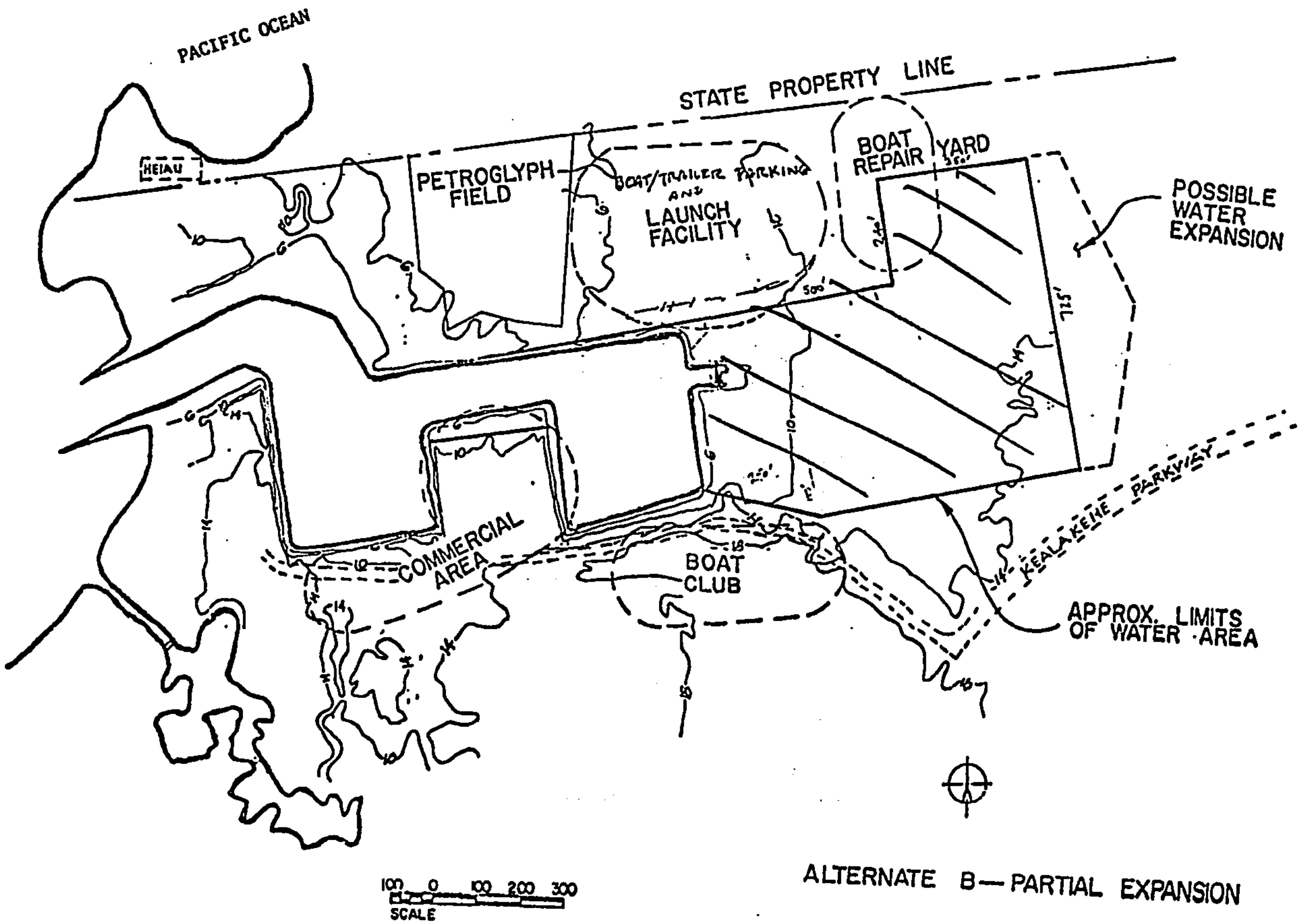


Figure 2. Proposed expansion B.



ALTERNATE B—PARTIAL EXPANSION

FIGURE 2

Figure 3. Proposed expansion C1.

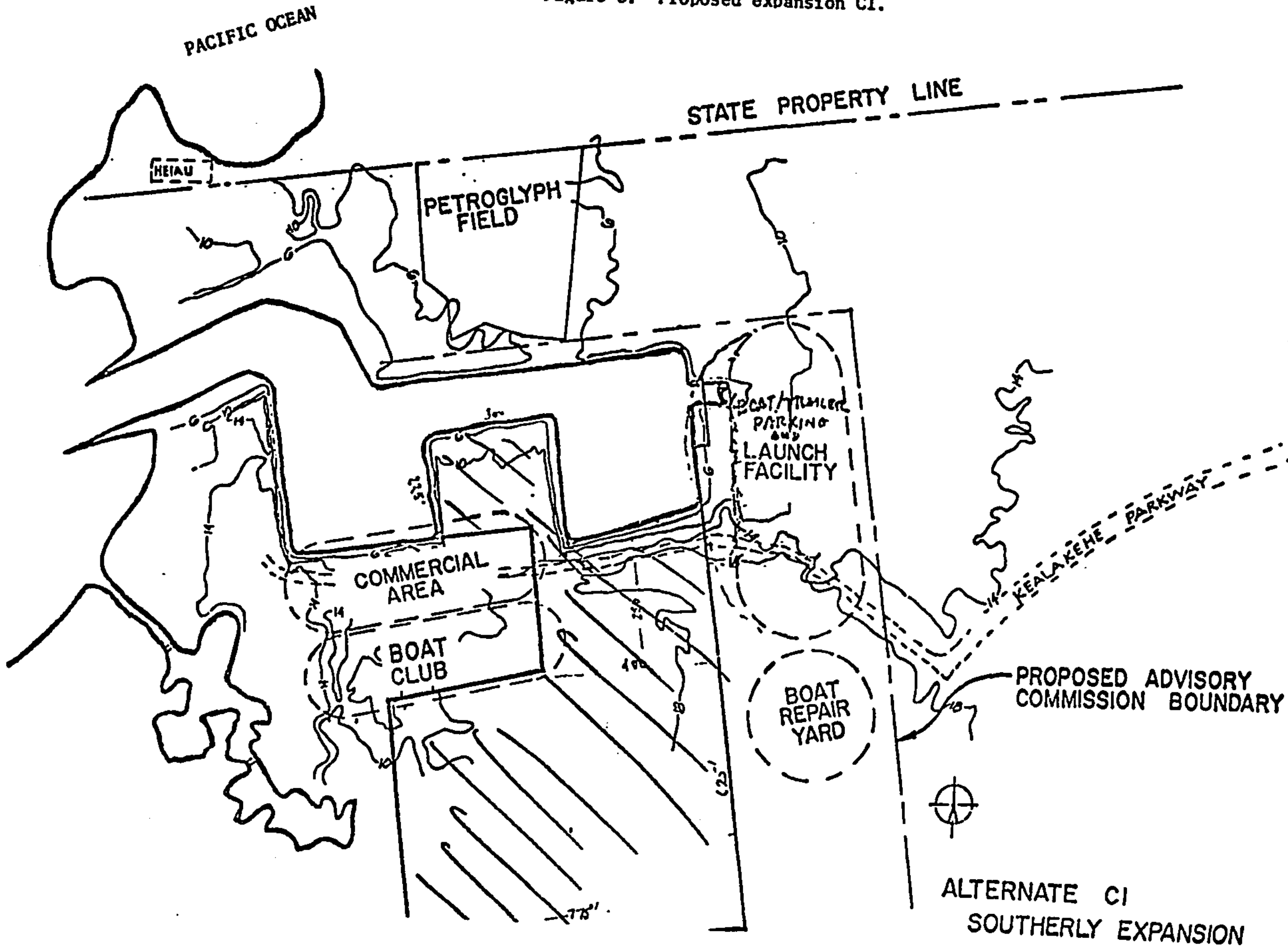
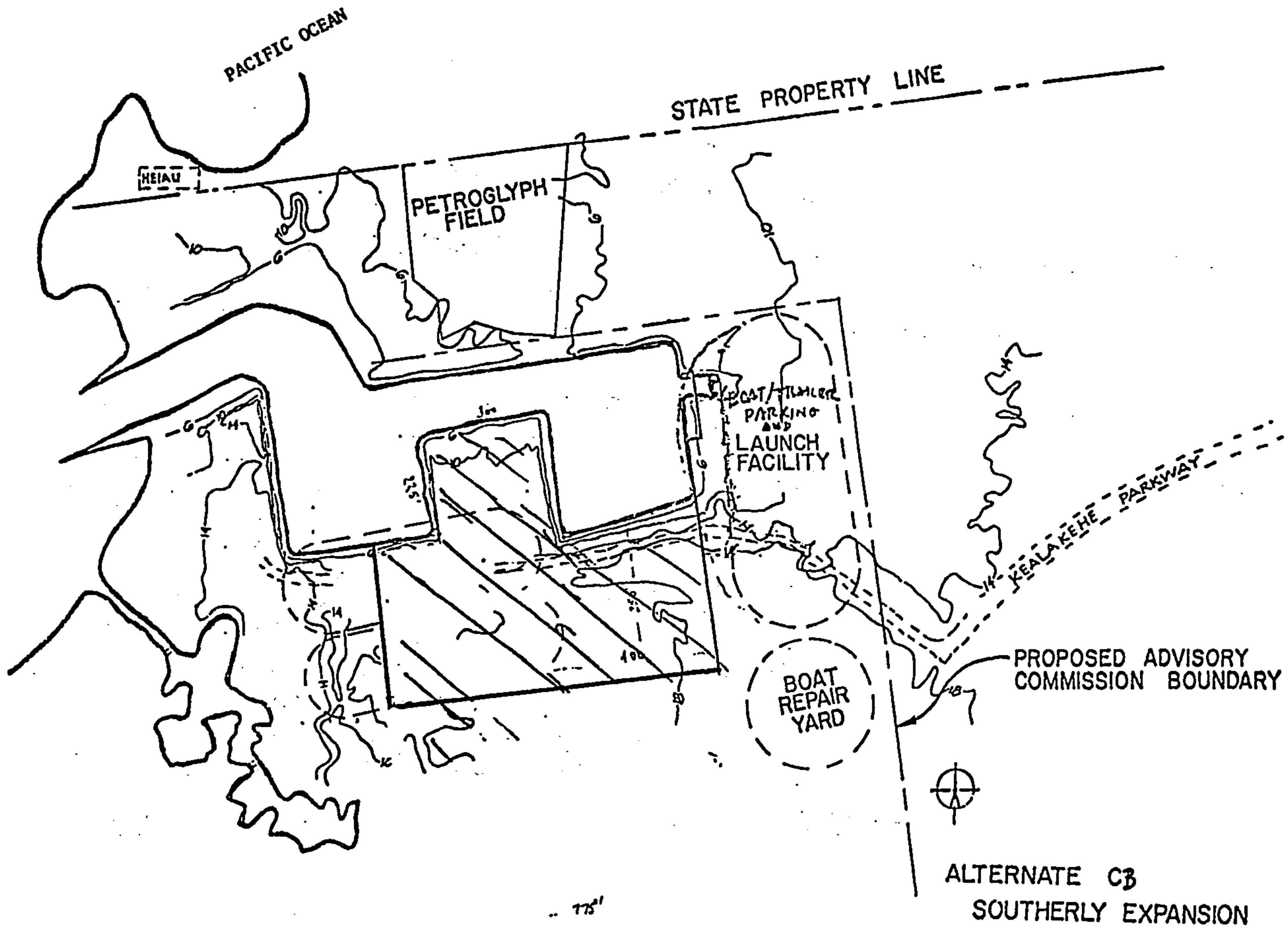


Figure 4. Proposed expansion C3.



Appendix I. Complete computer program and output for present harbor (plan A), natural frequencies and amplitudes of normal modes along with contoured map of mode amplitudes for the five modes with longest periods.

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LEVEL 21.8 ( JUN 74 )                    OS/360  FORTRAN H                                  DATE 75

           COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
                              SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
  ISN 0002           COMMON /A/IKEY
               C**THE BASIC EQUATION IS DEL*(H(X,Y)DEL)U(X,Y)=-C U(X,Y).
               C** THIS PACKAGE SETS UP AND SOLVES THE EIGENVALUE PROBLEM FOR A BODY OF WATER
               C** OF VARIABLE SHAPE AND DEPTH.  THE HX AND HY ARRAYS DESCRIBE THE BODY OF
               C** WATER. MAX NO. OF GRID POINTS IN WATER AREA IS 200 BUT THIS CAN BE CHANGED.
               C** MAX PROBLEM SIZE IS (NO. EVALS)*DIMENSION(EVCTR).LE.2000.
  ISN 0003           DIMENSION A(20100),B(2000),C(200),W(1200),Y(202),IN(200)
  ISN 0004           CALL ZERO(202,Y)
  ISN 0005           COMMON II(18,40),HX(18,41),HY(19,40)
  ISN 0006           CALL ZERO(18*40+18*41+19*40,II)
  ISN 0007           LOGICAL IN
               C** IPRINT=0, NEITHER A NOR B PRINTED. IPRINT=1, B PRINTED.  IPRINT=2, A PRINTED
               C** IPRINT=3, A AND B PRINTED.  JVCTR= NO. OF VECTORS DISPLAYED. JEVALS=NO. OF
               C** EIGENFREQUENCIES OUTPUTTED.   IEIGEN=0 EVALUES AND EVECTORS COMPUTED. IEIGEN=
               C** 1.EIGENVALUES COMPUTED ONLY. B IS OF DIMENSION L BY JVCTR.
  ISN 0008           IPRINT =0
  ISN 0009           IEIGEN=0
  ISN 0010           JVCTR=10
  ISN 0011           JEVALS=10
  ISN 0012           DELX=70.3
  ISN 0013           DELX=70.3
  ISN 0014           DELY=DELX
  ISN 0015           GRVTY=32.2
  ISN 0016           PRINT 18,DELX,DELY,GRVTY
  ISN 0017        18 FORMAT(' DELX = ',E12.5,', DELY = ',E12.5,', AND GRAVITATIONAL CON
                    .STANT = ',F8.2)
  ISN 0018           N=18
  ISN 0019           M=30
               C** BATHYMETRY IS READ IN OR ASSIGNED IN READH.  A IS USED AS A WORK AREA.
  ISN 0020           CALL READH(N,M)
               C** THE II MATRIX IS AUTOMATICALLY CONSTRUCTED.
  ISN 0021           L = 0
  ISN 0022           DO 2 J1=1,M
  ISN 0023           DO 2 I1=1,N
  ISN 0024           I=N-I1+1
  ISN 0025           J=M-J1+1
  ISN 0026           IF(HX(I,J)+HY(I,J)+HX(I,J+1)+HY(I+1,J).EQ.0.)GO TO 2
  ISN 0028           L = L+1
  ISN 0029           II(I,J) = L
  ISN 0030         2 CONTINUE
               C** A NODE IS PRESCRIBED AT THE FOLLOWING BOUNDARY POINTS.
  ISN 0031           DO 3 J=1,11
  ISN 0032           II(1,J)=L+1
  ISN 0033         3 II(13,J)=L+1
  ISN 0034           DO 4 I=1,13
  ISN 0035         4 II(I,1)=L+1
               C** MISSING INDICES ARE ELIMINATED IN II.
  ISN 0036           CALL CMPRS(N,M,L)
               C** II HX AND HY ARE DISPLAYED ALONG WITH A SCHEMATIC OF REGION.
  ISN 0037           CALL DISPL1(L,N,M,1,)
  ISN 0038           PRINT 19,L
  ISN 0039        19 FORMAT('0MAX INTEGER =',I4)
               C** FROM HERE ON DOWN THE PROGRAM IS UNCHANGED FOR EACH CASE.
  ISN 0040           IF (L.GT.200) STOP
```

2'

```
              C** SYMMETRIC MATRIX IS CONSTRUCTED.
 ISN 0042          CALL SYMOPI(L,A,N,M,DELX/SORT(GRVTY),DELY/SORT(GRVTY))
              C** EIGENVALUES AND EIGENVECTORS ARE CALCULATED.  J TH EVALUE IS IN C(J) AND
              C** EVCTR IN B(1,J).
 ISN 0043          CALL HOUGIV(A,C,B,W,Y,IN,L,JEVALS,JVCTR)
              C** JEVALS ARE PRINTED.
 ISN 0044          PRINT 20,JEVALS
 ISN 0045       20 FORMAT(/1X,I3,' EIGENVALUES OF A FOLLOW'/)
 ISN 0046          PRINT 21,(C(J),J=1,JEVALS)
 ISN 0047       21 FORMAT(10(1X,E12.5))
 ISN 0048          IF (IEIGEN.EQ.1) GO TO 13
              C** EIGENVECTOR IS PRINTED OUT WITH VALUES IN PROPER LOCATION IN PLAN VIEW.
 ISN 0050          DO 11 J=1,JVCTR
 ISN 0051          IKEY=1
 ISN 0052          CALL PRVTRI(J,B(1+L*(J-1)),C(J) ,N,M,L)
 ISN 0053       11 CONTINUE
 ISN 0054          DO 13 J=1,2
 ISN 0055          IKEY=2
 ISN 0056          CALL PRVTRI(J,B(1+L*(J-1)),C(J) ,N,M,L)
 ISN 0057       13 CONTINUE
 ISN 0058       99 CONTINUE
 ISN 0059       25 FORMAT('1')
 ISN 0060          STOP
 ISN 0061          END
*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
*STATISTICS*     SOURCE STATEMENTS =      60 ,PROGRAM SIZE =    97170
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******
                                                          35K BYTES OF CORE NOT USED
```

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3.  LEVEL 21.8 ( JUN 74 )                                    OS/360   FORTRAN H                                        DATE

                 COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
                                    SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                       C******
       ISN 0002                  SUBROUTINE READH(N,M)
                       C** CONSTRUCTS BATHYMETRY ARRAYS FOR HONOKOHOU
       ISN 0003                  COMMON II(18,40),HX(18,41),HY(19,40)
       ISN 0004                  DEL=2.
       ISN 0005                  DEL=1.88
       ISN 0006                  PRINT 21,DEL
       ISN 0007               21 FORMAT('ODEL=',E12.5)
       ISN 0008                  N1=N+1
       ISN 0009                  M1=M+1
       ISN 0010                  DO 1 I=1,N
       ISN 0011                  DO 1 J=1,M1
       ISN 0012                  X=1.0+DEL*(J-12)
       ISN 0013                  Y=1.5+DEL*(I-6)
       ISN 0014                  D=0.
       ISN 0015                  IF(X.GT.24..AND.X.LE.32.5.AND.Y.GT.10..AND.Y.LE.17.2)D=8.
       ISN 0017                  IF(X.GT.14.5.AND.X.LE.32.5.AND.Y.GT.7..AND.Y.LE.10.1)D=11.5
       ISN 0019                  IF(X.GT.7..AND.X.LE.16..AND.Y.GT.10..AND.Y.LE.16.6)D=12.
       ISN 0021                  IF(X.GT.7..AND.X.LE.14.5.AND.Y.GT.7..AND.Y.LE.14.3)D=15.
       ISN 0023                  IF(Y.GT.1..AND.X.LE.11.3.AND.Y.LE.7..AND.Y-.5*X.GT.-3..AND.
                               C  X.GT.7.)D=17.5
       ISN 0025                  IF(X.GT.11.3.AND.Y.LE.7..AND.Y-2.*X.GT.-20.)D=17.5
       ISN 0027                  IF(Y.LE.4.6.AND.X.LE.7..AND.Y.GT.1..AND.X.GE.1.)D=20.
       ISN 0029                  IF(X.LT.1..AND.X.GT.-18..AND.ABS(Y-2.75).LT.13.)
                                  D=20.+20.*((X-1.)**2+.5*(Y-2.75)**2)
       ISN 0031                  HX(I,J)=D
       ISN 0032                1 CONTINUE
       ISN 0033                  DO 2 J=1,M
       ISN 0034                  DO 2 I=1,N1
       ISN 0035                  X=1.5+DEL*(J-12)
       ISN 0036                  Y=1.0+DEL*(I-6)
       ISN 0037                  D=0.
       ISN 0038                  IF(X.GT.24..AND.X.LE.32.5.AND.Y.GT.10..AND.Y.LE.17.2)D=8.
       ISN 0040                  IF(X.GT.14.5.AND.X.LE.32.5.AND.Y.GT.7..AND.Y.LE.10.1)D=11.5
       ISN 0042                  IF(X.GT.7..AND.X.LE.16..AND.Y.GT.10..AND.Y.LE.16.6)D=12.
       ISN 0044                  IF(X.GT.7..AND.X.LE.14.5.AND.Y.GT.7..AND.Y.LE.14.3)D=15.
       ISN 0046                  IF(Y.GT.1..AND.X.LE.11.3.AND.Y.LE.7..AND.Y-.5*X.GT.-3..AND.
                               C  X.GT.7.)D=17.5
       ISN 0048                  IF(X.GT.11.3.AND.Y.LE.7..AND.Y-2.*X.GT.-20.)D=17.5
       ISN 0050                  IF(Y.LE.4.6.AND.X.LE.7..AND.Y.GT.1..AND.X.GE.1.)D=20.
       ISN 0052                  IF(X.LT.1..AND.X.GT.-18..AND.ABS(Y-2.75).LT.13.)
                                  D=20.+20.*((X-1.)**2+.5*(Y-2.75)**2)
       ISN 0054                  HY(I,J)=D
       ISN 0055                2 CONTINUE
       ISN 0056                  RETURN
       ISN 0057                  END

    *OPTIONS IN EFFECT*        NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,

    *OPTIONS IN EFFECT*        SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

    *STATISTICS*     SOURCE STATEMENTS =       56 ,PROGRAM SIZE =      1784

    *STATISTICS*  NO  DIAGNOSTICS GENERATED
```

```
4. LEVEL 21.8 ( JUN 74 )                    OS/360   FORTRAN H                                   DATE

        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
              C*****
  ISN 0002          SUBROUTINE DISPLI(L,N,M,SC)
              C**   PRINTS THE II, HX, AND HY MATRICES AS WELL AS A SCHEMATIC OF THE REGION.
  ISN 0003          COMMON II(18,40),HX(18,41),HY(19,40)
  ISN 0004          DIMENSION LK(100)
  ISN 0005          DATA BL,EYE,BAR,OH/' ','I','-','O'/
  ISN 0006          DIMENSION SYM(41,41)
  ISN 0007          DO 1 I=1,41
  ISN 0008          DO 1 J=1,41
  ISN 0009        1 SYM(I,J)=BL
  ISN 0010          MP1=M+1
  ISN 0011          NP1=N+1
  ISN 0012          PRINT 23
  ISN 0013          DO 4 I=1,N
  ISN 0014        4 PRINT 25,(II(I,J),J=1,M)
  ISN 0015          PRINT 24, SC
  ISN 0016          DO 2 J=1,M
  ISN 0017          IF(HY(1,J).EQ.0.)SYM(1,J)=BAR
  ISN 0019          IF(II(1,J).GT.L)SYM(1,J)=OH
  ISN 0021        2 LK(J)=SC*HY(1,J)
  ISN 0022          PRINT 26,(LK(J),J=1,M)
  ISN 0023          DO 5 I = 1,N
  ISN 0024          DO 6 J=1,MP1
  ISN 0025          IF(HX(I,J).EQ.0.)SYM(2*I,J)=EYE
  ISN 0027          IF(II(I,J).GT.L)SYM(2*I,J)=OH
  ISN 0029        6 LK(J) = SC*HX(I,J)
  ISN 0030          PRINT 27,(LK(J),J=1,MP1)
  ISN 0031          DO 7 J=1,M
  ISN 0032          IF(HY(I+1,J).EQ.0.)SYM(2*I+1,J)=BAR
  ISN 0034          IF(II(I+1,J).GT.L)SYM(2*I+1,J)=OH
  ISN 0036        7 LK(J)=SC*HY(I+1,J)
  ISN 0037        5 PRINT 26,(LK(J),J=1,M)
  ISN 0038          PRINT 28
  ISN 0039          PRINT 30,(SYM(1,J),SYM(1,J),J=1,M)
  ISN 0040          DO 8 I=1,N
  ISN 0041          PRINT 29,(SYM(2*I,J),J=1,MP1)
  ISN 0042          PRINT 30,(SYM(2*I+1,J),SYM(2*I+1,J),J=1,M)
  ISN 0043        8 CONTINUE
  ISN 0044       23 FORMAT ('0GRID NUMBERING SCHEME FOLLOWS.',/)
  ISN 0045       24 FORMAT ('0WATER DEPTHS FOLLOW, MULTIPLIED BY ',E12.5,/)
  ISN 0046       25 FORMAT (1X,43I3)
  ISN 0047       26 FORMAT(3X,32I4)
  ISN 0048       27 FORMAT(1X,32I4)
  ISN 0049       28 FORMAT('0OUTLINE OF REGION FOLLOWS'/)
  ISN 0050       29 FORMAT(1X,33(A1,2X))
  ISN 0051       30 FORMAT(1X,33(1X,2A1))
  ISN 0052          RETURN
  ISN 0053          END

 *OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
 *OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
 *STATISTICS*    SOURCE STATEMENTS =      52 ,PROGRAM SIZE =    8906
```

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LEVEL 21.8 ( JUN 74 )                                    OS/360  FORTRAN H                                      DATE

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
                               SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                        C*****
      ISN 0002                 SUBROUTINE CMPRS(N,M,LL)
                        C** ELIMINATES MISSING NUMBERS AND COMPRESSES THE II ARRAY.
      ISN 0003                 COMMON II(18,40),HX(18,41),HY(19,40)
      ISN 0004                 INTEGER A(300)
      ISN 0005                 CALL ZERO(300,A)
      ISN 0006                 DO 1 I=1,N
      ISN 0007                 DO 1 J=1,M
      ISN 0008               1 A(II(I,J)+1)=1
      ISN 0009                 L=LL+1
      ISN 0010                 K=1
      ISN 0011               6 IF(A(K+1).NE.0)GO TO 2
      ISN 0013               5 L=L-1
      ISN 0014                 IF(K.GT.L)GO TO 7
      ISN 0016                 DO 3 I=1,N
      ISN 0017                 DO 3 J=1,M
      ISN 0018               3 IF(II(I,J).GE.K)II(I,J)=II(I,J)-1
      ISN 0020                 DO 4 J=K,L
      ISN 0021               4 A(J+1)=A(J+2)
      ISN 0022                 IF(A(K+1).EQ.0)GO TO 5
      ISN 0024               2 K=K+1
      ISN 0025                 IF(K.LT.L)GO TO 6
      ISN 0027               7 LL=L-1
      ISN 0028                 RETURN
      ISN 0029                 END

*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
*STATISTICS*     SOURCE STATEMENTS =      28 ,PROGRAM SIZE =      1816
*STATISTICS*  NO  DIAGNOSTICS GENERATED                                                 47K BYTES OF CORE NOT USED
****** END OF COMPILATION ******
```

```
6. LEVEL 21.8 ( JUN 74 )                      OS/360  FORTRAN H                                    DATE
        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                       C*****
     ISN 0002              SUBROUTINE SYMOPL(L,A,N,M,DELX,DELY)
                       C** A SYMMETRIC MATRIX A OF DIMENSIO L IS CONSTRUCTED.  BATHYMETRY IS GIVEN IN A
                       C** RECTANGLE N BY M WITH GRID SPACINGS DELX AND DELY. A STORED IN SYM. FORM.
     ISN 0003              COMMON II(18,40),HX(18,41),HY(19,40)
     ISN 0004              DIMENSION A(1)
     ISN 0005              CALL ZERO(L*(L+1)/2,A)
     ISN 0006              DX = 1./DELX**2
     ISN 0007              DY = 1./DELY**2
     ISN 0008              DO 1 I=1,N
     ISN 0009              DO 1 J=1,M
     ISN 0010              IJ=II(I,J)
     ISN 0011              IF(IJ.EQ.0.OR.IJ.GT.L)GO TO 1
     ISN 0013              IR = IJ+(IJ*IJ-IJ)/2
     ISN 0014              A(IR) = -(HX(I,J)+HX(I,J+1))*DX-(HY(I,J)+HY(I+1,J))*DY+A(IR)
     ISN 0015              IF(HX(I,J+1).EQ.0.)GO TO 2
     ISN 0017              I1 = II(I,J+1)
     ISN 0018              IF (I1.LT.IJ) GO TO 2
     ISN 0020              IR=IJ+(I1*I1-I1)/2
     ISN 0021              A(IR) = A(IR)+HX(I,J+1)*DX
     ISN 0022            2 IF(HX(I,J).EQ.0.)GO TO 3
     ISN 0024           10 I1 = II(I,J-1)
     ISN 0025              IF (I1.LT.IJ) GO TO 3
     ISN 0027              IR=IJ+(I1*I1-I1)/2
     ISN 0028              A(IR) = A(IR)+HX(I,J)*DX
     ISN 0029            3 IF(HY(I+1,J).EQ.0.)GO TO 4
     ISN 0031           11 I1 = II(I+1,J)
     ISN 0032              IF (I1.LT.IJ) GO TO 4
     ISN 0034              IR=IJ+(I1*I1-I1)/2
     ISN 0035              A(IR) = A(IR)+HY(I+1,J)*DY
     ISN 0036            4 IF(HY(I,J).EQ.0.)GO TO 1
     ISN 0038           12 I1 = II(I-1,J)
     ISN 0039              IF (I1.LT.IJ) GO TO 1
     ISN 0041              IR=IJ+(I1*I1-I1)/2
     ISN 0042              A(IR) = A(IR)+HY(I,J)*DY
     ISN 0043            1 CONTINUE
     ISN 0044              RETURN
     ISN 0045              END
*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
*STATISTICS*    SOURCE STATEMENTS =      44 ,PROGRAM SIZE =     1018
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                                          43K BYTES OF CORE NOT USED
```

```
LEVEL 21.8 ( JUN 74 )                          OS/360  FORTRAN H                                DATE

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,
                              SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF
                     C*****
      ISN 0002                 SUBROUTINE PRVTR1(JT,EVCT,EVAL,N,M,L)
      ISN 0003                 COMMON /A/IKEY
                     C** VALUES OF EIGENVECTORS ARE PRINTED IN PROPER LOCATIONS IN PLAN VIEW.
      ISN 0004                 COMMON II(18,40),HX(18,41),HY(19,40)
      ISN 0005                 DIMENSION EVCT(L),LK(200),ND(4)
      ISN 0006                 DATA ND/'ST  ','ND  ','RD  ','TH  '/
      ISN 0007                 F = SQRT(ABS(EVAL))/6.28319
      ISN 0008                 IF (F.GT.1.E-45) T = 1./F
      ISN 0010                 NT = JT
      ISN 0011                 IF (NT.GT.4) NT = 4
      ISN 0013                 PRINT 21, JT,ND(NT),T,F
      ISN 0014              21 FORMAT (/,1X,I3,A3,'PERIOD = ',E12.5,', FREQUENCY =',E12.5)
      ISN 0015                 SC=100.
      ISN 0016                 IF(IKEY.EQ.2)SC=10000.
      ISN 0018                 DO 1 I = 1,N
      ISN 0019                 DO 2 J = 1,M
      ISN 0020                 LK(J) = 0
      ISN 0021                 IJ=II(I,J)
      ISN 0022                 IF(IJ.EQ.0.OR.IJ.GT.L)GO TO 2
      ISN 0024                 LK(J) = EVCT(IJ)*SC
      ISN 0025               2 CONTINUE
      ISN 0026               1 PRINT 22, (LK(J),J=1,M)
      ISN 0027              22 FORMAT (1X,43I3,/,2X,43I3,/,3X,43I3)
      ISN 0028                 RETURN
      ISN 0029                 END

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=58,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,NOMAP,NOEDIT,ID,NOXREF

*STATISTICS*     SOURCE STATEMENTS =       28 ,PROGRAM SIZE =      1712

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                          43K BYTES OF CORE NOT USED

*STATISTICS*  NO  DIAGNOSTICS THIS STEP
```

```
F88-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED   NONE
          DEFAULT OPTION(S) USED -  SIZE=(96256,43008)
****USERPROG  DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET

DELX =  0.70300E 02, DELY =  0.70300E 02, AND GRAVITATIONAL CONSTANT =    32.20

CEL= C.18800E 01

GRID NUMBERING SCHEME FOLLOWS.

195195195195195195195195195195195  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
195194183172161150139128117106 95  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
195193182171160149138127116105 94  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
195192181170159148137126115104 93  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
195191180169158147136125114103 92  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
195190179168157146135124113102 91 84 82 80 78 69 60  0  0  0  0  0  0  0  0  0  0  0  0  0
195189178167156145134123112101 90 83 81 79 77 68 59  0  0  0  0  0  0  0  0  0  0  0  0  0
195188177166155144133122111100 89  0  0  0 76 67 58 51  0  0  0  0  0  0  0  0  0  0  0  0
195187176165154143132121110 99 88  0  0  0 75 66 57 50 44 38 36 34 32 30 24 18 12  6  0  0
195186175164153142131120109 98 87  0  0  0 74 65 56 49 43 37 35 33 31 29 23 17 11  5  0  0
195185174163152141130119108 97 86  0  0  0 73 64 55 48 42  0  0  0  0 28 22 16 10  4  0  0
195184173162151140129118107 96 85  0  0  0 72 63 54 47 41  0  0  0  0 27 21 15  9  3  0  0
195195195195195195195195195195195  0  0  0 71 62 53 46 40  0  0  0  0 26 20 14  8  2  0  0
  0  C  0  0  0  0  0  0  0  0  0  0  0  0 70 61 52 45 39  0  0  0  0 25 19 13  7  1  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

Fig 11

ER DEPTHS FOLLOW, MULTIPLIED BY 0.10000E 01

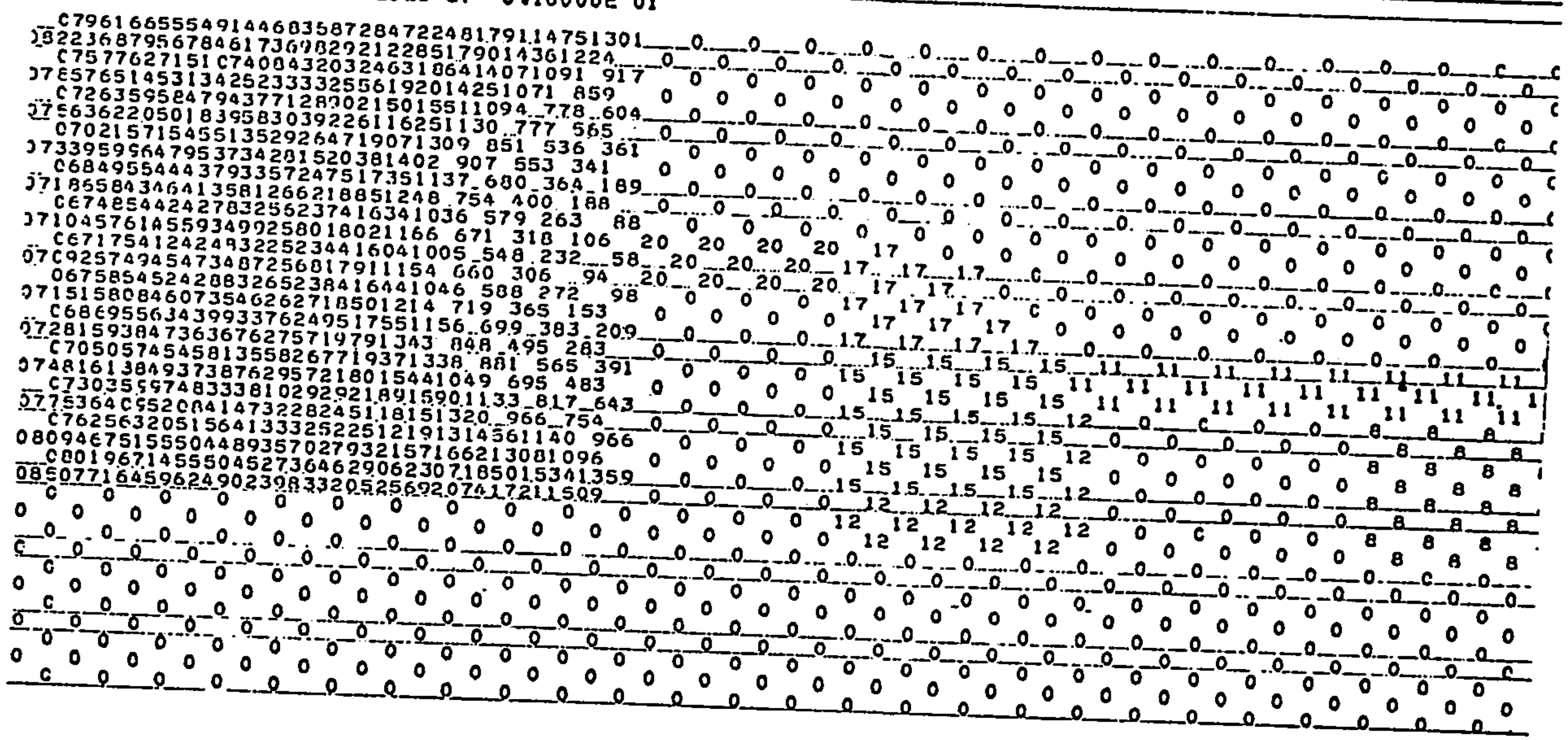
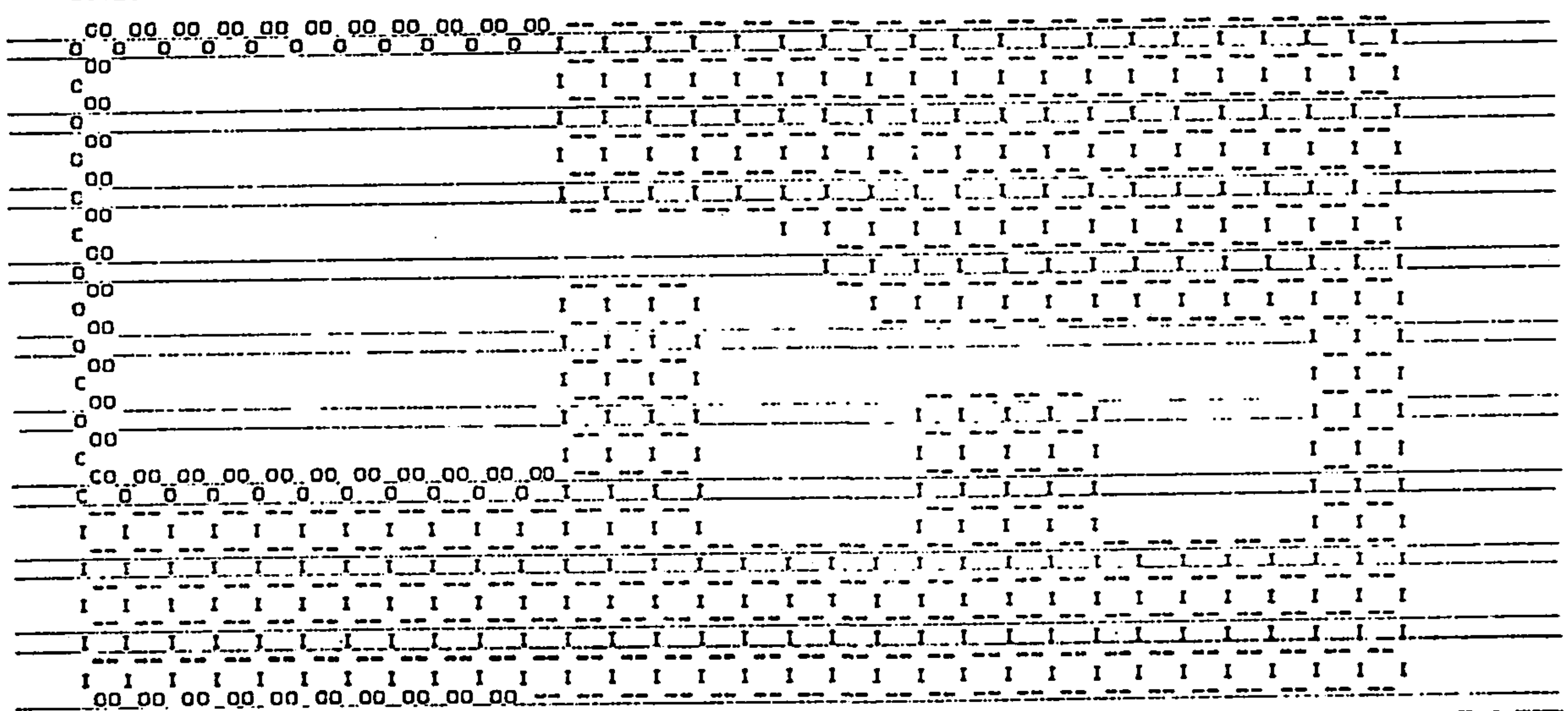


Fig 12

10

OUTLINE OF REGION FOLLOWS



MAX INTEGER = 194

Fig 13

11

P2 A

10 EIGENVALUES OF A FOLLOW

-0.32515E-03 -0.17611E-02 -0.11750E-01 -0.14665E-01 -0.18174E-01 -0.25053E-01 -0.36693E-01 -0.38860E-01

1ST PERIOD = 0.34845E 03, FREQUENCY = 0.28699E-02

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	7	14	20	25	29	36	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	7	14	21	28	33	36	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	37	40	43	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	40	43	47	52	60	67	74	80	86	90	93	95	96	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	43	45	48	52	60	67	74	81	87	91	94	95	96	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	45	46	48	50	0	0	0	0	93	94	96	97	97	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	46	47	48	49	0	0	0	0	96	96	97	98	98	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	47	48	48	48	0	0	0	0	97	98	98	99	99	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	47	48	48	48	0	0	0	0	98	99	99	99	99	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2ND PERIOD = 0.14972E 03, FREQUENCY = 0.66790E-02

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	15	28	41	51	58	71	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	15	28	42	56	64	70	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	68	71	73	75	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	77	77	75	67	51	33	13	-5	-23	-37	-46	-52	-55	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	83	83	82	79	72	52	33	13	-6	-28	-40	-49	-54	-57	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	89	89	88	86	84	0	0	0	0	-45	-50	-55	-59	-61	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	94	93	92	92	0	0	0	0	-56	-58	-61	-63	-65	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	97	97	97	96	96	0	0	0	0	-62	-63	-65	-67	-68	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	99	99	99	98	0	0	0	0	-65	-66	-67	-69	-69	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig 14

3RD PERIOD = 0.57964E 02, FREQUENCY = 0.17252E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	4	10	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	-2	3	14	36	67	90	99	95	79	61	47	36	30	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-12	-9	-2	8	27	64	89	98	91	67	49	35	25	20	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-20	-17	-12	-5	1	0	0	0	0	24	16	6	-2	-6	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-28	-26	-23	-19	-16	0	0	0	0	-14	-19	-26	-33	-37	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-35	-34	-31	-28	-27	0	0	0	0	-45	-49	-54	-59	-63	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-40	-39	-37	-35	-33	0	0	0	0	-62	-65	-70	-74	-77	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4TH PERIOD = 0.51885E 02, FREQUENCY = 0.19273E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	3	31	55	73	84	90	99	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	4	31	55	72	80	84	87	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	70	69	65	51	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	49	43	32	15	3	-5	-11	-16	-18	-19	-20	-22	-22	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	22	17	9	2	0	-5	-11	-15	-15	-16	-17	-18	-19	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-3	-5	-9	-14	-18	0	0	0	0	-5	-6	-6	-7	-8	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-28	-30	-33	-37	-40	0	0	0	0	6	5	5	4	3	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-47	-49	-52	-55	-59	0	0	0	0	16	16	15	15	14	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-60	-62	-65	-68	-70	0	0	0	0	22	22	21	21	20	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig 15

13

```
5TH PERIOD =  0.46607E 02, FREQUENCY = 0.21456E-01
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 8 14 18 20 21 19 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 8 14 17 19 18 16 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 16 14 8 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 13 10 3 -8-25-45-54-50-33 -7 24 57 84 99 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 10 7 0 -9-23-44-54-50-35-11 17 48 75 91 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 9 6 0 -6-12 0 0 0 0-22 -1 26 52 68 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 9 6 2 -2 -5 0 0 0 0-45-28 -2 22 37 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 10 7 4 0 -2 0 0 0 0-69-54-29 -6 8 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 10 8 5 1 0 0 0 0 0-84-70-46-23 -8 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

6TH PERIOD =  0.39696E 02, FREQUENCY = 0.25191E-01
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 -6-11-13-14-13 -8 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 -6-10-13-12 -9 -6 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 -8 -5 0 8 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 -6 -2 4 14 28 40 39 25 4-17-26-24-16 -9 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 -5 -1 5 14 25 39 39 25 2-23-29-21 -9 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 -7 -3 2 9 14 0 0 0 0-49-38-15 10 26 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0-10 -7 -2 2 6 0 0 0 0-62-40 -4 33 57 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0-14-11 -6 -2 0 0 0 0 0-67-38 7 54 84 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0-17-14-10 -5 -3 0 0 0 0-68-36 15 67 99 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

Fig 16

```
7TH PERIOD = 0.32801E 02, FREQUENCY = 0.30487E-01                  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  3 25 41 46 40 32-15  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  3 25 40 43 30 13-10  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  1  0  0  0 12 -2-25-48  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  4-10-33-54-63-43 -2 40 64 59 32 -4-40-61  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 -6-31-54-63-43 -2 39 62 51 27 -4-34-52  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0 27  8-20-48-64  0  0  0  0 23 11 -4-19-28  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0 52 31 -2-35-55  0  0  0  0 -9 -7 -2  2  6  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0 79 55 16-22-45  0  0  0  0-37-23  0 25 40  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0 99 73 31-11-36  0  0  0  0-54-32  2 38 60  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

8TH PERIOD = 0.31873E 02, FREQUENCY = 0.31374E-01               0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  3 27 43 48 42 35  3  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  3 27 42 44 28 16  2  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  1  0  0  0 -1 -6-13-20  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0-26-25-23-21-17-12 -4  5 12 12  8  0 -7-13  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0-45-38-26-15 -8 -9 -3  5 11 11  7  0 -6-11  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0-53-40-19  1 14  0  0  0  0  6  4  0 -3 -6  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0-53-34 -4 26 46  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0-50-26 12 52 79  0  0  0  0 -7 -4  0  4  7  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0-46-18 25 71 99  0  0  0  0-12 -7  0  7 11  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

15.

9TH PERIOD = 0.28961E 02, FREQUENCY = 0.34529E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	6	46	70	71	52	29	-93	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	6	46	68	64	31	-4	-55	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	2	0	0	0	-5	-23	-43	-41	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-21	-30	-35	-22	16	62	71	35	-21	-62	-58	-11	50	94	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-22	-26	-27	-16	11	61	70	34	-23	-69	-64	-20	38	78	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-7	-12	-18	-18	-13	0	0	0	0	-87	-72	-34	11	43	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	7	-6	-17	-23	0	0	0	0	-41	-37	-26	-10	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	27	6	-14	-26	0	0	0	0	39	23	0	-19	-30	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	44	17	-9	-25	0	0	0	0	99	70	24	-19	-45	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

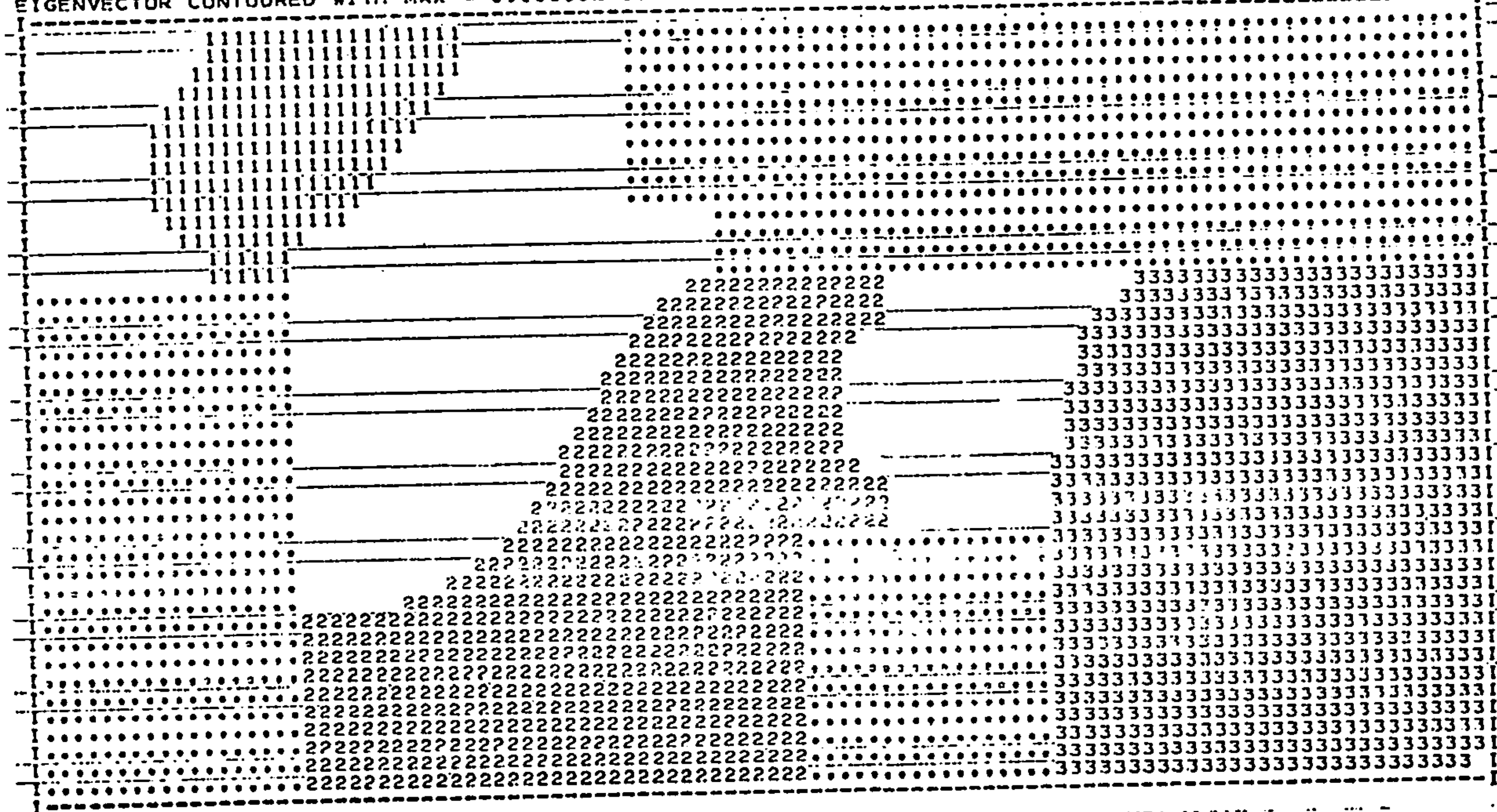
10TH PERIOD = 0.27022E 02, FREQUENCY = 0.37007E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	-2	-17	-26	-23	-13	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	-2	-17	-25	-22	-8	14	52	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-6	5	18	8	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-12	-6	-1	-5	-12	-6	5	14	14	7	4	9	18	25	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-19	-16	-14	-16	-17	-8	4	13	11	-2	-6	-1	7	14	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-17	-16	-16	-17	-19	0	0	0	0	-27	-27	-21	-13	-7	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-6	-7	-8	-9	-10	0	0	0	0	-25	-24	-22	-18	-14	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7	5	4	3	0	0	0	0	3	1	-1	-3	-3	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	20	18	16	15	0	0	0	0	30	26	19	14	10	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig 18

+3

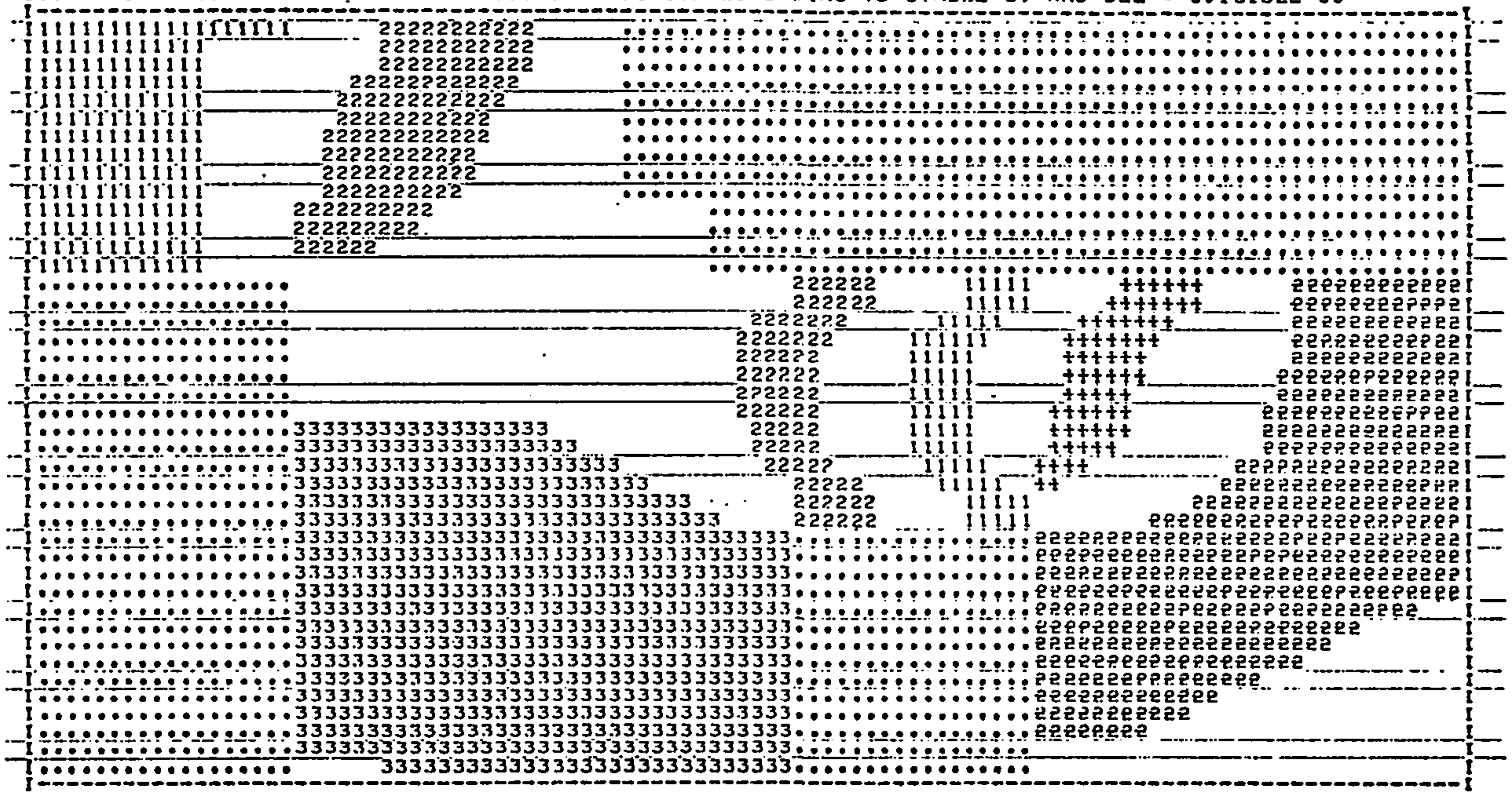
EIGENVECTOR CONTOURED WITH MAX = 0.10000E 01 CORRESPONDING TO SYMBOL 3, AND DEL = 0.18182E 00



PERIOD = 345.9231

Fig 2

EIGENVECTOR CONTOURED WITH MAX = 0.10000E 01 CORRESPONDING TO SYMBOL 3. AND DEL = 0.18182E 00

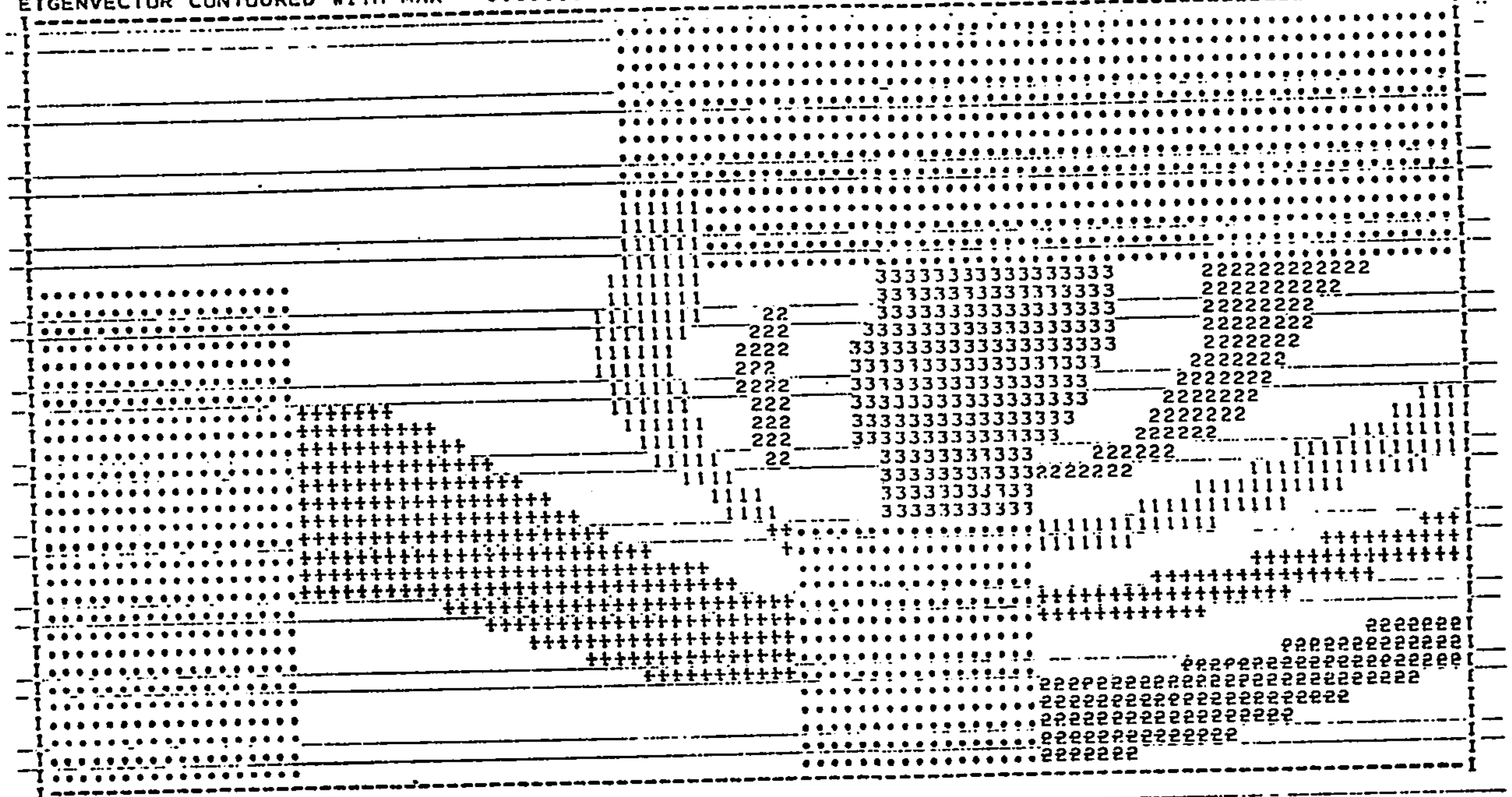


PERIOD = 148.8548

Fig 3

15

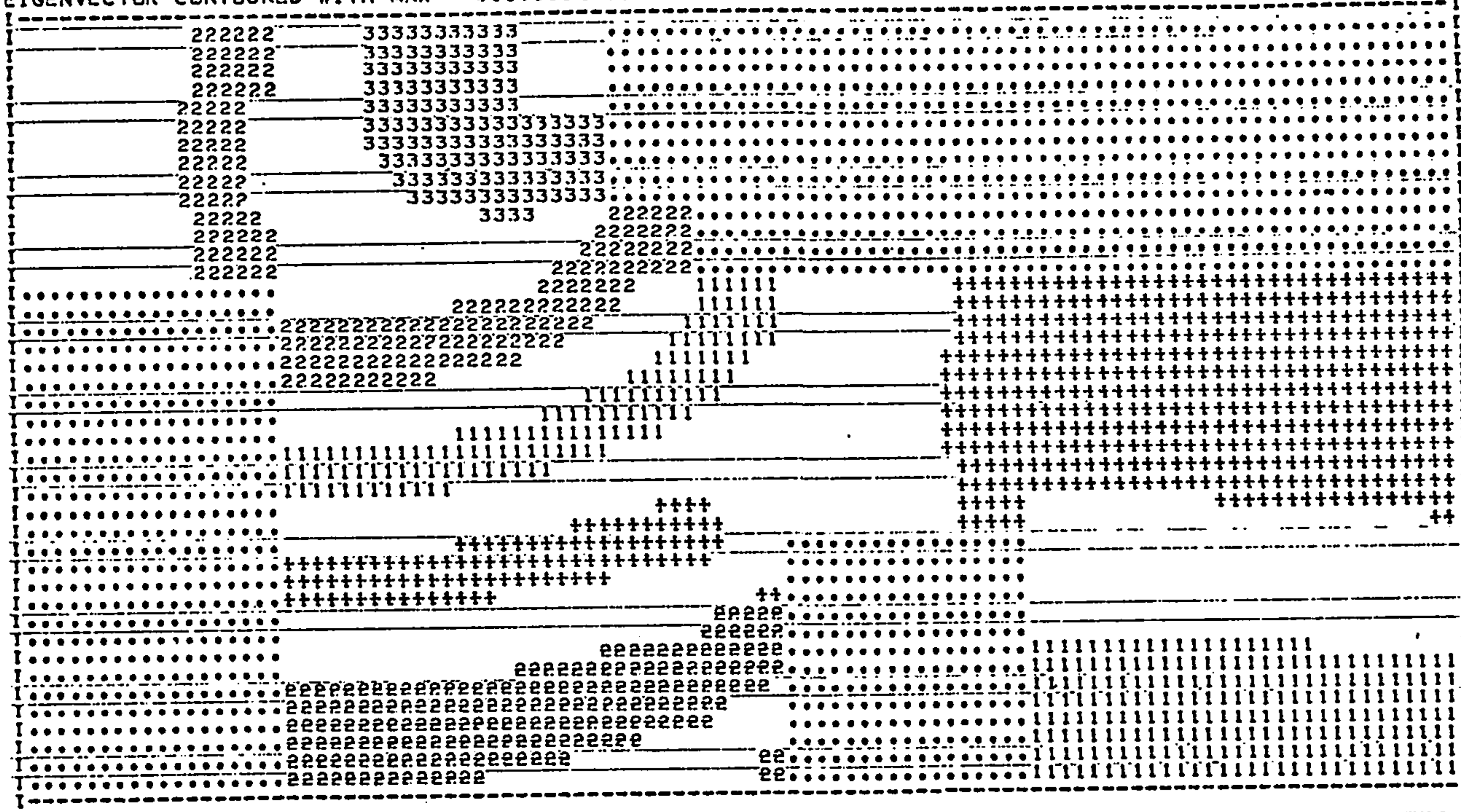
EIGENVECTOR CONTOURED WITH MAX = 0.10000E 01 CORRESPONDING TO SYMROL 3. AND DEL = 0.18182E 00



PERIOD = 57.9466

Fig 4

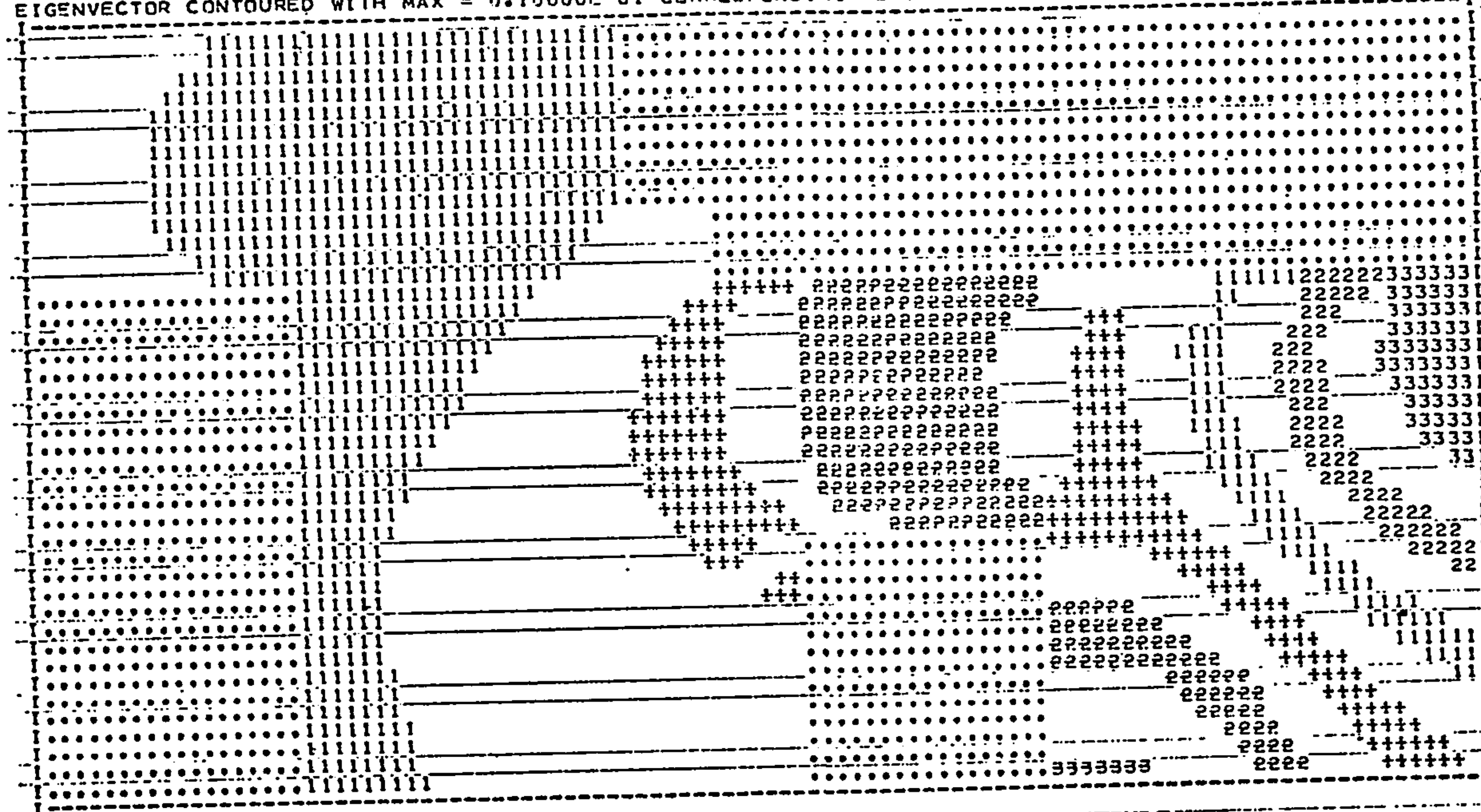
EIGENVECTOR CONTOURED WITH MAX = 0.10000E 01 CORRESPONDING TO SYMBOL 3, AND DEL = 0.18182E 00



PERIOD = 51.3644

Fig 5

EIGENVECTOR CONTOURED WITH MAX = 0.10000E 01 CORRESPONDING TO SYMBOL 3, AND DEL = 0.18182E 00



PERIOD = 46.4696

Fig 6

Appendix II. Normal modes of modification B.

1ST PERIOD = 0.68756E 03, FREQUENCY = 0.14544E-02

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	99	99	99	0
0	0	0	4	8	12	15	18	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	99	99	99	99	99
0	0	0	4	8	12	17	20	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	99	99	99	99	99
0	0	0	0	0	0	21	23	25	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98	98	98	98	99	99
0	0	0	0	0	0	24	25	27	29	34	40	47	53	59	65	70	73	76	79	82	84	87	89	91	92	94	96	97	99	98	98
0	0	0	0	0	0	26	27	28	30	34	40	47	53	60	66	70	74	77	79	82	84	87	89	91	92	94	95	96	97	98	98
0	0	0	0	0	0	27	28	29	30	31	0	0	0	0	71	73	75	78	80	82	85	87	89	91	92	94	95	96	97	97	97
0	0	0	0	0	0	29	28	29	30	30	0	0	0	0	74	75	77	79	81	83	85	87	89	91	92	94	95	96	96	97	97
0	0	0	0	0	0	28	29	29	29	30	0	0	0	0	76	76	78	79	81	83	85	87	89	91	92	93	95	96	96	97	97
0	0	0	0	0	0	29	29	29	29	30	0	0	0	0	76	77	78	80	81	83	85	87	89	91	92	93	95	95	96	97	97
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2ND PERIOD = 0.19372E 03, FREQUENCY = 0.51622E-02

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-67	-67	-68	-69	0
0	0	1	15	29	41	52	59	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-67	-65	-65	-66	-67	-69
0	0	1	15	29	43	57	66	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-62	-61	-62	-63	-65	-66
0	0	0	0	0	0	70	74	78	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-55	-54	-56	-59	-60	-62
0	0	0	0	0	0	79	81	93	86	87	86	83	79	74	68	62	56	50	43	34	24	14	4	-6	-17	-29	-42	-49	-53	-56	-57
0	0	0	0	0	0	85	87	88	89	90	87	84	79	74	67	61	56	49	43	34	24	14	4	-6	-16	-27	-37	-44	-48	-51	-52
0	0	0	0	0	0	91	91	92	93	93	0	0	0	0	62	59	54	48	41	33	24	14	4	-5	-15	-25	-33	-40	-45	-47	-48
0	0	0	0	0	0	95	95	95	96	96	0	0	0	0	59	57	53	47	40	32	23	14	4	-4	-14	-23	-31	-37	-42	-45	-46
0	0	0	0	0	0	97	97	98	98	98	0	0	0	0	58	56	52	46	40	32	23	14	5	-4	-13	-22	-29	-35	-40	-43	-44
0	0	0	0	0	0	99	99	99	99	99	0	0	0	0	57	55	51	46	39	32	23	14	5	-4	-13	-21	-28	-35	-39	-42	-43
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3RD PERIOD = 0.14193E 03, FREQUENCY = 0.70458E-02

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86	85	88	91	0
0	0	1	15	28	40	51	58	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86	83	82	84	87	91
0	0	1	15	28	42	56	63	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	73	74	77	80	83
0	0	0	0	0	0	67	70	72	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	57	61	66	70	72
0	0	0	0	0	0	75	76	75	72	62	43	20	-2	-24	-45	-60	-70	-75	-76	-74	-68	-58	-46	-30	-13	7	33	45	53	58	60
0	0	0	0	0	0	93	82	81	77	67	44	21	-2	-26	-50	-64	-72	-77	-78	-75	-68	-59	-46	-32	-15	2	20	33	41	47	48
0	0	0	0	0	0	89	88	87	85	82	0	0	0	0	-70	-75	-79	-81	-80	-77	-70	-60	-48	-34	-19	-3	11	23	32	37	38
0	0	0	0	0	0	94	93	92	91	90	0	0	0	0	-82	-84	-85	-85	-83	-78	-71	-61	-49	-36	-22	-7	5	16	24	29	30
0	0	0	0	0	0	97	97	96	96	95	0	0	0	0	-89	-90	-90	-88	-85	-80	-72	-63	-51	-38	-24	-10	1	12	19	24	25
0	0	0	0	0	0	99	99	99	98	98	0	0	0	0	-93	-93	-92	-90	-87	-81	-73	-63	-51	-39	-25	-12	0	9	17	21	22
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

II, 2

```
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
4TH PERIOD =  0.96075E 02, FREQUENCY = 0.10409E-01
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0-89-85-86-91  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0-88-81-79-79-83-91
 0  0  0  2  3  5  6  7  8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0-68-62-61-62-66-72
 0  0  0  2  3  5  7  8  8  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0-38-35-36-38-40-44
 0  0  0  0  0  0  8  8  8  7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  9  9  8  5  0 -7-16-23-30-34-35-33-28-21-10  0 11 20 25 25 18  0 -7 -9-11-12
 0  0  0  0  0  0 11 10  9  6  2 -7-16-23-30-35-36-33-28-21-10  1 12 21 28 30 28 22 18 17 18 20
 0  0  0  0  0  0 12 11 10  9  7  0  0  0  0-41-39-35-29-20 -9  2 14 24 32 37 40 40 40 42 45 49
 0  0  0  0  0  0 13 13 12 11 11  0  0  0  0-44-42-37-29-20 -8  3 16 27 37 45 50 54 58 62 67 73
 0  0  0  0  0  0 14 14 13 13 13  0  0  0  0-46-43-38-30-19 -7  5 18 30 41 50 58 64 70 76 83 91
 0  0  0  0  0  0 15 14 14 14 13  0  0  0  0-47-44-38-30-19 -7  5 19 31 43 53 62 69 77 84 91 99
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

5TH PERIOD =  0.72207E 02, FREQUENCY = 0.13049E-01
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0-24-17-10 -6  0
 0  0  0 -2 -3 -5 -6 -6 -7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0-24-21-15 -9 -5 -6
 0  0  0 -2 -3 -5 -6 -6 -6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0-19-16-10 -3  0  0
 0  0  0  0  0  0 -7 -6 -5 -2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0-15-13 -4  4 10 12
 0  0  0  0  0  0 -8 -7 -5  0  0 24 38 47 52 52 45 33 17  0-24-44-58-63-60-49-32-14  1 14 24 28
 0  0  0  0  0  0-10 -9 -6 -1  6 23 37 47 52 52 46 33 17  0-25-44-58-63-59-47-30-10  9 26 39 46
 0  0  0  0  0  0-12-11 -9 -6 -3  0  0  0  0 56 48 35 17 -3-26-45-57-62-57-44-26 -3 18 39 55 64
 0  0  0  0  0  0-14-13-12-10 -9  0  0  0  0 58 50 36 17 -4-26-45-57-60-55-41-21  2 27 50 69 80
 0  0  0  0  0  0-16-16-15-13-13  0  0  0  0 60 52 37 17 -5-27-45-56-59-53-39-17  7 34 59 79 93
 0  0  0  0  0  0-17-17-16-15-15  0  0  0  0 60 52 37 17 -5-27-45-56-59-52-37-15 10 38 64 85 99
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

6TH PERIOD =  0.56607E 02, FREQUENCY = 0.17666E-01
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 48 16-22-55  0
 0  0  0  1  1  2  3  3  7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 48 37 12-17-42-55
 0  0  0  1  1  2  2  4  6  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 39 30 10-12-31-41
 0  0  0  0  0  0  0  3  7 13  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 33 25 10 -7-22-29
 0  0  0  0  0  0 -3  0  6 17 38 69 91 99 92 74 54 38 26 19 15 15 21 27 31 33 29 22  9 -4-16-21
 0  0  0  0  0  0-10 -7  0 10 28 66 90 98 89 62 43 27 16 10  6  9 15 22 27 29 26 19  8 -3-13-17
 0  0  0  0  0  0-20-17-12 -5  1  0  0  0  0 18  9  0 -6 -9 -8 -3  4 13 20 23 22 16  6 -3-12-15
 0  0  0  0  0  0-29-27-24-19-17  0  0  0  0-20-24-29-32-31-27-18 -7  3 11 16 16 12  4 -5-12-16
 0  0  0  0  0  0-37-36-33-30-29  0  0  0  0-51-52-54-54-50-42-31-18 -5  4 11 12  8  1 -6-14-18
 0  0  0  0  0  0-43-41-39-37-36  0  0  0  0-67-68-68-66-60-51-39-24-10  0  7  9  6  0 -8-15-20
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

II.3

7TH PERIOD = 0.55582E 02, FREQUENCY = 0.17991E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	45	-16	-66	0
0	0	0	0	-1	-1	-1	-1	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	75	34	-12	-50	-66
0	0	0	0	-1	-1	-1	-1	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65	49	19	-14	-42	-56
0	0	0	0	0	0	-1	-1	-2	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	24	5	-18	-39	-52
0	0	0	0	0	0	0	0	-1	-4	-8	-14	-19	-20	-18	-14	-11	-9	-9	-9	-11	-13	-13	-12	-10	-6	-2	4	-4	-20	-35	-47
0	0	0	0	0	0	1	1	0	-2	-6	-14	-18	-20	-17	-11	-8	-6	-6	-7	-9	-10	-11	-10	-8	-6	-3	-1	-7	-16	-27	-35
0	0	0	0	0	0	4	3	2	1	0	0	0	0	0	0	1	1	0	-2	-4	-6	-7	-7	-6	-4	-1	-1	-3	-8	-13	-17
0	0	0	0	0	0	6	6	5	4	3	0	0	0	0	12	11	10	7	4	0	-2	-3	-4	-3	-1	1	2	3	2	2	3
0	0	0	0	0	0	8	8	7	6	6	0	0	0	0	20	19	17	13	9	5	2	0	0	0	1	4	7	10	13	16	22
0	0	0	0	0	0	9	9	8	8	8	0	0	0	0	25	24	21	17	12	8	4	1	1	1	3	6	10	14	19	25	33
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

8TH PERIOD = 0.52229E 02, FREQUENCY = 0.19147E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	27	61	99	0
0	0	1	10	18	24	28	30	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	5	19	44	72	99
0	0	1	10	18	23	26	28	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-10	-14	-3	11	24	34
0	0	0	0	0	0	23	23	23	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-50	-36	-28	-24	-25	-35
0	0	0	0	0	0	16	16	15	14	13	15	15	14	10	4	0	-1	-2	-2	-3	-6	-10	-16	-24	-32	-38	-41	-43	-47	-59	-82
0	0	0	0	0	0	6	6	5	5	6	13	15	13	9	2	-1	-2	-2	-2	-1	-2	-5	-10	-17	-24	-31	-36	-42	-51	-66	-91
0	0	0	0	0	0	-4	-4	-4	-5	-5	0	0	0	0	-6	-6	-5	-2	0	2	4	3	0	-5	-10	-16	-21	-26	-33	-44	-61
0	0	0	0	0	0	-14	-14	-15	-15	-16	0	0	0	0	-13	-11	-8	-3	2	7	11	12	12	9	5	2	0	-1	-2	-3	-4
0	0	0	0	0	0	-22	-22	-23	-23	-24	0	0	0	0	-17	-15	-10	-3	4	12	18	21	22	22	20	19	19	22	28	38	53
0	0	0	0	0	0	-27	-28	-28	-29	-29	0	0	0	0	-20	-17	-11	-2	6	14	21	26	29	29	29	29	32	38	48	64	89
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

9TH PERIOD = 0.51550E 02, FREQUENCY = 0.19399E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	-10	-23	-39	0
0	0	3	31	55	74	85	90	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	-1	-7	-17	-28	-39
0	0	3	31	55	72	80	84	86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	5	1	-3	-8	-12
0	0	0	0	0	0	70	69	64	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	13	11	10	11	16
0	0	0	0	0	0	52	49	42	29	10	-4	-15	-22	-24	-23	-21	-20	-19	-19	-18	-15	-11	-6	0	5	10	14	16	19	25	34
0	0	0	0	0	0	26	23	16	7	-2	-8	-16	-22	-23	-19	-16	-15	-15	-15	-14	-12	-9	-5	0	4	9	13	16	20	27	37
0	0	0	0	0	0	-1	-3	-8	-14	-19	0	0	0	0	-3	-3	-4	-5	-6	-7	-7	-5	-3	0	2	5	8	10	13	17	23
0	0	0	0	0	0	-25	-27	-31	-36	-40	0	0	0	0	12	11	9	6	3	1	0	-1	-1	0	0	1	1	1	0	0	0
0	0	0	0	0	0	-43	-45	-49	-53	-57	0	0	0	0	25	24	21	17	12	8	4	2	0	0	-1	-2	-4	-8	-12	-18	-25
0	0	0	0	0	0	-56	-58	-61	-64	-67	0	0	0	0	33	31	27	23	17	12	7	4	1	0	-2	-5	-9	-13	-20	-29	-41
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

II A

```
  0  0  0  0  0  0-43-45-49-55-5[illegible]
  0  0  0  0  0  0-56-58-61-64-67  0  0  0  0 33 31 27 23 17 12  7  4  1  0 [illegible]
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

 10TH PERIOD =  0.49637E 02. FREQUENCY = 0.20146E-01
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 32 13 -6-23  0
  0  0  0  8 14 19 21 22 23  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 32 22  9 -4-16-23
  0  0  0  8 14 18 20 20 20  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 12  8  3 -3 -8-12
  0  0  0  0  0  0 18 16 13  7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 -8 -6 -3 -1  0  0
  0  0  0  0  0  0 14 12  7  0-12-26-34-35-29-13  9 36 63 84 99 95 73 42  9-15-25-18 -9  1 10 14
  0  0  0  0  0  0  9  7  3 -3-12-26-34-35-29-18  2 29 56 76 88 83 61 30 -1-25-34-28-13  5 21 31
  0  0  0  0  0  0  5  3  0 -4 -8  0  0  0  0-33-16  9 37 58 69 61 39  9-20-41-47-37-16  9 33 48
  0  0  0  0  0  0  2  1 -1 -4 -6  0  0  0  0-55-40-14 13 34 43 36 14-14-42-60-62-47-19 13 43 63
  0  0  0  0  0  0  0  0 -2 -5 -6  0  0  0  0-76-61-35 -8 12 20 13 -7-35-61-76-74-55-22 16 51 74
  0  0  0  0  0  0  0 -1 -3 -5 -7  0  0  0  0-88-73-48-21  0  7  0-20-47-72-85-81-59-23 17 55 80
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

Appendix III. Normal modes of modifications C1.

MAX INTEGER = 193

10 EIGENVALUES OF A FOLLOW

-0.11123E-03 -0.11745E-02 -0.33427E-02 -0.46320E-02 -0.82318E-02 -0.10091E-01

1ST PERIOD = 0.634. E 03, FREQUENCY = 0.16795E-02

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	6	12	18	22	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	6	12	19	27	33	36	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	34	37	39	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	39	40	43	48	53	57	61	65	67	70	71	72	73	0	0	0
0	0	0	0	0	0	43	44	46	50	54	58	62	65	68	70	72	73	73	0	0	0
0	0	0	0	0	0	45	46	48	51	54	59	63	66	69	71	73	74	75	0	0	0
0	0	0	0	0	0	47	48	50	52	55	60	64	68	71	73	75	76	76	0	0	0
0	0	0	0	0	0	48	49	50	53	56	61	67	71	74	76	77	78	78	0	0	0
0	0	0	0	0	0	0	0	0	53	55	61	71	75	77	78	79	80	80	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	80	80	80	81	82	82	83	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	84	84	84	84	85	85	85	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	88	87	87	87	87	87	87	0	0	0
0	0	0	0	0	0	0	0	0	99	99	97	93	91	90	90	89	89	89	0	0	0
0	0	0	0	0	0	0	0	99	99	99	97	95	93	92	92	91	91	91	0	0	0
0	0	0	0	0	0	0	0	99	99	99	97	96	95	94	93	93	93	92	0	0	0
0	0	0	0	0	0	0	0	99	99	99	97	96	95	95	95	94	94	94	0	0	0
0	0	0	0	0	0	0	0	99	99	99	98	97	96	95	95	94	94	94	0	0	0
0	0	0	0	0	0	0	0	99	99	99	98	97	97	96	95	95	95	95	0	0	0
0	0	0	0	0	0	0	0	99	99	99	98	98	97	96	96	96	95	95	0	0	0
0	0	0	0	0	0	0	0	0	99	99	99	98	97	97	96	96	95	95	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2ND PERIOD = 0.154. E 03, FREQUENCY = 0.54544E-02

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	14	26	38	47	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	14	27	41	56	69	74	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	71	75	78	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	80	82	85	90	93	94	94	92	90	89	87	86	86	0	0	0
0	0	0	0	0	0	87	88	90	92	94	94	93	91	89	87	86	85	84	0	0	0
0	0	0	0	0	0	91	92	93	94	95	94	91	88	85	82	80	79	79	0	0	0
0	0	0	0	0	0	94	95	95	96	95	92	87	82	78	75	73	72	71	0	0	0
0	0	0	0	0	0	96	96	97	97	95	91	81	73	68	55	63	62	61	0	0	0
0	0	0	0	0	0	0	0	0	99	99	93	72	60	55	52	51	50	49	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	41	40	38	37	36	36	36	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	20	19	20	20	21	21	22	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	1	3	5	7	7	0	0	0
0	0	0	0	0	0	0	0	0	-92	-86	-74	-41	-26	-18	-12	-9	-7	-6	0	0	0
0	0	0	0	0	0	0	0	-92	-90	-84	-73	-55	-42	-33	-27	-23	-20	-19	0	0	0
0	0	0	0	0	0	0	0	-92	-90	-85	-76	-64	-54	-45	-39	-34	-31	-30	0	0	0
0	0	0	0	0	0	0	0	-94	-92	-87	-79	-71	-62	-54	-48	-43	-40	-39	0	0	0
0	0	0	0	0	0	0	0	-96	-94	-89	-83	-76	-68	-61	-55	-50	-47	-45	0	0	0
0	0	0	0	0	0	0	0	-98	-96	-92	-86	-79	-72	-65	-59	-54	-51	-49	0	0	0
0	0	0	0	0	0	0	0	0	-98	-94	-88	-81	-73	-66	-60	-55	-52	-50	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3RD PERIOD = 0.115. E 03, FREQUENCY = 0.92017E-02

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	12	23	33	40	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	12	24	35	47	57	60	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	58	60	61	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	63	63	62	58	49	36	22	8	-4	-16	-25	-32	-35	0	0	0
0	0	0	0	0	0	67	66	63	59	49	36	21	7	-6	-18	-27	-33	-37	0	0	0
0	0	0	0	0	0	70	68	65	60	51	36	19	3	-10	-22	-32	-38	-41	0	0	0
0	0	0	0	0	0	72	70	66	61	52	34	15	-1	-16	-28	-37	-44	-47	0	0	0
0	0	0	0	0	0	73	71	68	62	53	33	7	-10	-24	-35	-43	-49	-52	0	0	0
0	0	0	0	0	0	0	0	0	67	57	35	-7	-22	-32	-42	-49	-55	-58	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-38	-36	-41	-48	-54	-59	-62	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-43	-41	-44	-51	-57	-63	-65	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-39	-36	-42	-50	-58	-64	-67	0	0	0
0	0	0	0	0	0	0	0	0	92	75	50	-3	-21	-35	-47	-57	-64	-68	0	0	0
0	0	0	0	0	0	0	0	92	86	79	46	14	-9	-27	-43	-55	-63	-68	0	0	0
0	0	0	0	0	0	0	0	90	84	79	48	23	0	-21	-39	-53	-63	-68	0	0	0
0	0	0	0	0	0	0	0	91	85	71	52	28	4	-17	-37	-52	-63	-68	0	0	0
0	0	0	0	0	0	0	0	94	88	75	55	32	8	-15	-36	-52	-64	-70	0	0	0
0	0	0	0	0	0	0	0	99	93	79	59	35	10	-14	-36	-54	-67	-73			

4TH PERIOD = 0.92511E 02, FREQUENCY = 0.10973E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	10	18	26	31	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	10	19	27	36	43	44	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	43	44	44	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	46	45	43	36	24	9	-5	-21	-35	-47	-57	-64	-67	0	0	0
0	0	0	0	0	0	48	47	43	36	25	10	-5	-20	-35	-47	-56	-63	-66	0	0	0
0	0	0	0	0	0	50	48	44	37	27	11	-5	-20	-34	-46	-55	-61	-64	0	0	0
0	0	0	0	0	0	51	47	45	38	29	12	-5	-20	-33	-43	-51	-56	-59	0	0	0
0	0	0	0	0	0	52	50	46	40	32	12	-7	-21	-31	-39	-45	-50	-52	0	0	0
0	0	0	0	0	0	0	0	0	44	33	13	-15	-22	-28	-34	-38	-40	-42	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-25	-23	-24	-26	-28	-29	-30	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-20	-19	-17	-16	-16	-16	-16	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-11	-10	-8	-5	-2	-1	0	0	0	0
0	0	0	0	0	0	0	0	0	-49	-39	-25	-6	-3	1	6	11	14	16	0	0	0
0	0	0	0	0	0	0	0	-49	-45	-35	-23	-8	1	10	19	26	30	33	0	0	0
0	0	0	0	0	0	0	0	-45	-41	-32	-20	-6	7	19	31	40	46	50	0	0	0
0	0	0	0	0	0	0	0	-43	-39	-30	-17	-2	13	28	42	53	61	65	0	0	0
0	0	0	0	0	0	0	0	-42	-38	-29	-15	1	19	36	52	65	74	79	0	0	0
0	0	0	0	0	0	0	0	-43	-39	-20	-14	3	23	42	60	75	85	91	0	0	0
0	0	0	0	0	0	0	0	0	-43	-32	-16	3	25	46	66	82	94	99	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

73.6

5TH PERIOD = ~~0.69252E~~ 02, FREQUENCY = 0.14440E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	4	7	10	12	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	4	7	10	13	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	15	15	14	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	15	14	11	4	-5	-18	-32	-45	-58	-70	-80	-87	-90	0	0	0
0	0	0	0	0	0	16	14	11	5	-4	-16	-28	-40	-53	-64	-74	-81	-84	0	0	0
0	0	0	0	0	0	16	15	11	7	0	-8	-18	-28	-38	-48	-57	-64	-67	0	0	0
0	0	0	0	0	0	17	15	13	9	5	0	-5	-10	-17	-26	-33	-40	-43	0	0	0
0	0	0	0	0	0	17	16	14	12	9	6	9	10	6	0	-6	-12	-15	0	0	0
0	0	0	0	0	0	0	0	0	14	10	7	23	34	32	26	19	14	11	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	79	66	57	49	42	36	33	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	99	84	72	63	56	50	47	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	99	84	74	66	59	54	51	0	0	0
0	0	0	0	0	0	0	0	0	48	44	45	58	64	62	56	51	46	44	0	0	0
0	0	0	0	0	0	0	0	48	41	37	38	42	44	42	38	33	29	27	0	0	0
0	0	0	0	0	0	0	0	27	22	20	20	21	21	19	15	10	6	4	0	0	0
0	0	0	0	0	0	0	0	-2	-1	-1	0	0	-2	-5	-10	-15	-19	-21	0	0	0
0	0	0	0	0	0	0	0	-31	-26	-22	-21	-21	-24	-28	-34	-39	-44	-46	0	0	0
0	0	0	0	0	0	0	0	-53	-44	-39	-37	-37	-40	-45	-52	-58	-64	-67	0	0	0
0	0	0	0	0	0	0	0	0	-53	-46	-44	-44	-48	-54	-62	-69	-76	-79	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

66.5

6TH PERIOD = ~~0.62543E~~ 02, FREQUENCY = 0.15998E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-1	-1	0	0	2	4	6	9	12	14	16	18	19	0	0	0
0	0	0	0	0	0	-1	-1	0	0	1	3	5	8	10	12	15	16	17	0	0	0
0	0	0	0	0	0	-1	-1	-1	0	0	1	2	4	6	8	10	11	12	0	0	0
0	0	0	0	0	0	-1	-1	-1	-1	-1	0	0	0	0	2	4	5	6	0	0	0
0	0	0	0	0	0	-2	-1	-1	-1	-2	-3	-5	-5	-5	-3	-2	-1	0	0	0	0
0	0	0	0	0	0	0	0	0	-2	-2	-3	-9	-11	-11	-9	-8	-7	-6	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-22	-18	-15	-13	-12	-11	-10	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-23	-19	-16	-15	-13	-12	-11	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-17	-14	-13	-12	-12	-11	-10	0	0	0
0	0	0	0	0	0	0	0	0	99	72	44	4	-4	-7	-8	-8	-7	-6	0	0	0
0	0	0	0	0	0	0	0	99	80	59	35	13	1	-3	-4	-3	-1	0	0	0	0
0	0	0	0	0	0	0	0	59	49	34	20	7	0	-1	0	2	5	6	0	0	0
0	0	0	0	0	0	0	0	10	8	4	-1	-5	-6	-3	1	6	11	14	0	0	0
0	0	0	0	0	0	0	0	-37	-30	-26	-23	-19	-14	-7	1	10	18	22	0	0	0
0	0	0	0	0	0	0	0	-75	-60	-47	-41	-32	-22	-10	2	14	24	29	0	0	0
0	0	0	0	0	0	0	0	0	-75	-62	-51	-40	-28	-13	2	18	30	36	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

60.2

7TH PERIOD = ~~0.56508E~~ 02, FREQUENCY = 0.176[illegible]0E-01

7TH PERIOD = 0.[illegible] 02, FREQUENCY = 0.17670E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-1	-13	-24	-32	-37	-47	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-1	-13	-24	-32	-38	-42	-41	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-39	-38	-36	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-34	-31	-24	-8	8	20	27	27	22	13	2	-6	-11	0	0	0
0	0	0	0	0	0	-29	-24	-16	-4	10	22	29	29	22	12	0	-9	-15	0	0	0
0	0	0	0	0	0	-22	-18	-9	1	14	28	34	32	23	9	-4	-17	-24	0	0	0
0	0	0	0	0	0	-18	-13	-4	6	22	35	40	35	23	6	-11	-26	-35	0	0	0
0	0	0	0	0	0	-15	-10	-1	12	26	43	45	38	22	2	-18	-36	-45	0	0	0
0	0	0	0	0	0	0	0	0	15	35	57	48	39	21	-1	-25	-44	-55	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	54	41	21	-4	-30	-51	-62	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	54	41	20	-6	-33	-54	-67	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	52	39	19	-6	-33	-55	-67	0	0	0
0	0	0	0	0	0	0	0	0	-17	5	32	41	36	20	-3	-30	-51	-64	0	0	0
0	0	0	0	0	0	0	0	-17	-13	4	25	37	36	23	1	-24	-46	-58	0	0	0
0	0	0	0	0	0	0	0	-25	-19	-1	20	36	39	30	9	-15	-38	-51	0	0	0
0	0	0	0	0	0	0	0	-43	-33	-10	17	38	47	40	20	-6	-31	-45	0	0	0
0	0	0	0	0	0	0	0	-67	-51	-20	15	44	59	54	32	2	-26	-43	0	0	0
0	0	0	0	0	0	0	0	-95	-73	-31	16	55	76	72	46	8	-26	-48	0	0	0
0	0	0	0	0	0	0	0	0	-95	-41	21	73	99	94	60	11	-35	-63	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

59.2

8TH PERIOD = 0.~~54799~~E 02, FREQUENCY = 0.18249E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-2	-19	-35	-47	-54	-69	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-2	-19	-35	-47	-55	-61	-59	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-53	-53	-50	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-46	-42	-32	-11	7	20	24	19	7	-9	-26	-40	-48	0	0	0
0	0	0	0	0	0	-35	-30	-19	-3	13	25	28	23	10	-7	-25	-39	-47	0	0	0
0	0	0	0	0	0	-24	-18	-7	6	22	37	41	34	18	-1	-21	-37	-46	0	0	0
0	0	0	0	0	0	-16	-10	1	16	34	51	53	44	26	5	-16	-33	-42	0	0	0
0	0	0	0	0	0	-11	-4	8	27	47	67	63	51	32	10	-11	-28	-37	0	0	0
0	0	0	0	0	0	0	0	0	37	63	90	66	52	33	12	-8	-23	-32	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	60	45	28	9	-7	-20	-27	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	38	28	16	3	-8	-17	-22	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	9	7	1	-4	-10	-15	-17	0	0	0
0	0	0	0	0	0	0	0	0	14	-4	-24	-21	-13	-11	-11	-11	-10	-10	0	0	0
0	0	0	0	0	0	0	0	14	10	-3	-18	-24	-24	-21	-15	-9	-3	0	0	0	0
0	0	0	0	0	0	0	0	19	14	0	-16	-27	-31	-27	-17	-4	7	14	0	0	0
0	0	0	0	0	0	0	0	32	24	5	-15	-31	-38	-32	-17	2	20	31	0	0	0
0	0	0	0	0	0	0	0	50	38	12	-15	-38	-47	-39	-18	10	36	51	0	0	0
0	0	0	0	0	0	0	0	72	54	20	-18	-48	-60	-50	-20	17	53	74	0	0	0
0	0	0	0	0	0	0	0	0	72	27	-24	-64	-80	-67	-27	23	71	99	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

52.4

9TH PERIOD = 0.~~49349~~E 02, FREQUENCY = 0.20264E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	2	19	35	46	51	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	2	19	34	45	50	54	51	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	44	43	41	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	32	29	22	6	-3	-6	-3	2	8	14	18	20	21	0	0	0
0	0	0	0	0	0	15	12	5	-3	-10	-10	-5	0	7	12	15	17	18	0	0	0
0	0	0	0	0	0	0	-3	-9	-16	-21	-19	-10	0	6	9	10	8	7	0	0	0
0	0	0	0	0	0	-12	-15	-22	-29	-33	-28	-12	0	6	6	2	-2	-5	0	0	0
0	0	0	0	0	0	-20	-24	-32	-44	-40	-38	-9	7	10	4	-5	-14	-20	0	0	0
0	0	0	0	0	0	0	0	0	-64	-60	-55	9	26	20	6	-11	-26	-34	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	83	57	33	8	-16	-36	-47	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	99	68	38	7	-21	-43	-55	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	84	58	31	1	-25	-47	-59	0	0	0
0	0	0	0	0	0	0	0	0	-12	-4	5	24	30	16	-5	-28	-46	-56	0	0	0
0	0	0	0	0	0	0	0	-12	-8	-3	3	11	12	3	-10	-26	-39	-46	0	0	0
0	0	0	0	0	0	0	0	-5	-3	-1	0	1	0	-4	-11	-19	-25	-28	0	0	0
0	0	0	0	0	0	0	0	3	2	0	-3	-5	-7	-8	-8	-7	-6	-5	0	0	0
0	0	0	0	0	0	0	0	13	9	1	-6	-12	-14	-10	-3	6	15	20	0	0	0
0	0	0	0	0	0	0	0	24	17	3	-9	-19	-21	-14	0	18	35	44	0	0	0
0	0	0	0	0	0	0	0	0	24	5	-14	-28	-31	-20	0	27	51	65	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

49.9

10TH PERIOD = 0.~~46914~~E 02, FREQUENCY = 0.21316E-01

10TH PERIOD = 0.46914E 02, FREQUENCY = 0.21316E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	8	14	18	20	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	8	14	18	19	20	17	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	17	15	12	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	13	10	2	-12	-30	-47	-59	-66	-70	-69	-67	-65	-63	0	0	0
0	0	0	0	0	0	9	5	0	-11	-25	-40	-49	-55	-56	-55	-51	-48	-46	0	0	0
0	0	0	0	0	0	6	3	-1	-7	-15	-22	-25	-24	-22	-17	-11	-6	-3	0	0	0
0	0	0	0	0	0	5	3	0	-2	-4	-1	5	11	17	25	33	40	44	0	0	0
0	0	0	0	0	0	5	4	2	1	4	17	33	43	50	59	68	75	80	0	0	0
0	0	0	0	0	0	0	0	0	2	6	26	57	61	65	72	80	88	93	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	91	59	54	58	66	74	78	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	17	11	13	20	29	37	41	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-74	-49	-35	-25	-16	-9	-5	0	0	0
0	0	0	0	0	0	0	0	0	85	5	-73	-93	-80	-70	-61	-54	-49	-46	0	0	0
0	0	0	0	0	0	0	0	85	56	3	-47	-74	-89	-78	-75	-72	-70	-68	0	0	0
0	0	0	0	0	0	0	0	46	30	0	-31	-51	-60	-62	-63	-64	-65	-66	0	0	0
0	0	0	0	0	0	0	0	12	8	-2	-14	-22	-24	-26	-29	-33	-38	-42	0	0	0
0	0	0	0	0	0	0	0	-14	-9	-4	2	10	17	20	16	8	0	-6	0	0	0
0	0	0	0	0	0	0	0	-37	-24	-5	17	40	57	65	62	49	34	25	0	0	0
0	0	0	0	0	0	0	0	0	-37	-8	26	61	87	99	94	75	53	38	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix IV. Normal modes of modification C3.

IV.1

```
1ST PERIOD =  0.46060E 03, FREQUENCY = 0.21711E-02
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   1  10  20  29  37  42  53   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   1  10  20  30  41  48  53   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0  51  54  58  62   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0  58  60  63  67  72  77  82  85  88  90  92  93  94  95   0   0   0   0
  0   0   0   0   0   0  63  65  67  70  74  78  82  86  88  91  92  94  95  95   0   0   0   0
  0   0   0   0   0   0  67  69  70  73  75  80  84  87  89  91  93  94  95  96   0   0   0   0
  0   0   0   0   0   0  70  71  73  76  79  82  85  88  90  92  94  95  96  96   0   0   0   0
  0   0   0   0   0   0  72  73  75  78  80  84  87  89  92  93  95  96  96  97   0   0   0   0
  0   0   0   0   0   0  74  75  77  80  83  86  89  91  93  94  95  97  97  97   0   0   0   0
  0   0   0   0   0   0   0   0  86  86  87  89  91  92  94  95  96  97  98  98   0   0   0   0
  0   0   0   0   0   0   0   0  90  89  90  91  92  94  95  96  97  98  98  99   0   0   0   0
  0   0   0   0   0   0   0   0  92  92  92  93  94  95  96  97  98  98  99  99   0   0   0   0
  0   0   0   0   0   0   0   0  94  93  94  94  95  96  97  97  98  99  99  99   0   0   0   0
  0   0   0   0   0   0   0   0  95  94  94  95  95  96  97  98  98  99  99  99   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

2ND PERIOD =  0.10881E 03, FREQUENCY = 0.91904E-02
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0  -2-19-35-51-63-71-86   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0  -2-19-36-52-68-77-84   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0-80-93-85-85   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0-87-87-86-83-74-60-44-27-10   5  19  31  39  43   0   0   0   0
  0   0   0   0   0   0-91-90-87-82-74-60-43-26  -8   7  21  33  41  45   0   0   0   0
  0   0   0   0   0   0-94-92-88-82-74-58-40-22  -4  12  27  38  47  51   0   0   0   0
  0   0   0   0   0   0-96-93-88-80-71-54-36-17   1  18  33  45  54  58   0   0   0   0
  0   0   0   0   0   0-96-93-86-77-66-48-29-10   8  25  40  53  61  66   0   0   0   0
  0   0   0   0   0   0-97-93-85-71-59-40-21  -2  15  33  49  61  69  74   0   0   0   0
  0   0   0   0   0   0   0   0-58-54-44-29-12   5  23  41  56  68  77  81   0   0   0   0
  0   0   0   0   0   0   0   0-43-41-32-19  -3  13  31  48  63  75  84  88   0   0   0   0
  0   0   0   0   0   0   0   0-32-30-23-11   3  20  37  54  69  81  89  94   0   0   0   0
  0   0   0   0   0   0   0   0-24-22-16  -5   8  25  42  58  73  85  93  97   0   0   0   0
  0   0   0   0   0   0   0   0-20-19-12  -2  11  27  44  60  75  87  95  99   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

3RD PERIOD =  0.98574E 02, FREQUENCY = 0.10145E-01
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0  -4  -7-10-13-14-18   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0  -4  -7-10-13-15-17   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0-15-16-18-19   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0-16-16-17-19-22-27-33-39-45-51-57-61-64-66   0   0   0   0
  0   0   0   0   0   0-15-15-16-17-20-25-31-37-43-49-54-59-62-64   0   0   0   0
  0   0   0   0   0   0-13-13-13-13-15-19-24-30-37-43-48-53-56-58   0   0   0   0
  0   0   0   0   0   0-11-10  -9  -8  -8-11-16-21-27-34-40-45-48-50   0   0   0   0
  0   0   0   0   0   0  -9  -8  -5  -1   0   0  -4-10-16-23-29-34-38-39   0   0   0   0
  0   0   0   0   0   0  -7  -5   0   8  11  12   8   3  -3-10-17-22-26-28   0   0   0   0
  0   0   0   0   0   0   0   0  36  34  32  28  23  17   9   2  -4-10-14-16   0   0   0   0
  0   0   0   0   0   0   0   0  60  55  50  45  38  30  22  14   6   0  -3  -5   0   0   0   0
  0   0   0   0   0   0   0   0  79  73  66  59  50  41  33  24  16  10   6   3   0   0   0   0
  0   0   0   0   0   0   0   0  93  85  77  69  59  50  40  31  23  17  12  10   0   0   0   0
  0   0   0   0   0   0   0   0  99  92  83  74  64  54  44  35  27  20  16  13   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

4TH PERIOD =  0.75636E 02, FREQUENCY = 0.13221E-01
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   1  11  20  28  35  38  45   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   1  11  20  29  36  40  42   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0  40  40  39  36   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0  40  39  36  30  19   3-11-25-39-50-59-66-71-73   0   0   0   0
  0   0   0   0   0   0  40  38  33  26  17   3-11-24-37-47-55-62-67-69   0   0   0   0
  0   0   0   0   0   0  38  35  31  24  16   2-10-21-32-40-47-52-55-56   0   0   0   0
  0   0   0   0   0   0  36  33  28  20  13   1  -9-17-24-30-33-36-37-38   0   0   0   0
  0   0   0   0   0   0  35  31  24  15   7  -1  -8-13-15-16-16-16-15-15   0   0   0   0
  0   0   0   0   0   0  34  29  21   6   0  -7  -9  -8  -6  -2   1   5   8   9   0   0   0   0
  0   0   0   0   0   0   0   0-21-19-17-15-11  -4   3  11  20  27  32  35   0   0   0   0
  0   0   0   0   0   0   0   0-46-39-32-24-13  -1  11  24  37  47  54  58   0   0   0   0
  0   0   0   0   0   0   0   0-55-56-45-32-16   0  18  35  51  64  73  78   0   0   0   0
  0   0   0   0   0   0   0   0-78-64-54-37-18   1  23  43  61  76  87  92   0   0   0   0
  0   0   0   0   0   0   0   0-85-74-58-40-19   2  25  47  66  82  94  99   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

5TH PERIOD =  0.54981E 02, FREQUENCY = 0.18188E-01
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
```

IV.2

```
5TH PERIOD =  0.54981E 02, FREQUENCY = 0.18188E-01
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  2 17 31 42 49 52 57  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  2 17 31 41 47 50 51  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0 45 44 39 29  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0 38 35 28 16 -2-20-31-33-26-11  6 26 41 50  0  0  0  0
  0  0  0  0  0  0 29 25 17  5 -8-24-35-36-29-14  5 25 41 50  0  0  0  0
  0  0  0  0  0  0 19 15  7 -3-15-32-43-45-36-20  1 22 40 50  0  0  0  0
  0  0  0  0  0  0 11  7  0-10-22-39-50-51-43-26 -3 19 37 48  0  0  0  0
  0  0  0  0  0  0  5  1 -5-16-27-43-54-55-47-30 -8 14 33 43  0  0  0  0
  0  0  0  0  0  0  2 -1 -9-18-28-43-53-55-48-32-11 10 28 39  0  0  0  0
  0  0  0  0  0  0  0  0-21-16-23-36-46-50-45-31-12  8 25 34  0  0  0  0
  0  0  0  0  0  0  0  0  4  3 -7-22-35-41-39-28-11  6 22 31  0  0  0  0
  0  0  0  0  0  0  0  0 42 31 14 -5-21-31-32-24-10  6 21 29  0  0  0  0
  0  0  0  0  0  0  0  0 78 58 35 10 -9-22-25-20 -8  7 20 28  0  0  0  0
  0  0  0  0  0  0  0  0 99 74 47 20 -2-16-22-17 -6  7 20 27  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

6TH PERIOD =  0.50584E 02, FREQUENCY = 0.19769E-01
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0 -2-17-31-41-47-51-57  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0 -2-17-31-41-44-47-49  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0-37-38-37-32  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0-24-24-24-22-20-24-29-31-31-27-20-11 -4  0  0  0  0  0
  0  0  0  0  0  0 -5 -6 -6 -8-10-19-24-28-29-24-17 -8  0  3  0  0  0  0
  0  0  0  0  0  0 15 14 12  9  4 -5-14-20-22-17 -9  0  9 14  0  0  0  0
  0  0  0  0  0  0 34 32 30 26 20  8 -3-12-14-10 -1 10 21 27  0  0  0  0
  0  0  0  0  0  0 49 47 45 41 34 19  4 -5 -9 -4  5 18 30 37  0  0  0  0
  0  0  0  0  0  0 59 58 56 54 43 25  7 -5 -9 -4  7 22 35 43  0  0  0  0
  0  0  0  0  0  0  0  0 99 70 46 22  2-11-14 -9  4 21 36 44  0  0  0  0
  0  0  0  0  0  0  0  0 85 60 35 10-10-23-26-18 -3 15 31 41  0  0  0  0
  0  0  0  0  0  0  0  0 45 32 12 -8-27-38-40-30-13  7 25 35  0  0  0  0
  0  0  0  0  0  0  0  0  0  0-10-27-43-53-52-41-22  0 18 29  0  0  0  0
  0  0  0  0  0  0  0  0-28-20-26-40-53-61-60-48-29 -5 14 25  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

7TH PERIOD =  0.47690E 02, FREQUENCY = 0.20969E-01
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0 -1-10-18-23-26-27-26  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0 -1-10-18-23-24-24-22  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0-21-18-12 -2  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0-18-14 -5  8 31 55 70 74 67 51 31  9 -7-17  0  0  0  0
  0  0  0  0  0  0-15-10 -1 12 29 51 64 67 60 45 24  3-13-22  0  0  0  0
  0  0  0  0  0  0-13 -9 -1  9 21 39 50 51 42 27  7-12-28-37  0  0  0  0
  0  0  0  0  0  0-14-10 -4  3 11 23 29 27 18  4-12-28-40-47  0  0  0  0
  0  0  0  0  0  0-16-13 -7 -2  1  5  5  0 -7-17-29-38-45-49  0  0  0  0
  0  0  0  0  0  0-17-15-11 -7 -7-10-15-22-28-33-36-37-38-38  0  0  0  0
  0  0  0  0  0  0  0  0-15-10-13-21-30-37-40-39-33-25-18-14  0  0  0  0
  0  0  0  0  0  0  0  0  0  0-10-24-37-45-44-36-21 -4  9 18  0  0  0  0
  0  0  0  0  0  0  0  0 28 18  0-19-36-45-42-27 -5 20 41 53  0  0  0  0
  0  0  0  0  0  0  0  0 61 40 14-12-32-41-36-17 10 41 68 83  0  0  0  0
  0  0  0  0  0  0  0  0 82 54 23 -6-29-39-32-11 20 54 83 99  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

8TH PERIOD =  0.45920E 02, FREQUENCY = 0.21777E-01
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0 -1-11-20-26-29-30-34  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0 -1-11-19-25-26-27-28  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0-18-19-19-16  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0 -7 -8-10-11-12-16-15 -9  3 23 47 71 89 99  0  0  0  0
  0  0  0  0  0  0  8  5  2 -2 -7-15-18-14 -3 14 36 58 75 85  0  0  0  0
  0  0  0  0  0  0 24 21 15  7  0-15-24-27-22-10  6 24 39 47  0  0  0  0
  0  0  0  0  0  0 39 34 26 16  5-13-29-38-40-35-26-14 -4  1  0  0  0  0
  0  0  0  0  0  0 51 45 35 22  9-11-29-42-50-53-51-47-42-39  0  0  0  0
  0  0  0  0  0  0 59 53 41 25 11 -6-23-37-48-55-60-62-63-64  0  0  0  0
  0  0  0  0  0  0  0  0 26 17  8 -1-11-21-31-41-50-57-62-65  0  0  0  0
  0  0  0  0  0  0  0  0  3  1  3  4  4  1 -4-12-23-33-41-46  0  0  0  0
  0  0  0  0  0  0  0  0-25-15 -3 10 21 27 27 21 11  0 -9-14  0  0  0  0
  0  0  0  0  0  0  0  0-50-32 -9 14 35 49 55 52 44 32 22 16  0  0  0  0
  0  0  0  0  0  0  0  0-64-41-12 17 43 62 71 71 63 52 41 35  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

9TH PERIOD =  0.43434E 02, FREQUENCY = 0.23023E-01
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

9TH PERIOD = 0.13434E 02, FREQUENCY = 0.23023E-01.

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	14	24	31	34	35	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	14	24	30	30	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	20	19	17	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	7	6	5	3	0	-1	1	3	6	9	10	11	12	12	0	0	0	0	0
0	0	0	0	0	0	-9	-8	-7	-6	-5	-3	0	2	5	7	8	8	9	9	0	0	0	0	0
0	0	0	0	0	0	-25	-22	-18	-13	-10	-5	-1	0	2	2	2	1	1	0	0	0	0	0	0
0	0	0	0	0	0	-37	-33	-25	-17	-11	-4	-1	0	0	-2	-4	-5	-7	-8	0	0	0	0	0
0	0	0	0	0	0	-47	-40	-28	-14	-5	0	1	0	-2	-5	-9	-11	-13	-14	0	0	0	0	0
0	0	0	0	0	0	-52	-43	-26	-1	6	9	7	2	-2	-7	-11	-13	-15	-16	0	0	0	0	0
0	0	0	0	0	0	0	0	77	46	30	20	11	4	-2	-6	-9	-11	-11	-11	0	0	0	0	0
0	0	0	0	0	0	0	0	99	59	36	21	10	2	-2	-5	-5	-5	-3	-3	0	0	0	0	0
0	0	0	0	0	0	0	0	55	33	18	9	2	-2	-4	-3	-1	2	5	7	0	0	0	0	0
0	0	0	0	0	0	0	0	-25	-14	-10	-9	-9	-8	-6	-2	3	9	14	17	0	0	0	0	0
0	0	0	0	0	0	0	0	-85	-51	-32	-22	-17	-13	-8	-2	5	13	19	23	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

10TH PERIOD = 0.37322E 02, FREQUENCY = 0.26794E-01

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	14	23	28	28	26	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	13	23	25	23	17	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	13	7	-3	-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	6	0	-12	-28	-49	-65	-66	-54	-33	-9	11	26	36	40	0	0	0	0	0
0	0	0	0	0	0	2	-3	-14	-28	-42	-55	-55	-42	-23	-3	12	22	27	29	0	0	0	0	0
0	0	0	0	0	0	4	0	-8	-18	-25	-31	-25	-11	3	13	16	11	4	0	0	0	0	0	0
0	0	0	0	0	0	9	5	0	-5	-6	0	10	23	32	30	17	-2	-22	-34	0	0	0	0	0
0	0	0	0	0	0	15	12	8	5	9	23	39	51	53	41	16	-15	-45	-62	0	0	0	0	0
0	0	0	0	0	0	20	17	14	10	16	34	51	61	59	43	13	-22	-55	-74	0	0	0	0	0
0	0	0	0	0	0	0	0	-2	-1	10	26	41	49	48	34	9	-20	-48	-64	0	0	0	0	0
0	0	0	0	0	0	0	0	-49	-22	-5	5	14	21	23	18	5	-10	-26	-36	0	0	0	0	0
0	0	0	0	0	0	0	0	-45	-20	-15	-16	-16	-13	-7	0	3	4	3	2	0	0	0	0	0
0	0	0	0	0	0	0	0	26	11	-9	-30	-42	-44	-34	-17	1	19	32	38	0	0	0	0	0
0	0	0	0	0	0	0	0	99	45	0	-35	-55	-61	-49	-26	1	28	49	60	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

/-/-/-/-/-/-/ APPROXIMATE ACCOUNT STATUS --- UHCC ACCT.# 031

COMP CHRG = MUS * RATE + (READ+PRINT+PUNCH)
OUTPUT SUPP CHRG = PAGES * UNIT.COST +

	EFFECTIVE BUDGET	CHARGE FOR THIS JOB	AMOUNT U THIS FISCA
COMPUTER USAGE	$ 1907.95	$ 8.39	$ 1764.
SUPPLIES	$ 92.04	$ 0.07	$ 95.

/-

THE CHARGES SHOWN ABOVE REFLECT ONLY HASP/370 USAGE. OTHER CHARGES WIL

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